

Measuring the impact of quality infrastructure in Latin America: Experiences, achievements and limitations

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Editors



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This document was prepared by staff and consultants of the participating institutions: Sebastian Rovira, Economic Affairs Official of the Economic Commission for Latin America and the Caribbean (ECLAC), who was assisted by Daniela Montiel and Stephany Scotto; Jorge Goncalves, researcher at the Chair of Innovation Economics of the Berlin Institute of Technology, and Karl-Christian Göthner, consultant to National Metrology Institute of Germany (PTB). The studies herein were carried out by researchers and officials from various national institutes working in the area of quality infrastructure.

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Foreword

The possibility of advancing along more inclusive and sustainable development paths depends on a range of factors and elements that are not always taken into account and analyzed in depth by countries. The competitiveness of economies, as well as the chances of companies integrating themselves into value chains (both global and local), or the repercussions of economic activities on health and the environment, along with the issue of consumers' rights, are some of the critical factors that characterize societies and their development processes.

In this regard, the Quality Infrastructure (QI) is a concept that covers the whole spectrum of institutions, methods and procedures for codifying, analyzing, standardizing, measuring and evaluating different aspects of a product or production process. These include most notably metrology, standardization, technical regulation and compliance assessment and accreditation, in addition to management technologies and quality control, which are decisive factors for the type of development that can be pursued.

Of course, issues related to the services provided by the QI are generally dealt with and analyzed from a purely technical viewpoint, unrelated to public policy, and often without any real grasp of their importance.

This document, which is partly based on by the study *Impacto de la Infraestructura de la Calidad en América Latina*,¹ is a second joint effort by the Economic Commission for Latin America and the Caribbean (ECLAC) and the German National Metrology Institute (PTB) to move towards a more detailed understanding of the role played by the Quality Infrastructure in opening up possibilities for the countries in the region to innovate and compete. This book, which was made possible thanks to the financial support of The German Federal Ministry of Economic Cooperation and Development (BMZ), was put together with the technical support of the various regional institutions associated with the Quality Infrastructure, prominent among which were the National Institute of Industrial Technology of Argentina (INTI), the Brazilian National Institute of Metrology, Standardization and Industrial Quality (INMETRO), the Panama National Metrology Center (CENAMEP), the Peruvian

¹ Study conducted in 2011 thanks to the German Agency for Technical Cooperation through the German Federal Ministry for Economic Cooperation and Development (BMZ) and executed by GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) and the PTB.

National Institute for the Defence of Competition and the Protection of Intellectual Property (INDECOPI), and the Technological Laboratory of Uruguay (LATU).

Through methodological analysis and the realization of case studies at the national level in certain countries in the region, the document “Measuring the impact of the Quality Infrastructure in Latin America: Experiences, Achievements and Limitations” seeks to offer a more comprehensive picture of the impact of the Quality Infrastructure and its importance for the economic and social development of countries. The document analyzes various QI related aspects, with particular emphasis on a review of conceptual elements, the role of the QI in the innovation systems of countries and a brief analysis of a set of case studies in Latin American countries. It also identifies a series of challenges and limitations for carrying out impact studies. These elements are taken up again in the final conclusions of the book, where a number of policy recommendations are outlined.

The fundamental objective of this publication is to help deepen the awareness of the importance of the QI in various aspects of the economy and society, and to strengthen the leading role it must play in public policies. It is also hoped that it will serve as a stimulus for further impact studies in Latin American and Caribbean countries, thus making it possible to improve the functioning and positioning of the institutions that provide quality services in those countries. The QI is essential not only for countries to be able to compete and become integrated into global production chains, but also to guarantee certain quality standards for the people that consume or use the various goods and services.

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Part I
Introduction to quality infrastructure

I. Introduction to the quality infrastructure²

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A. What is meant by “Quality Infrastructure”?

Measuring, standardizing, and testing are important elements for assuring the quality of industrial products, and they form an essential technical basis for trade in goods and merchandise, the protection of the consumer, health and the environment. The elements that guarantee a certain level of quality have been developed over many centuries by various cultures and countries. They usually operate in an invisible manner, since manufacturers and consumers use components from this system on a daily basis without being fully aware of it. Some examples of this are the fact that screws screw properly into nuts, cell phones work and medicines contain the correct dose of substances.

In a globalized world with significant worldwide flows of goods and services, these elements of measurement, standardization, and testing are becoming increasingly important for the functioning of international trade. However, environmental protection, health services and food safety also demand a growing number of reliable standards, measurements, and tests. Standards support compatibility and can reduce costs through the use of common parts, specifications and methods; they are important for creating new industries and making use of the potential of new technologies; and they are decisive for accessing markets and maintaining a position within them.

In recent decades, quality-related concepts have gained importance, becoming the object of an increasing number of studies and scientific and technological definitions. At the same time, the business world and society find themselves in a process of rapid and constant change. World trade involves the exchange of goods and services that often serve as inputs for manufacturing other products; this means that goods must comply with certain characteristics in order for parts to fit and function as expected. The lifecycle of products has now become shorter and the pace of technological development is accelerating, so consumers are demanding increasingly high levels of safety, reliability

² Document published in ECLAC/PTB/GIZ (2011) “Impacto de la infraestructura de la calidad en América Latina”.

³ Consultant at PTB.

and sustainability and improved functioning of goods and services. All of this must be facilitated by standardization⁴ and an adequate institutional network.

But this does not just happen automatically or of its own accord. At the national, regional, international and corporate level, numerous organizations are involved in the process of developing standards and, particularly, in verifying that those standards have been implemented and that compatibility in processes, products, and services have been achieved. These organizations, which are linked together in numerous ways, need funds and require an appropriate authority, form a complex network of structures and activities.

Over the last few years, different acronyms have been used to refer to the various combinations of metrology, standards, testing, and quality assurance, accreditation and certification. Given that these different names have led to a great deal of confusion, more recently the term most frequently used has been Quality Infrastructure (QI)⁵, which has the advantage of highlighting the fact that a functioning society not only needs infrastructures related to transport, energy production and distribution, basic health and education services, but also an infrastructure that guarantees the quality of products and services.

In general, suppliers and buyers come to an agreement on the quality requirements of a product or service before the commercial transaction can be initiated. Once agreement is reached, the buyer must be certain that the product or service delivered conforms to the established requirements. To put it in more technical terms, the chain of proof facilitating the exchange begins with standards and is complemented by proof of conformity (conformity assessment), and can only be reliable if the technical capability of those providing these services is assured.

BOX 1

QUALITY INFRASTRUCTURE: DEFINITION AND OBJECTIVES

The quality infrastructure can be defined as the totality of the institutional network, of either public or private actors, and the legal framework that regulates it, which is responsible for formulating, editing, and implementing standards (for common and repeated use aimed at achieving the optimum degree of order in a given context, taking into account existing and potential problems), and providing evidence of compliance with them (the relevant combination of inspection, testing, certification, metrology and accreditation).

The objective of QI standards is to improve the appropriateness of products, processes and services for the desired ends, to prevent trade barriers and to facilitate technical cooperation.

Source: Produced by authors.

Over the last century, the services required to meet these needs have come to form the quality infrastructure at the national and international level, the individual or collective result of which is the following:

- Standards and Technical Regulations: correspond to the formalized documentation containing the requirements to which a product, process or service must conform. Standards are considered to be essentially voluntary in nature. Only if they are agreed in a contract does conformity become a mandatory requirement. If the State uses them as a basis for formulating and implementing technical regulations for reasons of health or safety of the population, then they become mandatory.

⁴ In Spanish, the terms “*normas*” and “*normalización*” are used to refer to standards and standardization, as they are in the Spanish version of this document, although sometimes in the scientific literature the terms “*estándares*” and “*estandarización*” are also used as synonyms for standards and standardization.

⁵ The term QI is used for example by the WTO or the EU. In the United States, the term “Infratechnologies” is employed, while others refer to it as the “Quality System”.

- Metrology: is the technology and science of measurement, which is normally subdivided as follows:
 - Scientific metrology, which describes and disseminates units of measurement,
 - Industrial metrology, which ensures the proper functioning of the measuring instruments used in production and calibration tests, and
 - Legal metrology, which ensures the accuracy of measurements in cases where they affect the transparency of economic transactions, and health and safety.
- Testing: determines the characteristics of the product in relation to the requirements of the standard. Tests can vary from a simple visual or non-destructive assessment (for example X-ray tests or pressure tests after which the products are still fit for use) to a totally destructive analysis (for example, chemical, mechanical, physical or metallurgical tests after which the products are no longer fit for use) or any combination of the two.
- Certification: is the formal verification that a product, service, management system of an organization, and/or the competence of an individual corresponds to the requirements of a standard.
- Inspections: include activities contracted by private customers, business organizations or State authorities to examine product designs, products, services, procedures or facilities, by means of which their conformity or non-conformity with the general or special requirements that exist in the form of laws, technical regulations, standards or specifications are assessed.
- Accreditation: is the activity that gives independent confirmation as to the competence of an individual or an organization that provides specified services (for example, calibration, testing, certification, inspections, etc.).
- Conformity Assessment: includes all the activities necessary to verify that a product, process, service, or the technical competence of an organization is in accordance with standards and/or special requirements (tests, certifications, inspections).

All these elements are interrelated and should, to a certain extent, give the buyer, user, or the authorities, the appropriate assurance that the product, process or service conforms to expectations.

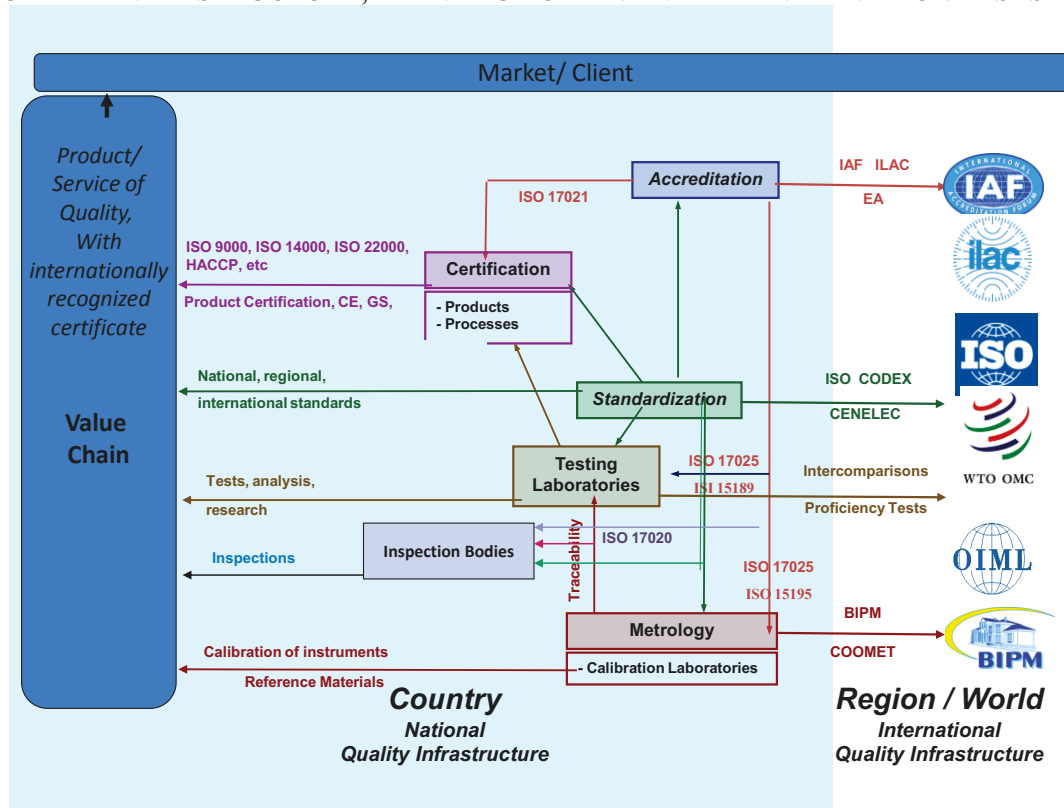
As supporting processes, quality management requires measurement, standardization and testing. This increases the acceptance of conformity assessments by accredited certification bodies. As a framework, it also requires an economic order that promotes quality, and a legal order that punishes violations of the technical regulations. To fulfil these functions, it is necessary to adequately train the people involved in the production and in the provision of services.

The following figure shows the relationship between the different organizations of the quality infrastructure. The fundamental element of analysis is the standards, which contain the requirements for the product or service. Standards can be national or international, or may even include a specific standard of a company.

Once it has been manufactured, the product must be evaluated by a testing laboratory, following which the certification body assesses the supplier and the product or service, and issues a certificate confirming the conformity to the standard.

With the help of metrology (calibration certificates), the testing laboratory can ensure that the measuring equipment is in accordance with standards; thus, with the aid of accreditation (accreditation certificate) proof of the laboratory's technical competence is provided.

DIAGRAM 1
THE INTER-RELATIONSHIPS BETWEEN THE DIFFERENT COMPONENTS OF THE
QUALITY INFRASTRUCTURE, THE VALUE CHAIN AND THE INTERNATIONAL SYSTEM



Source: ECLAC -PTB 2011, completed by the author.

At the international level, there is a range of organizations that have been set up (such as ISO, ILAC, IAF, OIML, BIPM) and that include the authorized national organizations as members. In this way, it is possible to promote a common understanding and mutual recognition of the performance of the quality system throughout the world. Consequently, it is possible to speak of a National Quality Infrastructure that is a part of, and is closely linked to, an International Quality System.

B. Public and private actors and the role of the State

The QI is a network of many elements that are of importance to various aspects of economic, social and scientific development. It is a system with a large number of actors ("stakeholders") or interested parties, including:

- the government with its regulatory agencies,
- micro, small, and medium enterprises (MSMEs) and large companies producing goods,
- trade,
- services,
- testing and calibration laboratories, clinical laboratories,
- consumers and consumer protection NGOs (non-governmental organizations),
- environmental NGOs,

- the academic world, and
- research, development and innovation institutions

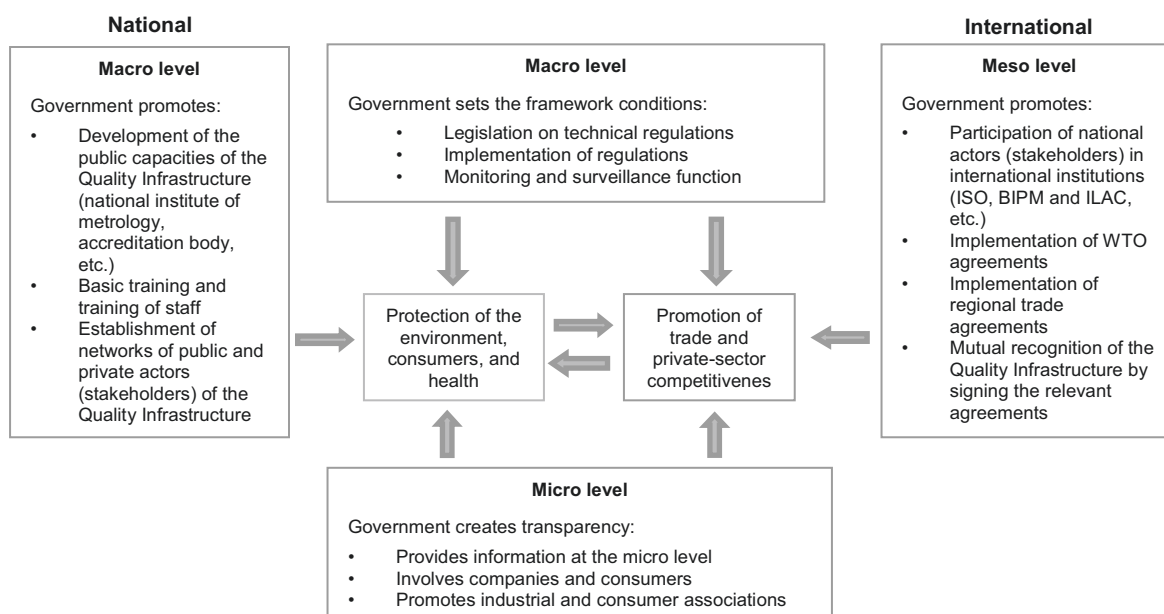
A large number of public and private actors are involved in the development of QI services. This leads to the discussion about the role and responsibility of the different actors in the system.

Although a widely accepted definition has not yet been reached, there is a growing consensus that the QI largely represents a public good to which everyone must have free access, and with regard to which the role of the State is to prevent possible market distortions, that is to say, to guarantee access to the QI, its services and information. This refers especially to National Metrology Institutes as an essential part of the system, which requires high investments to be set up and high operational costs to be maintained.

The principles of accreditation —technical competence, credibility, accessibility, impartiality and transparency— are valid for the entire network and need State intervention. These elements are part of the good governance of the State, vested with the special power to develop the legal and institutional framework that forms the basis for the development of the system and its components, in accordance with international standards and best practices. It is also a function of the State to regulate issues related to the measurement system in place, to regulations and standards on environmental, health and safety issues, as well as to the responsibilities of public and private organizations. The State must also ensure compliance with the requirements arising from international conventions, for example of the WTO. In short, States that have efficient public structures, which include many institutions related to the quality infrastructure, are better able to articulate the interests of their population in the design framework of overall policy and to implement the appropriate international regulations to ensure compliance with certain quality standards.

Given that the system has many stakeholders, the art lies in involving them according to their interests in the elaboration and development of the system and its legal and institutional framework. The responsibilities of the State, in particular, are shown in diagram 2.

DIAGRAM 2
THE GOVERNMENT'S RESPONSIBILITY FOR THE QUALITY INFRASTRUCTURE AT THE MACRO, MESO AND MICRO LEVELS



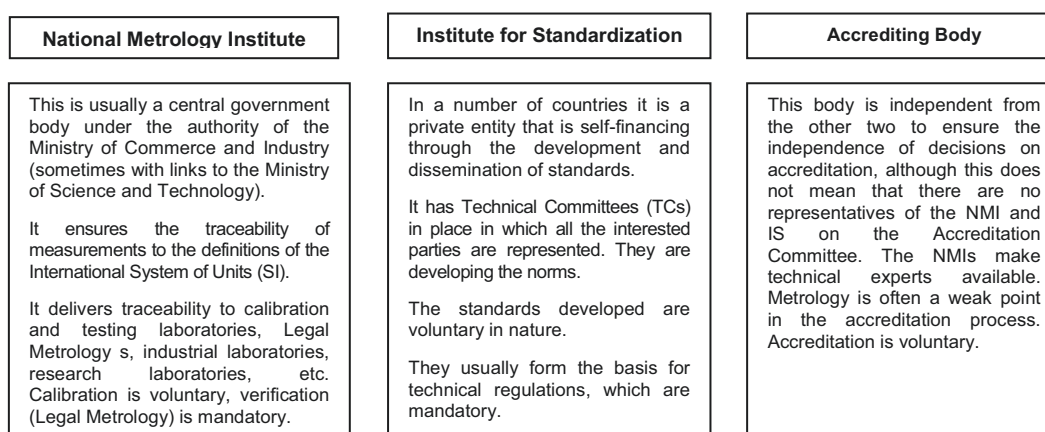
Source: ECLAC-PTB, 2011.

There are three basic elements at the heart of the system (see diagram 3). In most countries, the National Metrology Institute (NMI) is a State institution with its own line item in the State budget. If the NMI is managed by the private sector, there is usually a contract defining its obligations. On the other hand, in many countries the Institute for Standardization (IS) is a private institution, but with State participation on the Board of Directors. Finally, in many countries the Accreditation Body (AB) is a private entity, but also with State participation, and its activity is regulated by the legal framework of the QI.

In summary, there are a number of basic conditions that ensure proper functioning, in accordance with international standards and national interests:

- The political independence of the three institutions.
- The transparency of their activities and decisions.
- The technical competence of their members at all levels, and
- The participation of stakeholders in the development of institutional policies.

DIAGRAM 3
THE THREE BASIC PILLARS OF A NATIONAL QUALITY INFRASTRUCTURE



Source: ECLAC-PTB, 2011.

Scientific and industrial metrology in particular is considered a public good⁶ for the following reasons:⁷

- The fixed costs of custody and development of national measurement standards, which ensure traceability to the international system of units (SI), are relatively high (national standards of measurement, environmental conditions, qualified personnel, among others), but the marginal costs of disseminating acquired knowledge to users are low.
- In addition, the applicability of results is highly generic (non-rivalry in consumption), which is why all users (consumers, SMEs, large companies, State regulatory agencies, etc.) must be guaranteed access to national measurement standards, without exclusion or monopoly. Due to the high costs of metrology (in particular for SMEs), access to

⁶ Musgrave and Musgrave (1979).

⁷ See for example P. Swann (2009) and G. Tassej (2008).

extremely precise primary standards is difficult and very expensive, and the State must therefore intervene to correct market errors.

For this reason, some metrology institutes, such as the NIST (USA) or the PTB (Germany), as well as INMETRO (Brazil), are funded by the State (either through the State budget or projects) since they contribute to the competitiveness of their national economies and protect the health and improve safety for their inhabitants. The experiences of countries where custody of national standards has been handed over wholly or partially to the private sector (for example the United Kingdom, Denmark, Chile) show that the State is obliged in particular to finance the establishment of national standards and their maintenance on the basis of contracts with private entities, which set out the duties of the two parties: the State and the private entity. In many cases, the contracts define a monitoring system to assess the compliance with the contract and the performance of the contracted institution.

The **private business sector** is also a key player in the system. Its demands and specific needs by and large determine the development of the different components of the QI system. The greater the number of local companies that have access to an internationally recognized national QI, the greater the participation it will have in stimulating economic development through global trade. Without its consultation and its participation on the board of directors of the various institutions, there is a danger of the system developing in a direction that does not correspond to national needs and requirements. In this context, it is necessary to remember that the lack of sustainability in the development of SMEs is often due to the fact that this inherent part of business management has been forgotten and that these companies do not have a solid relationship with the development of the QI.

Other important factors are the **testing and calibration laboratories**. Many countries have set up their own networks and partnerships in order to better influence the development of the system. They are usually well acquainted with the problems of their customers (companies, governments, NGOs) and have a technical competence that is indispensable.

Particularly in high-income countries, but in some other countries too, **consumer and environmental protection organizations** have gained strength and technical competence. In some cases, they have their own testing laboratories, or in other cases they contract competent laboratories to assess the quality of products and services and environmental quality. As representatives of the consumers and inhabitants of a country, they can and must be an import stakeholder in the system.

An established and internationally recognized national quality infrastructure constitutes the heart of a national quality policy and can be applied to all parameters of products and processes. In times of globalisation, and with the growing complexity of the quality infrastructure, this does not mean that every country must develop a complete structure. What is necessary is to have a policy that facilitates the access to quality services, particularly for SMEs, either within the country or in neighbouring countries. Taking into consideration the complexity of the QI, and the amount of investment needed, coordination and cooperation between countries, particularly from different regions of the world, is now more essential than ever.

A quality infrastructure promotes sustainable development, especially through:

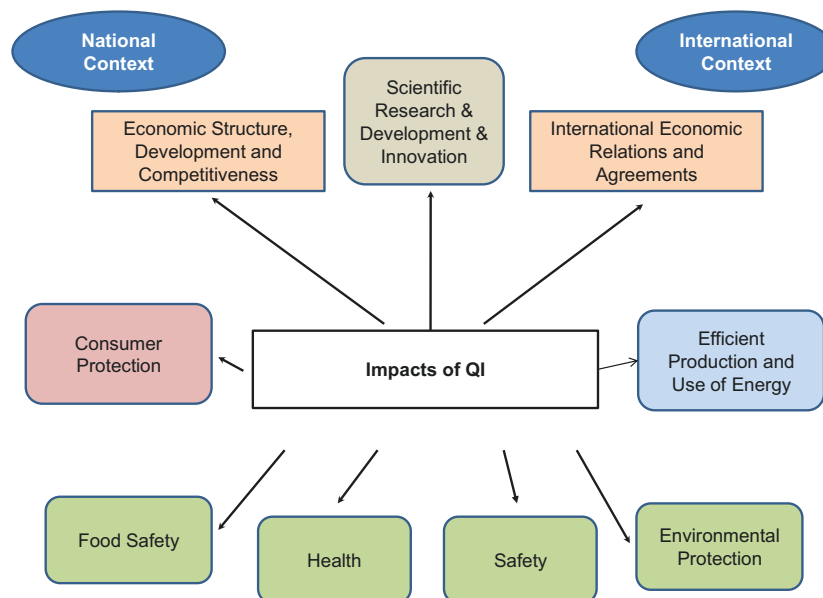
- the establishment of a national regulatory framework and through the provision of associated services, by specialized institutions;
- the strengthening of the private-sector economy, with an improvement in the competitiveness of companies;
- the defence of consumers' interests;
- the protection of the environment to ensure favourable conditions for human life, flora and fauna; and
- the establishment of the preconditions for the integration of countries into the system of global trade on an egalitarian basis.

C. The economic, social and environmental impact of the quality infrastructure

The demand for QI services arises from many fields of economic and social development, consumer and environmental protection. Food Safety, drinking water, efficient energy use, the realization of commercial transactions in the internal and external market, technological innovation, consumer protection on fraud related with weight, volume and quality, and from products and substances that are hazardous to health cannot be achieved without measurements, standards and technical regulations (see diagram 4).

Thus, the positive or negative, direct and indirect impact of the Quality Infrastructure, its various components, and the interrelationship between them, must play a leading role in productive, economic and social development concepts and policies.

DIAGRAM 4
DEMAND FOR THE SERVICES OF THE NATIONAL QUALITY INFRASTRUCTURE



Source: ECLAC-PTB, 2011.

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II. Quality infrastructure and innovation

Jan Peuckert,⁸ Taynah Lopes de Souza⁹ and Axel Mangelsdorf

The strong link between social institutions of quality assurance and innovations is not immediately evident for many. In the following it shall be argued that the services of standardization, metrology, conformity assessment and accreditation that are provided by the national quality infrastructure are important drivers of new social and technological developments. All elements of quality infrastructure contribute to the ability of a society to cope with varying challenges in a changing environment by creating and diffusing new technologies.

A. Introduction

A national quality infrastructure is composed of various institutional elements that are complexly interlinked and highly interdependent. In the following, we will demonstrate its impact on innovation processes by illustrative examples for each quality infrastructure element. It should however be noted that no quality infrastructure service could effectively work without the other complementary elements.

The term innovation frequently leads to misunderstandings because of its manifold interpretations. Innovation has many aspects that make defining it a difficult, but indispensable task. Although there are other important dimensions to innovation, here we focus primarily on technological change. According to the definition of the Oslo Manual technological innovations “comprise implemented technologically new products and processes and significant technological improvements in products and processes” which “involve a series of scientific, technological, organisational, financial and commercial activities” (OECD, 2005: 31). In the following, we generally refer to this definition, but we extend our considerations to innovation categories discussed for example by Schumpeter (1934), such as

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the opening of new markets, the conquest of new sources of supply, or the re-organization of industries, that go beyond the narrow firm-level focus of the Oslo Manual.

B. Standards and innovation

At first sight, standardization and innovation appear to be complete antipodes. Standards describe the current state of the art, whereas innovations are defined in opposition to the standard way of doing things. Nevertheless many innovations would never happen without the prior agreement on standards, because innovation as a collaborative process needs a common language for interaction in the exchange of ideas. The coordination from standards helps the diffusion of knowledge and the application of new solutions.

From pure basic research over the different phases of development to market diffusion of new technologies, standards take different roles in the innovation process (Blind and Gauch, 2009). Terminology (or semantic) standards are required for efficient communication and play a crucial role in the transfer of knowledge from basic to oriented-basic and applied researches. Besides codified knowledge, R&D activities involve a considerable share of tacit knowledge which is at least partially transferred and further developed through standardization. Measurement and testing standards support the progress towards first product-related developments. Interface standards and compatibility standards allow the interoperability of components, between products or whole systems. The transition of pilot products into mass markets requires minimum quality standards that guarantee that the products comply with regulations and lead user demands. The broad diffusion of new products is fostered by variety-reducing standards, which allow the exploitation of economies of scale, and by compatibility standards generating positive network externalities among users.

Blind and Gauch (2009) argue that developments of innovative products solely driven by science and technology pushes are running into the problem of being of little relevance and of being not accepted by customers and consumers. Standards developed within open standardization processes allowing not only the participation of researchers and companies, but also the active involvement of the demand side, i.e. of practitioners and consumers or consumer organizations, increase the likelihood of innovations to be successfully introduced into the market.

The importance of standards for innovation can be illustrated by the example of nanotechnology. The German federal government promoted research in nanotechnologies already since the early 90's and even more intensively since 1998. Nevertheless, in 2004 the German Federal Ministry of Education and Research realized that Germany, despite substantial public investments in nanoscience and a strong growth in scientific publications and patent applications, was lagging behind in the field of nanotechnology-based products and industrial applications (BMBF, 2004).

The lagging start of German standardization activities helps to understand this relative underperformance. According to Blind and Gauch (2009), German researchers in nanotechnology perceived that the procedures in formal standardization processes did not correspond to the dynamics in their emerging technology and that there was a discrepancy between the large public investments in nanotechnology research and the rather delayed standardization activities in this field compared to other countries like the USA, the UK and China.

The nanotechnology case demonstrates the importance of defining a standardization strategy early at the beginning of the research and innovation process. In a structured approach, politics and business via its representative organizations must identify those sectors with the highest development and growth potential. In these sectors, key positions at operational and management levels in the standardization field should be filled by suitably trained and qualified experts. Meanwhile, the German standardization strategy promotes standardization as an integral part of the technical innovation process and related R&D activities in order to support German innovations to gain a rapid foothold in regional and global markets. Schemes to foster standardization at the R&D stage, pilot

projects, and information platforms have been established to improve the transfer of knowledge and technology between industry, research and higher education.

C. Metrology and innovation

Metrology is the element of the quality infrastructure that provides confidence to the measurement processes involved in any other element of that infrastructure. A sound metrological basis is ensured by a national metrology institute (NMI), which will then work in synergy with the other branches of the quality infrastructure.

The provision of measurement standards is considered as having an inductive nature by Gregersen (1992), an argument that finds support in the analysis provided by Swann (1999, p. 36), according to whom: “Publicly funded measurement systems encourage the sorts of innovation by outsiders that disrupts this stability and familiarity. So while measurement competes for part of the innovation budget, it must be seen as a complementary activity to innovation. Without necessary measurement techniques, there can be no success in innovation”.

An example of a successful innovation that is directly affected by advances in the metrology element of quality infrastructure is the global positioning system (GPS). Today, the GPS has spread to different fields of utilization and its usage has now reached a significant part of enterprises and consumers all over the world, for being a tool of multiple functions: essential for aviation, used for displacements in the city or in the countryside, and available even on mobile phones. This system is regarded as one of the most important tools in humankind’s attempts in determining its whereabouts since old ages of exploration (The Economist, 2002). What may be seen as a radical innovation in our daily lives was materialized as a result of great effort in S&T, as it may be considered as a "paradigm shift". Even more, it should be emphasized that a good part of these efforts are intrinsically related to advances in the field of scientific metrology (Brandi and Souza, 2010).

To better explain how the advances in the scientific metrology have been able to promote the success of this strategic innovation, it is important to understand how the system works. The GPS system consists of 28 satellites located in six orbital planes, four satellites in each plane, at around 20,200 km altitude. Signals are broadcasted among three satellites and an object located on Earth. The time difference between arrivals of the signals reflected by the object in each satellite is measured, and knowing the difference, its position in space and time is determined. However, as Brandi and Souza (2010) point out, the GPS only exists because of the possibility of measuring time with an enormous exactitude, as the fundamental unit of time —the second— can be measured with an uncertainty of less than one part in 10¹³ (nowadays the second is measured with an uncertainty less than 10⁻¹⁶). This level of uncertainty is the result of tremendous effort made throughout the years by many research groups around the world, which allowed the storage and freezing of atoms. The scientists William Phillips, Steven Chu and Claude Cohen-Tannoudji, for instance, received the Nobel Prize in Physics in 1997 for their contribution to this research field.

With this very practical example, one can perceive the inductive nature of investments in scientific metrology, intensive in R&D and mainly conducted in the scope of governmental laboratories, which will supply the sound basis for later advances by the industrial sector (Gregersen, 1992). This rationale rests in the core of the defense of the provision of sound national policies for scientific metrology, as according to Tassej (2004; 2005), it is strategic to invest in R&D for scientific metrology, in order to complement the industrial efforts that will later be made, transforming those R&D efforts into innovations for the market. Analyzing the GPS case, we can only agree with these statements.

D. Conformity assessment and innovation

Conformity assessment schemes are important drivers for the diffusion of innovations by influencing both the expectations of companies about future demands on the one hand and the information available to consumers about usually unobservable quality characteristics of goods and services on the other hand. Companies investing in innovation form beliefs about future demands. The introduction of conformity assessment schemes both effectively signals and forms future consumer preferences.

A study of the European Commission (EC, 2009) provides a number of examples for the use of certification and labeling schemes as market pull instruments for promoting innovation. For instance, the introduction of the Energy labeling scheme within the household appliance sector illustrates how companies perceived the likely impact on the future market situation and how the scheme eventually shifted demand towards energy efficient appliances. The faith in the ability of the energy labels to influence demand led to an increase in the supply of energy efficient appliances, secondly consumers started to show a preference for energy efficient appliances and were often convinced enough to pay a higher initial price.

Typically consumers do not behave completely rational. It is well-known that consumers tend to use mental short-cuts for decision-making, to respond more to losses than gains or to value products much more once they own them. Since new products are usually subject to high uncertainties on the demand side, the market success of innovations depends crucially on the creation of consumer acceptance. Voluntary certifications and the testing of compliance with technical regulations serve as instruments to reduce the consumers' perceived risks related to the quality or the compatibility of new products. On the other side, the lack of such institutions can severely undermine consumer confidence and effectively hinder the formation of markets for innovative products, as will be illustrated by the case of biofuel addition in Germany.

German consumers generally trust in the products introduced in their market. Strong consumer protection agencies and market surveillance mechanisms create an environment in which certain health and safety standards are almost taken for granted. Because consumer acceptance does not depend exclusively on prior purchasing experiences or reputational mechanisms (like brands), this trust helps innovative firms to find market demand, facilitates market entry for start-ups and for firms coming from abroad. If however consumers get the impression that defaults have been violated, the reaction can be intense.

In February 2011 a new fuel blend (E10) composed of 10% bioethanol and 90% fossil fuel was introduced at German petrol stations, following a mandatory quota regulation that required oil companies to sell a certain proportion of biofuels (2009: 6.25% gradually increasing to 8% by 2015). In addition to being cheaper than the conventional 98 octane fuel or the earlier standard blended with 5% bioethanol (E5), E10 was supposed to help decarbonizing transport.

In France, E10 has been sold since April 2009 and reached a market share of 17.6% by April 2011. In the USA, E10 was used for many years and E15 will soon be introduced. In Brazil, the percentage of ethanol used in petrol has reached up to 25%. Even though German car manufacturers' association, VDA, estimated that at least 90% of the vehicles operating on German roads were E10-compatible, many drivers feared damaging their cars by running a higher ethanol content fuel.

These concerns were further fuelled by the practice of oil companies to label their pumps with warning signs while claiming that information on compatibility with the new fuel could only be offered by car manufacturers. Drivers associations encouraged E10 boycotts, saying not enough information was available on which cars were compatible with the fuel. An aggressive media campaign started accusing the government and the mineral oil industry of failure and called the introduction of E10 a big disaster. Bioethanol producers believe that the bad information policy may have been part of a strategy of the oil industry to discredit biofuels and eventually get rid of the biofuel mandates (Ethanol Producer Magazine, 2011).

This also caused a current of opponents discussing about environmental and ethical merits of biofuels.¹⁰ The perception of the environmental advantages of biofuels was originally positive and many stakeholders were supporting an increased development, production and use of biofuels. However, this positive perception has changed substantially. Since the ‘food vs. fuel’ discussion is on the agenda some stakeholders switched their branding of biofuels from ‘good’ to ‘evil’. Indeed, in summer 2012 the German Minister of Development and Economic Cooperation called for an immediate stop to the sale of E10 at German petrol stations, which has been welcomed by German aid organizations and a number of environmental and consumer protection NGOs (for example Greenpeace, BUND, Foodwatch).

As a result of these polemics, a large part of consumers retains that E10 can really cause engine failure in their cars and many believe it was not an environment-friendly product. The latest available data published by the German association of ethanol producers BDBe (2012) shows that roughly two thirds of all drivers using gasoline never filled their cars with the new blend. Of those, 73% avoided E10 because of technical concerns and another 16% rejected it for various ethical or environmental considerations. In practice, the majority of German drivers still opt for the higher price, and petrol stations continue to offer E5, which was originally intended as the reserve fuel for the 10% of German vehicles unable to run on E10.

The E10 example clearly shows the importance of creating consumer acceptance for new products. Insufficient user information has certainly slowed down the diffusion of this innovation and could easily have completely ended up its marketing. In fact, no case of car damage due to E10 has ever been registered, and German car owners now start to understand that the technical risks are low. The growing skepticism about its environmental and developmental impacts can however become a significant barrier for its further diffusion, which should be come up against with effective conformity assessment mechanisms.

The ‘food versus fuel’ debate and the discussion about the environmental performance of biofuels in general has led to the development of the concept of indirect land use change (iLUC) and the proposal to include iLUC factors into environmental assessments of biofuels. According to a recent study of Finkbeiner (2013), the currently available iLUC methodologies suffer from a number of deficiencies. If however further research achieves a better understanding of these impacts, scientifically robust and consistent iLUC factors might be used in Life Cycle Assessments and Carbon Footprint certifications to meet consumer concerns. Producers of environmentally and ethically justifiable bioethanol all over the world should be interested in establishing a corresponding quality assurance system.

E. Accreditation and innovation

Accreditation is a procedure by which an authoritative body gives formal recognition that a body or a person is competent to carry out specific tasks. An organization that issues certificates needs to be reputable; otherwise its certification documents are without informative value. For that reason, a certification body proves its reliability through an independent confirmation of its competence. The accreditation process ensures that its certification practices are acceptable, that it is able to test and certify third parties, behaves ethically and employs suitable quality assurance.

National accreditation bodies themselves operate according to the international standard ISO 17011 to ensure international recognition of their assessments. Mutual recognition agreements

¹⁰ The environmental benefits of biofuels have been called into question as considerable amounts of carbon dioxide are emitted during the harvesting and processing of crops and because it may be less efficient. Furthermore, high demand for biofuels could reduce the farmland available to grow food crops, therefore increasing food prices, famines and inflation.

between different governmental and regulatory organizations on regional, national and international levels guarantee that each member of the agreement has to recognize other members' accredited bodies as if they themselves had performed the accreditation. This has important implications for the international trade of certified goods, because it avoids the costs of double testing and facilitates the access to international markets.

Recent empirical research provides evidence that becoming a signatory of mutual recognition agreements is beneficial for a country's trade performance. Blind and Mangelsdorf (2012) show in a gravity model of international trade that signatories of a mutual recognition agreement for ISO 9001 quality management certifications trade more with each other than countries which are not signatories of the agreement. The agreement is negotiated under the umbrella of the International Accreditation Forum (IAF) - the global organization of accreditation bodies. IAF established together with a range of regional accreditation groups (e.g. EA –European Cooperation for Accreditation or PAC– Pacific Accreditation Cooperation) a 'multilateral mutual recognition arrangement' (MLA) for the ISO 9000 quality management system standard. Accreditation bodies can become signatories of the MLA when their operations are successfully evaluated by peer evaluation teams to ensure that signatories comply with relevant international standards and IAF rules.

In their macroeconomic study covering international trade of manufacturing products, Blind and Mangelsdorf (2012) can show that it is beneficial for countries to become signatories of the IAF-MLA. Signatories significantly trade more with each other and the trade enhancing effect has about the same magnitude as regional trade agreements. Finally, the IAF-MLA is most important for exporters from less developed countries aiming to access markets in developed countries.

In sum, internationally recognized certification services help companies to market their products in international markets. When market requirements differ internationally, the supply of foreign customers generally involves significant technological adjustments. Whereas the international harmonization of standards helps particularly companies that would not easily adapt to different consumer preferences and different regulatory frameworks, accreditation services in general improve the access to new foreign markets by facilitating the international verification of product conformity. Especially innovative firms from developing countries with reputational problems benefit from these institutions and are enabled to export their innovations to high-income countries.

F. Conclusion

As has been discussed above quality infrastructure services influence research, development and innovation processes in manifold ways, from providing basic technological infrastructure to creating market conditions that allow consumers to express sophisticated demands and make informed purchase decisions based on reliable quality signals. National quality infrastructure institutions thus represent fundamental elements of the national innovation system that help knowledge transfer from research to market application and delineate the quality dimensions on which innovative firms are able to compete internationally.

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III. Cooperation between the Brazilian National Institute of Metrology, Quality and Technology (INMETRO) and the German National Institute of Metrology (PTB): approaches and effects

Jorge Gonçalves¹¹ and Taynah Souza¹²

A. Introduction

This essay is a historical overview on the importance of cooperation in the field of metrology, namely on its contribution to the setting up of an institute in a country that had scarce metrological facilities and services, as well as on the outcomes arising from a long-standing cooperation, where both institutions are now more leveled in terms of their physical and human resources. It will provide a perspective on the general impacts resulting from the cooperation between the metrological institutes of Brazil (INMETRO) and Germany (PTB), which officially began in 1967, when the first agreement was signed.

From the mid 1970s until the late 1990s, Brazil managed to build up a well-established national metrology institute called INMETRO, currently considered a leader within several metrological fields. Its success is due in part to the sound investments made by the Brazilian government within a relatively short period of time, along with support from various international agencies and cooperation activities, particularly PTB. The cooperation between the Brazilian government and PTB evolved in terms of fields, complexity, and the roles performed by each institution. What was initially considered a support effort by PTB to INMETRO, in less than three decades, became a close cooperation from which both institutions and the countries they represent could benefit. Taking the innovation system point of view, this cooperation is extremely relevant because it allows the actors of both countries to interact and cooperate in their R&D processes. It also

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facilitates trade between them and supports the development of value chains by improving the interoperability among production systems. Also, this is relevant in order to share the investments in terms of funding and human resources incurred with metrological R&D, while the outcomes of which can benefit both countries.

The first part of this essay will analyze INMETRO's historical context and the cooperation with PTB and how its development was part of their strategy since very beginning. The section that follows introduces the modes of cooperation that consisted of three main directions: training, acquisition of equipment, and facilities construction.¹³ The fourth section will introduce a list of possible impacts and present some data collected that shall indicate their magnitude.

B. INMETRO and PTB Cooperation

1. The historical context of INMETRO

The Brazilian National Institute of Weights and Measures (INPM) was founded in 1961 as a federal institute with a special focus on legal metrology. In 1967 state level institutes for weights and measurements (IPEMs) were established in order to enforce the technical regulations throughout the country's vast territory which is politically organized as a federal republic with 27 federal states. In this same year, the law referred to as, "Política Nacional de Metrologia" (National Policy for Metrology) was formulated. This legislation confirmed that Brazil would exclusively use the International System of Units, created in 1960, and that the country would collaborate with the Bureau International des Poids et Mesures (BIPM) and the International Organization of Legal Metrology (OIML).

In this period, the focus was still mainly on legal metrology-related issues. However, in the late 1960s and early 1970s, with the growth of Brazilian exports (which doubled from 1971 until 1973), and particularly with the higher presence of industrialized goods (from 28% of the total exports in 1971 to 40% in 1974), the quality of goods to be exported increasingly became an issue for the producers, namely in their effort to comply with technical regulations in Europe and the U.S. (Dias, 1998). In order to achieve this, the traceability of the measurements to the international system of units was a requisite to be provided by the national metrology institute (NMI). The only alternative would have been to acquire these services from a foreign institution from Europe or the U.S., as there was no capable NMI to provide them at that time in Latin America. This alternative would have also been costly and implied a further increase in imports.

The Brazilian Government also changed its perspective on how to improve the technological capabilities of the national production system, gradually left its imports substitution industrialization, and began considering the importance of incorporating foreign technologies by national firms, as this could foster economic growth and innovation. The government regarded the development of metrology as an important aspect of this new strategy, and in order to help the establishment of metrology in Brazil, decided to sign a cooperation agreement with PTB given the long-lasting cooperation between Brazil and Germany.

In 1967, a cooperation agreement was signed between INMETRO and PTB with a projected time span of twenty years (between 1975 and 1995), during which Germany was asked to support the establishment of a public institution in Brazil that was to be responsible for the realization and dissemination of international measurement standards and methods.

¹³ Given the scope of this essay, we left out the section that describes in detail the cooperation projects that took place in the different divisions of INMETRO that received the most support by PTB. They were the thermometry, mechanical, acoustics and vibration, electrical, optical, chemical and legal metrology divisions, as well as, the accreditation division and the mechanical workshop.

Armênio Lobo, director of INPM between 1975 and 1980, visited PTB in the early 70s with the objective of developing a strategy for the national metrological system inspired by the German experiences. Additionally, the INPM also received the mission of supporting local industry by providing equipment and metrological services, considered beyond the scope of legal metrology factors, and which implied the development of industrial and scientific metrology. In 1971, funds were allocated for the INPM to acquire equipment and build the National Centre of Metrology, which in 1973 was to be called INMETRO, after the promulgation of the law no. 5966 (Dias, 1998).

Throughout this period, Brazil experienced a trade deficit in technological goods. In 1972, for instance, the deficit for these goods was US\$ 450 million, and was projected to reach up to US\$ 1 billion by 1980 (in current prices), as the local companies were growing and there was an increasing demand for high-tech equipment. Therefore, technological autonomy was established as a core developmental goal. With the assistance of the United Nations Industrial Development Organization (UNIDO), the PADTC (Plano de Desenvolvimento Científico e Tecnológico) was designed, putting emphasis in nuclear energy and highly technological industries such as electronics, chemistry and aeronautics. The budget for 1973 and 1974 totalled \$700 million and was to be used for science and technology, a part of which went to the creation of INMETRO (*idem*).

2. Cooperation agreements between INMETRO and PTB

The cooperation began had an emphasis on scientific and industrial metrology, and would be done through a variety of measures such as equipment deliveries, long-term (9 months or 1,5 years) and short-term stays (2 weeks) at INMETRO of PTB experts and training of INMETRO staff at PTB (29 long-term and 11 short-term stays), calibration services by PTB, exchange of documents, as well as seminars and consultations. Cooperation in the field of legal metrology took place parallel to this and helped in the development of the directorate for legal metrology of INMETRO (Dimel). The focus then was on the field of verification required for medical devices and the legal control of weight of pre-packaged goods.

The objectives for the cooperation listed in the 1967 project proposal were defined as:

- Training of Brazilian professionals
- Equipment supply and consulting services for the establishment of industrial and scientific metrology laboratories
- Exchange of technical literature and technical documents

According to PTB (1995), there were two distinct phases which were defined according to the needs in each of these two periods. The first, from 1975 until 1985, was focused on establishing the basic capabilities on metrological issues. The second, from 1985 until 1995, had a broader scope, taking in consideration quality infrastructure as a whole (QI), namely through the creation of a conformity assessment system, a network of calibration laboratories, an accreditation body, especially as a consequence of a growing demand associated with the implementation of ISO 9000, which was firstly published in 1987. The increasing importance of international standards in order for Brazilian companies to participate in international trade required the accreditation of laboratories in order to guarantee and demonstrate traceability to international measurement standards.

The cooperation between these two institutions proceeded after the end of this first cooperation agreement. In 2002, and again in 2007, new cooperation agreements were signed, conceding a formal character to the cooperation between these two metrology institutes. In these new agreements, INMETRO and PTB sought a more horizontal cooperation in the scientific and technological fields. It was horizontal in the sense that it no longer had the character of one institute directly supporting the other, but that both of them would jointly engage in research and dissemination projects. The activities concerned scientific, industrial and legal metrology, and accreditation. Both institutions included their priorities in the documents, namely in new areas such as chemical metrology and other advanced fields within it, involving activities like bilateral comparisons of

measurement standards meant to secure uncertainties and traceability, the participation in international forums, and joint investigation of new principles and methods that aimed at improving primary standards (INMETRO, 2012).

Until today, these two institutes often work together on dissemination and cooperation projects to help other countries establish or improve the functioning of their NMIs. INMETRO has, therefore, become a close partner of PTB for the dissemination of metrological knowledge both in Latin America and Africa, particularly for countries which have very little in terms of the implementation of metrological infrastructure.

C. Measuring the impacts

1. Methodological remarks

In this section, we will outline some of the possible impacts arising from the cooperation between INMETRO and PTB. As most of the projects took place in the 1980s and 1990s, given the restrictions in terms of data availability, and that the cooperation was so broad in nature, we will not argue that these impacts are an exclusive consequence of the cooperation projects between these two institutions, as it would not be possible to isolate them.

2. The counterfactual

Measuring the impacts of an intervention implies assessing the changes that it caused. In order to do this, one has to compare the actual situation (under the intervention) with a hypothetical one (the counterfactual). For example, what would have happened without the intervention? In this study, the intervention considered is the cooperation projects undertaken by INMETRO and PTB. The counterfactual is constructed through a non-experimental approach because we cannot separate a control group which received the intervention from a treatment group which did not receive the intervention since the services of INMETRO are publicly available (if one considers the scientific metrology, conformity assessment or accreditation divisions) or affect the whole Brazilian population (if one considers its legal metrology activities).

Ideally, in order to compare what was before and what was after the intervention, we should have indicators, from the 1970s up to now for all the items analyzed. It is, however, difficult to gather comparable data from the period before 1995. In any case, this study shall give an idea of how much INMETRO and the metrological system in Brazil evolved since the cooperation agreement was signed, until it became a well-recognized NMI in the World.

INMETRO started as a calibration laboratory with traceability to other NMIs (including PTB), and gradually moved into a reference laboratory, presently performing a wide variety of primary methods in different metrological fields. In true fact, INMETRO is nowadays engaging in the most advanced fields of scientific metrology. Considering that by 1975 there was no scientific metrology at all in Brazil, it is a significant evolution of the institute, and here we shall try to outline to which extent the cooperation projects have contributed to this development.

Looking at the history of what preceded INMETRO helps us understand what the initial metrological level of the country was before the intervention. According to Armênio Lobo, during the 1950s, when he began working at the National Institute of Technology (INT), responsible for the Brazil's metrological activities, they lacked facilities, equipment and qualified staff, and those measurement activities were carried out at a very low level, without reference standards. Ilso Oliveira (technician at INT) also recounts that before INT started working in legal metrology, for example, stones were often used as reference standards for weight. These practices stopped once INT was founded, and replaced by a more scientific approach to the Brazilian metrological system. According to Adejair Trigo (responsible for the implementation of legal metrology in the State of São Paulo) the only then was on

legal metrology and the scope of work was very limited. It was considered by the technicians of INT that this metrological division of INT was not capable of coping with all the scientific and legal metrological needs of the country. As a consequence of the many problems that the division of metrology was facing and its incompetencies, the technicians decided to create a body to deal specifically with the metrological issues in Brazil, independent from other institutions (Dias, 1998).

It was in this context that the INPM was created in 1961, with a reduced set of services and without any international recognition. Its sole focus was on legal metrology, and without any department specifically dedicated to scientific metrology. During the period from 1963 to 1973, its budget was on average, US\$ 656 thousand (current prices), which was extremely low for a country with approximately 100 million inhabitants. Nevertheless there were some developments in terms of legal metrology, with a focus on scales and gas stations, which were known to often be subject to fraud. In this period, 38 technical regulations were approved with high incidence (38%) in issues related to the commercialization of oil and its derivatives (idem).

It was not until 1968 that the INPM headquarters were founded in Rio de Janeiro, with laboratories for mass, thermometry and pre-packaged products. There were, however, significant limitations to making these services reach all the Brazilian states, and it continues to be a relevant challenge, as Brazilian states still show great differences in terms of their metrological capacity level.

This was the context in which the cooperation with PTB started. There was no scientific metrology and the legal metrology activities were outdated as they had not yet incorporated the norms set by OIML.

In our case it is difficult to construct the alternative scenario especially in what concerns the capacity-building of INMETRO, if the cooperation projects had not taken place. As previously mentioned, the building of facilities, acquisition of equipment and training of staff that set up the first divisions and laboratories the collaboration with PTB was a key element. The Brazilian government invested significant funds for the development of INMETRO, including the organization of courses to train metrologists in Brazil. World Bank and United Nations Industrial Development Organization (UNIDO) were also involved, along with other NMIs which gave technical support to INMETRO in different fields, like NIST in the field of chemical metrology. Adding to this, as most of the projects took place between the 1970s and 1990s it is difficult to collect the data required to isolate the impacts specifically arising from the cooperation projects INMETRO – PTB.

Therefore, this analysis does not respond to all the methodological issues that an impact study would imply. Instead we provide an overview the process of capacity-building of INMETRO. We will analyze what this capacity-building implied, in terms of the economic, innovation and social issues, and how this led to further dissemination of metrological knowledge and competencies to other countries.

3. Categorization of impacts

In order to systematize the kinds of impacts that we can find as a consequence of this cooperation between PTB and INMETRO, we separated them in the following categories: capacity-building, economic, social, and spillover effects. We firstly introduce the capacity-building of INMETRO in metrological fields and aspects that can be considered as outcomes of the cooperation projects, and this shall provide the basis to justify the remaining impacts.

We considered the dissemination of metrological knowledge as an impact, that will not only benefit INMETRO or PTB, but third parties, to which INMETRO could provide support as a consequence of cooperation projects with PTB. Apart from impacts in the market access of Brazil and Germany and the possibility of more players interacting within the same metrological system (enhancing interoperability and enlarging the innovation systems), it will have similar impacts to those that we have named for Brazil (economic, social, and capacity-building of the metrological sector).

a) Capacity-building of INMETRO

In 1994, at the end of the first wave of investments and of the cooperation agreement with PTB, Brazil reached important goals which were difficult to obtain, namely on the traceability of Brazilian measurement standards on length, mass, time, and the electrical resistance of the light intensity to international standards, on the realization of the fixed points of the temperature scale, and on the dissemination of the SI base units: meter, second, kilogram, kelvin, ohm, candela. Derived quantities as, for example, on strength, viscosity, pressure, angle, roughness, electrical quantities such as voltage, resistance, current, power, etc. nevertheless still presented some gaps. INMETRO was taking part, in opportunities, within international inter-comparisons and with that it demonstrated its technical capacity (PTB, 1995), reflecting their capacity to reduce the uncertainty of its measurements.

Uncertainty reduction is one of the main tasks of an NMI. The lower the uncertainty is, the higher the comparability of the results of a measurement. This has several consequences for society. From the point of view of producers, the fact that they base their measurement procedures on a system with lower uncertainties means that they can reduce losses due to wrong measurements, and also have more confidence on the results of other producers within the value chain. From the perspective of consumers/citizens, this means that lower uncertainty reduces the probability of allowing the use of an instrument producing results outside the legal limits. If instruments measure with higher errors, more losses can derive from a transaction, or the higher the probability of a citizen being unfairly sanctioned is increased.

For INMETRO, a consequence of reduction of uncertainties is the ability to perform a higher number of primary methods and to successfully participate in key comparisons, and therefore receive international recognition of their capabilities (this is reflected in publicly announced Calibration and Measurement Capabilities (CMCs)).

One example of an uncertainty reduction as a result from a cooperation project with PTB is referred by Gregory Kyriazis, researcher from the electrical division of INMETRO. After his training at PTB, he returned to INMETRO and applied what he had learnt in his training. As a consequence there was a reduction in the uncertainty of capacitance measurement from 3 to 0,01 in 10⁻⁶.

As reported by PTB (1995), by comparing measurements, for example, the laboratories for length measurement and electric units - capacity measurement, through inter-comparisons with the Instituto Nacional de Tecnología Industrial (INTI), from Argentina, and PTB, they could demonstrate that the results shown by the calibration certificates of the laboratory gauge blocks in blind tests, were almost the same as the values of PTB certificates.

Bilateral comparisons with NMIs that already participated in a key comparison are a faster way for a country to acquire calibration certificates. PTB often provided this opportunity to INMETRO, which accelerated the expansion of its activities, namely regarding the calibration services provided to laboratories, giving them traceability to international standards.

The participation in key comparisons, acquiring more CMCs, and the participation in mutual recognition agreements are all possible because of the reduction of uncertainty.

According to BIPM (2012), Brazil has participated in almost 150 key comparisons, the 16th highest number in the world. Prior to 1994, Brazil had only participated in 13 key comparisons, 11 of them in the field of ionizing radiation, one in time and frequency which was done in 1977, another in length, in 1988, in frequencies of Helium-Neon lasers at wavelength 633 nm. All were carried out by Brazilian institutions. In 1994, INMETRO participated in its first key comparison on DC voltage (Josephson standards) which was a field to which Dr. Klonz (PTB) provided technical support.

In overall, in the period between 1994 and 2000, Brazil participated in 15 inter-comparisons, out of which only 4 concerned ionizing radiation. The division of Acoustics, Ultrasound, and Vibration of INMETRO, participated in 4 inter-comparisons in this period. In the field of electrical metrology, there were 3 inter-comparisons. In dimensional metrology, there were 2 key comparisons and 1 supplementary, all related to interferometry. These were all metrological fields in which PTB

provided an intense support. At last, there was a key comparison in viscosity, a field where INMETRO was supported by the ‘Istituto Nazionale di Ricerca Metrologica’ (Inrim), from Italy.

Since 2000, Brazil participated in 121 key comparisons and 29 supplementary comparisons, with a higher degree of diversification concerning the metrological fields.

The CMCs listed in the appendix C of BIPM represent another important indicator of the capacity-building of INMETRO and a consequence of the participation in inter-comparisons. Currently Brazil has a total of 463 CMCs, ranking 15th Worldwide (BIPM, 2012).

As a consequence of the participation in inter-comparisons and the acquisition of CMCs, there were also some developments in accreditation. The number of accredited national laboratories in the Rede Brasileira de Calibração (Brazilian Calibration Network) increased from 23 in 1991 to 51 in mid-1994, and by then another 26 were in the process of being accredited (PTB, 1995). There are currently 303 (INMETRO, 2012a), accredited laboratories and a total of 1509 conformity assessment institutions (including laboratories) accredited by INMETRO. In the following table we can see INMETRO’s performance in the fields of scientific metrology that received the most significant support by PTB.

TABLE 1
INTERCOMPARISONS, CMCS AND ACCREDITED LABORATORIES

Field	Number of inter-comparisons - National Institute of Metrology, Quality and Technology of Brazil (INMETRO) / National Metrology Institute of Germany (PTB)	Number of calibration and measurement capabilities (World ranking)	Number of accredited laboratories
Length	12/23	19 (23)	98
Electricity	12/60	131 (25)	72
Pressure	6/30	14 (9)	101
Force	0/19	16 (4)	50
Acoustic, vibration and ultrasound	11/20	37 (13)	13
Thermometry	3/14	11 (44)	82
Total	144/450	438 (15)	303

Source: [1] BIPM (2012) [2] INMETRO (2003).

Primary methods

The capacity to perform primary methods is one of the main challenges faced by any NMI. Realizing a measurement unit has various implications, namely on the autonomy of the NMI to guarantee its traceability to international standards, without requiring their calibration in foreign NMIs, which is not only more time-consuming, but also implies higher costs for the NMI (which indirectly will be paid by the local industry and laboratorial sectors) as well as an increase of imports.

INMETRO is already performing various primary methods, several of which may be considered a result of cooperative projects with PTB. As an illustration, Gustavo Ripper, a researcher in the vibrations participated in a course at PTB with Fink in 1992, after which he started working at INMETRO. Later, in 1996, he went to Braunschweig for two weeks in order to calibrate various pieces of INMETRO’s equipment. With the knowledge he obtained, INMETRO was able to implement the primary method for accelerometers. This meant that from 1999 onwards, INMETRO did not have to have its equipment calibrated at PTB, what would naturally be more expensive as a result of transportation costs. Calibrating at PTB would cost INMETRO around €5000, whereas now that INMETRO has the primary method it costs approximately €1000.

Technical regulations

Concerning the evolution of technical regulations, an important indicator to observe the development of legal metrology, another attribute of the cooperation with PTB, especially from 1980 onwards, when five researchers from INMETRO went to PTB for training in this metrological field. Between 1960 and 1979, 384 technical standards had been approved, an average of 19 per year. Since 1980, this number increased significantly. From 1980 till 1995, 6435 technical standards were approved, an average of 396 per year (own calculations, using data from Silva, 2003).

This also had impacts on INMETRO's revenues derived from legal metrology activities, and a significant source for its budget. In 1983, 51% of INMETRO's budget was covered by revenues coming from legal metrology directorate (Dimel). In current prices, the Dimel's total revenue was US\$ 8,6 million in 1983 and increased up to US\$ 45 million in 1995 (41% of the budget for that year), by the end of the first cooperation agreement. If we compare with an earlier period, this increase would be even more significant. In 1973, INPM total budget was US\$ 751 thousand (current prices). In 2011, the total revenue from legal metrology was US\$ 269 million.

TABLE 2
SUMMARY OF CAPACITY-BUILDING INDICATORS OF INMETRO

Capacity-building indicators	Before (year or period)	After (year or period)
Number of key comparisons	0 (before 1993)	136 (desde 1993)
Number of supplementary comparisons	0 (before 1993)	30 (desde 1993)
CMCs	---	463 (2012)
Technical regulations	384 (1960-1979)	6 435 (1980-1995)
Certified Reference Materials (CRMs)	0 (1995)	011)

Source: [1] BIPM (2012) [2] Silva (2003) [3] INMETRO (2012b).

b) Economic effects

The capacity-building of INMETRO leads to several impacts to the Brazilian economy. Given the data limitations, we can only analyze the impacts of the capacity-building of INMETRO in the Brazilian trade balance.

Measurement Sector Trade Balance

When the researcher Paulo Couto returned to INMETRO after the training at PTB, he conducted a research in partnership with the Pontifícia Universidade Católica do Rio de Janeiro (Puc-RJ) and provided training to local producers on pressure and temperature transducers. As a consequence, these producers started to produce these instruments when before they were imported.

Similarly, with the development of the force laboratory, which received a strong support by PTB, the Brazilian production of manometers increased significantly, and the trade balance concerning manometers evolved from a deficit to a superavit. It had a deficit of US\$ 3,8 million in average between 1997 and 1999, and from 2004 until 2011 there was a superavit, in average, of US\$ 3,4 million (Aliceweb, 2012). The exports of manometers amounted to US\$ 16,2 million in 2011, when in 1998 they were only US\$ 1,2 million.

Analyzing the overall trade balance of different measurement instruments through data available at Aliceweb (the official Brazilian website with the data regarding the trade balance), we observe the evolution of this sector. According to these estimations, in 1997 the imports of this kind of equipment were of US\$ 240 million (0,5% of the total imports in 1997). In 2011, the imports of measurement equipment was already US\$ 1,7 billion (0,7% of total imports), a 7 times increase, much

higher than the general increase of imports in the same period (4,8 times more), reflecting the growing needs of the industry for measurement instruments, especially when trying to promote exports or to address technical regulations. This reflects the growing demands of industries for technological goods in the field of measurement and sustains the concerns regarding the technological deficit.

Yet, Brazilian measurement instruments sector made significant improvements in terms of its exports. In 1997, the exports of measurement instruments were US\$ 27 million, while in 2011 it was US\$121 million. It has increased 5 times and this would not have been possible without an NMI providing low uncertainties, traceability to the equipment, and good quality measurement services, otherwise this equipment could not be exported.

To have a more complete idea of how the development of the national measurement instruments industry evolved in order to reduce the needs of importing goods, data about the national sales of this sector would be required. Unfortunately this data is not available.

Nevertheless, one example can be provided of how the cooperation between INMETRO and PTB led to a reduction of imports of goods from the measurement sector. This can be considered a “new-to-the country” innovation, meaning that the local industry was capable to start producing a new product or service.

BOX 2

PRODUCTION OF PH CERTIFIED REFERENCE MATERIAL (CRMS)

In June 2000, Vanderléa Souza was hired with the mission of setting up the division of chemical metrology, particularly the implementation of the primary method of pH, which would also allow the production of the CRM for pH, and this would facilitate the production of other CRMs, which are increasingly demanded by industries. In October 2001, after a period of research, she went to PTB to participate in a seminar, and stayed an additional week to stay with Petra Spitzer, who had been conducting the research in this field within PTB. When she came back to Brazil, Souza could specify all the necessary equipment for the project as well as the required laboratorial infrastructure. During her stay at PTB, she could learn and register the processes associated with the pH primary system in detail. This helped her mission of transferring the knowledge she had collected to her colleagues back at INMETRO, especially to the team that was responsible for setting up the system. They stayed in close contact with Spitzer, who would answer their doubts. In 2002, Spitzer was invited to participate in an event at INMETRO, and this occasion was used for further exchange of experiences. In 2003, she was invited to provide training to INMETRO staff working on this project, and in this period PTB also gave support to INMETRO in order to find a good Harned cell, which was crucial to obtain good results. In June 2003, the pH primary system was inaugurated but it still had a significant uncertainty and INMETRO kept working. In 2004, Spitzer peer reviewed the INMETRO pH primary system, so that it could acquire the CMC. This was very important to improving the system and reducing uncertainty, which now stands at the lowest levels in international terms. This allowed two Brazilian laboratories to be accredited to produce the secondary CRM (the calibrant), which were worth for the main types (ph 4, 7 and 12) of US\$ 137 thousand in 2011. Without the implementation of the primary method, Brazilian laboratories would only be able to produce non-certified reference material unless they could certify their reference materials at a foreign NMI with such CMC. Additionally, the production of the primary CRM by INMETRO reduced the Brazilian imports of this good by US\$ 1,3 million in 2012, as this used to be imported from the U.S. for a price three times higher than the actual cost while being produced at INMETRO.

Source: Own calculations based on data from the Division of Chemical Metrology INMETRO.

Overall exports of Brazil

80% of the total global trade is already affected by standards and regulation and the costs associated with technical regulations, standards, compliance certification and testing range from 2% to 10% of total production costs (OECD 1996; 1999). Compliance with these standards and technical regulations implies the need of measurement traceability of the companies, which requires the use of accredited laboratories that have their measurement instruments and standards calibrated from an NMI that has the respective CMC, hereby having its certificates internationally recognized. Looking at the evolution of the Brazilian exports, one can observe the expansion of these services

and how it enabled local producers to demonstrate their compliance with the standards and technical regulations required for exporting.

This does not intend to say that the growth of exports is a consequence of INMETRO activities, but that the Institute provides infrastructural support to these exports. The overall Brazilian exports grew 4,8 times (from US\$ 53 billion to US\$ 256 billion), and is directly related to the period during which Brazil opened up to international trade, after decades of protectionism. We intend to show that when policymakers decided to go for an exports promotion strategy, INMETRO was ready to give the support that companies required because without its work they would not be able to comply to standards and technical regulations.

Furthermore, in 2000, Brazil, through Cgcre (the Brazilian accreditation body that is part of INMETRO' structure), was one of the founding members of ILAC (International Laboratory Accreditation Cooperation), along with other 25 countries, mostly from EU and North America. It was then the only one from the whole Latin America. After Cgcre, only in 2005 another Latin American institution signed this mutual recognition agreement, which naturally gave Brazil an advantage in comparison to all other countries had not sign it, giving international recognition to the services of the Brazilian accredited laboratories.

c) Social effects

Consumer protection is one of the examples where QI can play an important role, namely through legal metrology. This field also significantly supported by PTB with five INMETRO researchers participating in a training in Germany within the scope of PTB-INMETRO cooperation agreement. In overall, the number of technical regulations implemented by INMETRO increased significantly after the cooperation with PTB. In terms of social impacts resulting from this, we shall briefly overview two different cases.

Scales. The cooperation projects were useful to support the process of reformulating technical regulations, for example, helping to decrease the maximum error allowed in scales. In the end of the 1980s, César Luiz, researcher from INMETRO, was responsible for the task of elaborating a new law to replace the old one from 1944. In 1981, he received his training at PTB where he dedicated himself to the topics of weight instruments and type approval. By this time, PTB was already quite advanced in the legislation of these topics, and were aligned with the standards under development by the OIML. When he went back to Brazil in the 1980s, César Luiz became responsible for coordinating the Brazilian Network for Legal Metrology, and had an active role in completing an overall reform in the Brazilian law concerning scales, which was completed in the year of 1993, contributing to the necessary training and equipping of IPEMs. One of the consequences of this overall reform was that from then on in order for Brazilian scales to be approved by INMETRO; they had to present 50% less errors than the maximum errors allowed in the previous legislation.

Lei Seca (Dry Law). The implementation of 'Lei Seca' in Brazil, which created very strict rules about driving under alcohol influence, had significant impacts in terms of accidents reduction. The implementation of this law significantly contributed to the observed reduction of 25% of deaths resulting from driving accidents between 2008 and 2010 in the city of Rio de Janeiro (for which there are available data), for which the INMETRO's contribution was crucial to guarantee the enforcement of the law, namely through the calibration of breathalyzers.

d) Spillover effects

INMETRO is a very active player in terms of cooperation projects, playing an important role in the dissemination of metrological knowledge in Latin America and the Caribbean, and also in African countries, especially in the Portuguese speaking ones. This could be considered a spill-over effect resulting from the initial cooperation. According to Caint, the international coordinator for INMETRO, 29 countries were assisted by INMETRO in 2011 the institute has signed 65 technical cooperation

agreements have been signed between 2004 until 2011. Often, INMETRO' staff trained at PTB provided training upon their return to other Sistema Interamericano de Metrologia (SIM) staff members.

More recently, a trilateral agreement was established between INMETRO, PTB and Innoq (the NMI of Mozambique), that shall support the latter to develop in a similar way that PTB supported INMETRO when it was created. The fact that Portuguese is an official language in both Mozambique and Brazil facilitated the relationships between these two institutions and training of staff. This eased the task of PTB of spreading its metrological knowledge, as it could share this task with INMETRO.

D. Conclusion

The long-lasting cooperation between INMETRO and PTB has produced a multitude of impacts and benefited both NMIs and respective countries. For INMETRO, the NMI that is being established, the cooperation with a more experienced NMI fosters the processes of capacity-building because it is a way of gaining many of their inputs and reducing possible mistakes. In addition, the experienced NMI can provide services and credibility, namely through certificates, to the supported NMI, once the latter is capable of dealing with the necessary technical requirements. This shall help the country's companies to gain access to foreign markets, namely for the producers of measurement equipment.

From the experienced NMI and its country perspective, it means gaining a partner in the future to collaborate on research activities, helping to disseminate metrological knowledge, while it facilitates the entrance of the companies into a new market, because they share a similar measurement system, technical regulations and standards.

Given the specificities of metrology, it would be interesting to further analyze how cooperation projects have taken place. A detailed analysis to a similar cooperation project could provide more information about the cost-effectiveness of these activities, namely, to assess the impacts on: the dissemination of metrological knowledge to other countries; the access to international markets by local companies; the development of the national measurement sector; the participation of local companies in global value chains; the implementation of regulation, by comparing different countries that tried to implement a similar technical regulation and compare its effectiveness with and without the support of quality infrastructure services.

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Part II
**Economic and social impacts of the quality
infrastructure: an analysis based on case studies**

IV. Economic impact study of weighing scales on entry to ports and industrial plants¹⁴

*Mariela Saavedra*¹⁵

A. The structure of the legal metrology program in Argentina

In Argentina, until 2002 (the year prior to the modification of the legislation), legal metrology was based on the manufacturer's declaration, in line with the policy of deregulation and the withdrawal of the State from control activities.

Within this context, in December 2002 an agreement to provide technology services was signed between the National Institute of Industrial Technology (INTI) and the Federal Administration of Public Revenues (AFIP) with the aim that INTI would perform the verification of weighing scales and storage tanks used for foreign trade-related operations.

This study brings together information relating to the following instruments and examines a certain number of cases for each one of them (see table 3).

¹⁴ This chapter was published in “Impacto de la Infraestructura de la Calidad en América Latina”, ECLAC-PTB 2011.

¹⁵ Administrative Coordinator of INTI's Metrology and Measurement Quality Program. The author gratefully acknowledges the collaboration of Leandro Garcia and Constantino Martinez, who provided the data necessary for the completion of this study. She is also grateful to Dr. Hector Laiz, the Director of Metrology at INTI, for defining the topics of study and for the general supervision of the work.

TABLE 3
INSTRUMENTS ANALYZED

Instruments	Quantity
Medium-capacity scales	71
Hoppers	86
High-capacity scales	440
Storage tanks	286
Gas pipelines	3

Source: ECLAC-PTB, 2011.

The main conclusions of the analysis include most notably the following:

- 70 % of the instruments verified did not comply with the corresponding metrological and technological regulations and exceeded the established tolerance;
- Instruments without model approval were found to be installed;
- The procedure for entry to calibration of the equipment was not the one declared in the model approval documents; and
- The instruments found did not have the conditions to allow for calibration, i.e. it was possible to use the instrument in a fraudulent manner.

As a result of these findings, and the government's policy, in force since 2003, for the State to return to a more active role, the National Executive enacted Decree N° 788/2003 (Decree N° 788/03), which together with Law N° 19,511 makes up the regulatory framework on metrology in Argentina. Decree N° 788/2003 eliminates the system of sworn Statements provided by manufacturers and reassigns the functions emanating from the law, dividing them between the two bodies within the State structure: the Secretariat of Internal Trade (SCI) and the National Institute of Industrial Technology (INTI).

In the new legislation INTI maintains all functions relating to scientific and industrial metrology, which it has already fulfilled for decades. In regard to metrology related to trade, health or the environment, that is, legal metrology, the Decree assigns to INTI the following functions regarding the regulated measuring instruments:

- Carrying out the necessary tests for model approval; the procedure through which a competent body certifies that a prototype of an instrument to be produced complies with the provisions of the applicable regulation;
- Carrying out the necessary tests for primitive verification; the procedure through which a competent authority verifies and certifies that the instruments produced by a manufacturer are in accordance with the applicable regulatory requirements;
- Carrying out periodic verification whether directly or indirectly via third parties; the verification subsequent to the primitive verification or declaration of conformity, conducted periodically by the competent authority at the request of its head, it has a validity of one year;
- Carrying out the monitoring of use; the monitoring conducted by the competent authority in an unannounced manner and in the place of operation;
- Performing audits on manufacturers; and
- Proposing technical regulations.

The SCI, for its part, is responsible, among other functions, for issuing the regulations proposed by INTI and approving models on the basis of the technical reports produced by INTI.

With regard to measuring instrument regulations, Argentina shows significant backwardness, not only due to the low number of regulated instruments, but also due to the age (that is to say, the technological obsolescence) of several of the regulations. An example of this is that the following instruments are currently still regulated:¹⁶

- Scales (1980);
- Weights (1983);
- Petrol, kerosene and diesel pumps (1989);
- Speed cameras (1998);
- Axle weighing scales (2001);
- Flowmeters for wheat (1998);
- Capacity measures (1989);
- Material measures of length (2000);
- Test tubes and graduated vessels (1926);
- Butyrometers (1927);
- Mercury-in-glass clinical thermometers (2002); and
- Taximeters (2001).

During 2012, new instruments were regulated, which are detailed below:

- Liquid storage tanks (for measuring hydrocarbons or vegetable oils);
- Electrical energy meters;
- Water meters;
- Alcoholmeters;
- CNG pumps;
- Measurement of natural gas by ultrasonic meters;
- Digital thermometers; and
- Measurement of crude oil in oil pipelines.

B. The economic impact of the intervention by INTI in the verification of high-capacity scales for unloading grains at ports and in industries

As was mentioned in the previous section, INTI performs the periodic verification of regulated measuring instruments. Table 4 shows the number of instruments verified during the first half of 2010.

¹⁶ In brackets is the year of issuance of the regulations.

TABLE 4
INSTRUMENTS VERIFIED DURING THE FIRST HALF OF 2010

Instruments	Quantity
Pumps (petrol pumps)	25 425
Scales	4 110
Speed cameras	120
Other	~ 1 000

Source: ECLAC-PTB, 2011.

Legal metrology provides support for industry, traders and producers, since they find themselves at a disadvantage if they deliver greater quantities than those agreed upon and paid for, in much the same way that industrialists lose out if they have no way to properly measure their raw materials, processes, and finished products. It is for this reason that legal metrology verifies measuring and control instruments, thereby protecting industry and commercial development by avoiding unfair competition or prohibiting the commercialization of products that do not comply with the rules or regulations in force.

Scales are one of the regulated measuring instruments most commonly used in commercial transactions, at loading terminals and industrial plants, and this is where kilograms of partial deviations can turn into tonnes by the end of a day of operations.

In Argentina, cereals and oilseeds have three destinations: industry for the preparation of oils and flours, stockpiling in silos and storage at ports for exportation. The grains are transported by truck to these destinations, across the Argentine road network. The National Directorate of Roads (DNRV) is the regulatory body for national highways and carries out the control of axle weighing of vehicles to determine overloads that may cause traffic accidents, allowing the movement of trucks with a weight of up to 45 tonnes (t).¹⁷

Consequently, the maximum net load that a truck can carry is approximately 30 t. Prior to 2003, during a series of visits by INTI to the mayor cereal processing and treatment terminals, the following situation was systematically encountered: a) when weighing the "gross weight" of the truck (truck + load) the respective scales weighed less, and b) when weighing the unloaded truck, the "tare weight" (empty truck) the respective scales weighed more. It can be assumed that the customs terminals and industrial plants appropriated the two differences for themselves.

In the study on high capacity scales, two relevant aspects are analyzed, both before and after INTI began to act as the control body, with the two periods being separated by the coming into force of Decree N° 788/03.

An analysis will be made of the direct economic impact of the intervention by INTI in the verification of high capacity scales at port terminals and grain processing plants in the period from 2003 to 2008, based on the average FOB value of the grains.

¹⁷ Dirección Nacional de Vialidad, maximum weights per axle allowed for vehicles, Law 24,449 , Decree 779/95, Decree 79/98 and resolution S. T. 497/94.

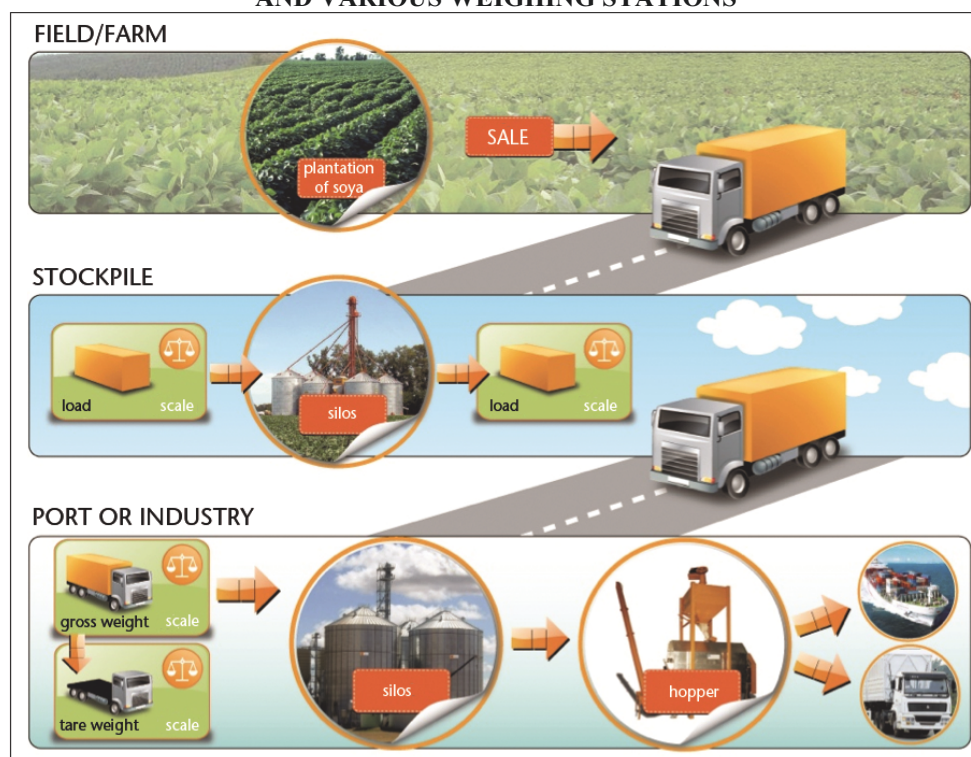
C. Economic impact of the verification of high capacity scales in the production of cereals and oilseeds in Argentina

Since the producers are not able to control the processes for measuring cereals, they need the authorities to carry out controls of this activity, by means of legal metrology. In this way, the State seeks to protect the various sectors that make up the production or commercial chain.

The present study shows, in three different time periods, the losses incurred in the production of soy, wheat, corn and sunflower prior to the intervention of INTI as a control body, as well as the economic impact subsequent to it intervening in the monitoring of high capacity scales at port terminals and industrial plants.¹⁸

Figure 5 shows the route taken by the grains from the field to their export or processing point. These grains are weighed when they arrive at and leave storage plants, when they arrive at ports/industries, and when they leave there by boat or in trucks.

DIAGRAM 5
TRANSIT OF CROPS FROM THE FIELD TO THEIR EXPORT OR PROCESSING POINT AND VARIOUS WEIGHING STATIONS



Source: ECLAC-PTB, 2011.

The impact analysis focuses on the scales at entry to the plant (marked with a circle in figure 5). In major port terminals and large industries, different scales are available to weigh the full truck (gross weight) and to weigh the empty truck (tare).¹⁹

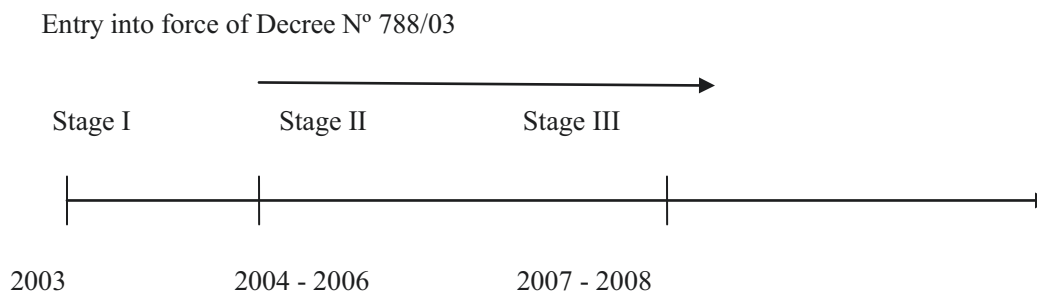
¹⁸ This study did not include blatant fraud, only the small and systematic fraud, which is the kind that can be measured.

¹⁹ Payment for the product, for its part, is made according to the net weight, i.e. the gross weight minus the tare weight.

As can be observed, in this study an analysis has not been made of the scales at the storage plant, where differences can certainly also be found in the weighing of cereals, as well as in the hoppers when being loaded onto boats to be exported or in trucks to be taken to the industry.

1. Description of the stages analyzed

The period considered for the study stretches from 2003 to 2008, and is subdivided into three stages of analysis.



Stage I: Prior to the INTI intervention, and following the entry into force of Decree N° 788/03, the Argentine Grain Storage Federation (Federación de Acopiadores de Granos de la Argentina) reported that there was a loss in the net weight delivered by truck of more than 200 kg for every 30 t. We will determine what the losses were in the 2003 period, without proper verification of the scales, i.e. with an error of the order of 0.67 %.

Stage II: From 2004 to 2006, with the entry into force of Decree N° 788/03, when INTI demanded that scales should be within the legal tolerances of 30 kg for every 30 t. This criterion, which is strictly legal, allows the owner of the scales to adjust the gross weight scales to the negative minimum and the tare scales to the positive maximum and obtain an additional benefit of 60 kg for a net weight of 30 t to the processing plant's advantage while remaining within the accepted tolerances, with an error of 0.2 %.

Stage III: In the period from 2007 to the present day, INTI instructed its technicians to demand that the gross weight scales are in balance with the tare scales, that is to say, that the error in the net weight must be less than 30 kg for every 30 t, which is equivalent to 0.1 %.

2. Economic impact assessment model

We have described the three stages we wish to compare to see the effect caused by Decree N° 788/03 and the participation of INTI. In order to analyze the economic impact, each stage must be compared with the one immediately preceding it, that is, comparing the scenario with the implementation of the new policy and without it.

Thus, we will demonstrate what happened before INTI intervened as a control body, what happened when it began to carry out the verifications of scales (Stage II - Stage I), and on the basis of this analysis comparisons will be made in order to assess the economic impact. Another of the possible comparisons is to analyze the differences between the situations with and without the application of the criterion established for Stage III (Stage III - Stage II), in which case the difference obtained will be the effect or impact generated by the new policy.

TABLE 5
PRODUCTION OF CEREALS AND OILSEEDS, 2002-2003

	Tonnesa	Loss (0.67 %), in t	FOB price (US\$) ^a	Difference (US\$)
Sunflower	3 714 000	24 884	247	6 144 225
Soy	34 818 550	233 284	190	44 362 895
Wheat	12 301 440	82 420	181	14 904 220
Corn	15 044 530	100 798	103	10 348 631
Total	65 878 520	441 386		75 759 970

Source: ECLAC-PTB, 2011.

^a Secretariat of Agriculture, Livestock and Fisheries and Food SAGPyA, ^b Average FOB price SAGPyA.

STAGE II: After the entry into force of Decree N° 788/03

To consider the effect of the entry into force of Decree N° 788/03, let us take the case of a typical truck loaded with a "regulation" total weight of 45 t, on the basis of which we find the following measurement error:

Gross (truck+ load of cereal) = 44,970 kg

Tare (unloaded truck) = 15,030 kg

The terminal pays the producer for the difference, which is the value of the load (Gross - Tare):

44,970 Kg - 15,030 kg = 29,940 kg

However, the producer delivered to the terminal 30,000 kg of cereal, which means that during the transaction the terminal appropriated 60 kg (30,000 kg - 29,940 kg) as a result of the manipulation of the weighing instruments to its own advantage, albeit while complying with the requirements of the regulations in force.

TABLE 6
CEREAL AND OILSEED PRODUCTION, 2003-2004, 2004-2005 AND 2005-2006

	Tonnesa	Loss (0.2 %), in t	FOB price (US\$) b	Difference (US\$)
2003-2004				
Sunflower	3 160 672	6 321	252	1 591 925
Soy	31 576 752	63 154	200	12 651 752
Wheat	14 562 955	29 126	161	4 696 553
Corn	14 950 825	29 902	105	3 152 132
Total	64 251 204	128 502		22 092 362
2004-2005				
Sunflower	3 662 109	7 324	260	1 904 297
Soy	38 289 742	76 579	183	13 975 756
Wheat	15 959 580	31 919	152	4 865 012
Corn	20 482 572	40 965	91	3 738 069
Total	78 394 003	156 788		24 483 134
2005-2006				
Sunflower	3 759 736	7 519	232	1 746 397
Soy	40 537 363	81 075	183	14 863 700
Wheat	12 593 396	25 187	186	4 676 348
Corn	14 445 538	28 891	126	3 630 645
Total	71 336 033	142 672		24 917 090

Source: ECLAC-PTB, 2011.

^a Secretariat of Agriculture, Livestock and Fisheries and Food SAGPyA, ^b Average FOB price SAGPyA.

Table 7 shows the effects of the entry into force of Decree N° 788/03 and the control implemented by INTI, on account of which the measurement error decreased to 0.2 %. Consequently, from 2004-2006 the production of sunflower, soy, wheat and maize in Argentina totalled 213,981,240 t and the losses amounted to U\$S71, 492,586, to the detriment of the producers and stores.

3. Comparison between Stage II and Stage I

Using the estimates produced, it is possible to perform a simulation exercise. Table 7 shows the results of the comparison, in the same period from 2004-2006, of the impact that would have occurred with the implementation of the policy and without its implementation (Stage II - stage I).

Through this exercise, it is possible to measure the improvement produced by the intervention of INTI, showing that the reduction in economic conflict in commercial transactions of cereals and oilseeds amounts to U\$S 168,007,578, which in tonnes of grains is equivalent to an improvement of 1,005,712 t.

TABLE 7
COMPARISON BETWEEN STAGE II AND STAGE I, 2004 TO 2006
(In dollars)

	Sunflower	Soy	Wheat	Corn	Total
Stage II (0.2 %)	5 242 619	41 491 208	14 237 913	10 520 847	71 492 586
Stage I (0.67 %)	17 562 774	138 995 545	47 697 007	35 244 837	239 500 164
Improvement	12 320 155	97 504 338	33 459 095	24 723 990	168 007 578

Source: ECLAC-PTB, 2011.

STAGE III: Implementation of the INTI criterion with regard to the difference between the gross and tare scales

Based on production, prices per tonne and the estimates of losses caused by measurement differences, it is possible to work out loss estimates for stages I and II. Table 8 shows the effect of the entry into force of Decree N° 788/03 and the instruction that INTI gave to the verifiers. In the 2007-2008 period, the production of sunflower, soy, wheat and corn totalled 144,224 t, which, at the respective FOB price for each one of the cereals and oilseeds analyzed, implies a loss for the period amounting to U\$S 39,180,020 , to the detriment of cereal producers and storers.

TABLE 8
PRODUCTION AND LOSSES OF CEREALS AND OILSEEDS DUE TO INCORRECT ADJUSTMENT OF SCALES, 2006-2007 AND 2007-2008

	Tonnes ^a	Loss (0.1 %), in t	FOB price (U\$S) ^b	Difference (U\$S)
2006-2007				
Sunflower	4 650 365	4 650	336	1 564 073
Soy	46 238 087	46 238	248	11 443 927
Wheat	16 347 722	16 348	270	4 412 523
Corn	22 016 926	22 017	161	3 533 717
Total	89 253 100	89 253		20 954 239
2007-2008				
Sunflower	2 483 437	2 483	528	1 311 462
Soy	30 993 379	30 993	362	11 222 186
Wheat	8 372 592	8 373	358	2 994 597
Corn	13 121 380	13 121	206	2 697 537
Total	54 970 788	54 971		18 225 782

Source: ECLAC-PTB, 2011.

^a Secretariat of Agriculture, Livestock and Fisheries and Food SAGPyA,

^b Average FOB price SAGPyA.

4. Comparison between Stage III and Stage II

If we conduct an exercise similar to the one performed for the comparison between stages I and II, and we calculate for the same time period (2007-2008) the impact with and without the implementation of the policy (Stage III - Stage II), we can measure the improvement experienced due to the instruction given by INTI with respect to the permissible difference between the gross and tare scales. In this regard, it can be observed that the savings for the sector amount to US\$ and 39,180,020, and in tonnes of grain the improvement was 144,224 t.

TABLE 9
COMPARISON STAGE III AND STAGE II, 2007 TO 2008
(In dollars)

	Sunflower	Soy	Wheat	Corn	Total
Stage III (0.1 %)	2 875 534	22 666 113	7 407 120	6 231 254	39 180 020
Stage II (0.2 %)	5 751 069	45 332 225	14 814 239	12 462 507	78 360 041
Improvement	2 875 534	22 666 113	7 407 120	6 231 254	39 180 020

Source: ECLAC-PTB, 2011.

Another action carried out by INTI was to seal the scales following the verifications, and in this way to implement security measures not previously applied to prevent possible tampering with the instruments.

5. Comparison of the improvement in the 2008-2009 period

Based on production and price-related data, it is possible to estimate the earnings achieved by the policies implemented through a comparison of the situation in the 2008-2009 period, in relation to the three stages analyzed (see table 10).

TABLE 10
COMPARISON STAGE I, II AND III, 2008-2009
(In dollars)

	Tonnes ^a	FOB price (US\$) ^b	Values (US\$)	Stage I (0.67 %)	Stage II (0.2 %)	Stage III (0.1 %)
Sunflower	2 483 437	528	1 311 461 689	8 786 793	2 622 923	1 311 462
Soy	30 993 379	362	11 222 185 980	75 188 646	22 444 372	11 222 186
Wheat	8 372 592	358	2 994 597 072	20 063 800	5 989 194	2 994 597
Corn	13 121 380	206	2 697 537 038	18 073 498	5 395 074	2 697 537
Total	54 970 788		18 225 781 779	122 112 738	36 451 564	18 225 782

Source: ECLAC-PTB, 2011.

^a Secretariat of Agriculture, Livestock and Fisheries and Food SAGPyA,

^b Average FOB price SAGPyA.

For the crop values analyzed, the intention is to show the three stages I, II, III, in the same time period, with the same economic variables, and thus be able to estimate the amount of the producers' money that would have ended up in the hands of the port terminals. The result is the following:

Stage I, without the intervention of INTI, with an error of 0.67%, the producers and storers would have suffered losses of US\$ 122,112,738.

Stage II, with the implementation of Decree N° 788/03, with an error of 0.2%, the losses would have amounted to U\$S 36,451,564 and the improvement brought about by the intervention is equivalent to U\$S 85,661,174.

Stage III, with the instruction given to the verifiers by INTI with regard to the difference between the gross and the tare weight, with an error of 0.1 %, it is noted that the losses amount to U\$S 18,225,782 and the improvement when compared to stage II is U\$S 18,225,782; and when compared to stage I, the total improvement owing to the actions of INTI amounts to U\$S 103,886,956.

It is also important to add that, although they have a high-impact because much of the country's grain production passes through them, the scales under analysis account for a very low percentage of the total number of scales verified.

6. Improvement due to the intervention of INTI

To show the total improvement obtained in stage III (with a permissible difference of 0.1%), we compared the total production of cereals and oilseeds in the 2003 to 2008 period with stage I, when INTI was not acting as a control body, and the permissible difference reached 0.67%.

The total production of cereals and oilseeds in the period from 2003 to 2008 amounted to 511,367,490 t. This was weighted at the average FOB price for the 2008 period, and we compared both situations, with and without the implementation of the policy, thereby obtaining the results shown below.

TABLE 11
COMPARISON WITH AND WITHOUT THE INTERVENTION OF INTI, 2003-2008

	Tonnesa	Without the intervention of INTI		With the intervention of INTI		
		FOB price 2008 (U\$S) b	0.67 %	Difference (U\$S)	0.1 Percentage	Difference (U\$S)
Sunflower	24 928 051	528	167 018	88 198 835	24 928	13 164 005
Soy	269 936 659	362	1 808 576	654 849 059	269 937	97 738 665
Wheat	94 685 645	358	634 394	226 903 638	94 686	33 866 215
Corn	121 817 135	206	816 175	167 789 216	121 817	25 043 167
Total	511 367 490		3 426 162	1 137 740 748	511 367	169 812 052

Source: ECLAC-PTB, 2011.

^a Secretariat of Agriculture, Livestock and Fisheries and Food SAGPyA,

^b Average FOB price SAGPyA.

As a consequence of the entry into force of Decree N° 788/03 and the instruction given by the Legal Metrology Program to the INTI verifiers, the uncertainty of measurement was reduced to 1 %. As a result, in the Republic of Argentina during the period from 2003 to 2008, the losses amounted to U\$S 169,812,052 to the detriment of cereal producers and storers.

By making a comparison for the same time period with and without the implementation of the policy (Stage III - Stage I) and by measuring the improvement achieved by the instruction from INTI's Legal Metrology Program, the reduction in economic conflict in commercial transactions of cereals and oilseeds in dollars is shown to involve savings for the sector that amount to U\$S 967,928,696, which in tonnes of grain is equivalent to an improvement of 2,914,795 t.

7. Indirect impact of a change in the verification of high capacity scales for grain loads: the case of withholding tax on exports

Withholding tax on exports is applied to attenuate the transfer of a sharp increase in international prices to domestic prices. In this sense, the aim of the withholding tax on exports in Argentina was the appropriation by the State of a part of the income generated in the agricultural sector in order to promote

a better distribution of wealth. It was hoped that this mechanism would help to control inflation, by preventing a rise in domestic prices due to an external factor not directly linked to rising production costs, and in turn increase resources to be able to support various kinds of policies and programs.

In this sub-section, a simulation analysis is performed on the impact of the change in the policy on the verification of high capacity scales for grain loads and its impact on the withholding tax on agricultural exports during the 2003-2008 period, focusing on the production of soybeans.

The aim is to show how much the State would fail to collect in withholding tax on soy exports due to differences in the regulatory mechanism of the scales.

TABLE 12
WITHHOLDING TAX ON SOY EXPORTS, 2003-2008, WITHOUT INTERVENTION

Year	Tonnesa	FOB price 2008 (US\$) b	Without the intervention of the INTI		With the intervention of the INTI			
			0.67 %	Loss	Loss on withholding tax 35% (US\$)	0.1 %	Loss	Loss on withholding tax 35% (US\$)
2003	8 850 610	190	59 299	11 266 827	3 943 389	8 851	1 681 616	588 566
2004	6 667 820	200	44 674	8 934 879	3 127 208	6 668	1 333 564	466 747
2005	9 822 630	183	65 812	12 043 527	4 215 234	9 823	1 797 541	629 139
2006	8 177 100	183	54 787	10 025 942	3 509 080	8 177	1 496 409	523 743
2007	12 028 200	248	80 589	19 986 057	6 995 120	12 028	2 982 994	1 044 048
2008	11 847 200	362	79 376	28 734 199	10 056 970	11 847	4 288 686	1 501 040
Total	57 393 560		384 537	90 991 430	31 847 001	57 394	13 580 810	4 753 284

Source: ECLAC-PTB, 2011.

^a Secretariat of Agriculture, Livestock and Fisheries and Food SAGPyA,

^b Average FOB price SAGPyA.

Now, for the present simulation analysis a series of critical assumptions were made:

- Exports of soybeans only, in the 2003-2008 period;
- Average FOB prices for the period; and
- Implementation of the tax rate of 35%²⁰

Under these assumptions with respect to the export of soy beans, and supposing that the same policy of a withholding tax on the export of soy beans had been implemented from early 2003 until 2008, during this period of time the State would have failed to collect US\$ 31,847,001 in withholding tax. With the implementation of decree n° 788/03 and the instruction given by INTI with respect to the methodology for adjusting scales, the State would fail to collect US\$ 4,753,284, which means that the economic impact would be of the order of US\$ 27,093,717. This improvement translates into a better redistribution of income and more funds for public investment.

C. Conclusions

The regulations in force establish the maximum error tolerated in the main measurement instruments used in commercial transactions. But from the analysis of results obtained from the metrological

²⁰ Decree N°. 1176/08 of the National Executive, repealing Resolution No. 125/08 reestablishing Resolutions N°. 368 and 369 of the Ministry of Economy and Production of the 7 November 2007.

control carried out by INTI we have shown throughout this study that a company operating with multiple measuring instruments can manipulate them to its own advantage while still remaining within the maximum error established by the regulations for each one of these instruments.

We can cite the high capacity scales as evidence of INTI verifiers have systematically found gross scales that were under weighed and tare scales over weighed, with the users of the scales appropriating both differences for themselves.

On the basis of these results, INTI has drafted a resolution to be adopted by the National Secretariat of Internal Trade, which aims to prevent the use of legal tolerances for personal benefit, and thus seeking to protect the different parties involved in commercial transactions.

Given the evidence collected, the draft resolution aims to:

- Prohibit users of measuring instruments, regulated by law 19,511, whose measurements are employed for carrying out commercial transactions, from making systematic use of their maximum permissible errors for their own benefit;
- That in establishments of any kind that use in business transactions several regulated instruments of the same type, the confirmation during the periodic verification or monitoring of the use of an average of their errors (each calculated regarding the personal benefit), which exceed half of the maximum permissible errors, shall be construed as systematic use covered by the previous article.

Furthermore, the social return on public-sector investment is very high, since INTI's work in legal metrology is financed almost entirely with the fees charged for verifications, in other words, with a low percentage of contribution by the National Treasury. The budget for the 2009 period for the Legal Metrology Program was \$ 7,500,000, including investments, largely funded by the fees charged for the verifications of scales, pumps and storage tanks. If we take into account that improvements in the study of scales amount to U\$S 967,928,696, the cost-benefit ratio is extremely high.

In this way, INTI's Legal Metrology Program seeks to make increasing progress in the struggle to improve equity and ensure the just enforcement of contracts and agreements. In this regard, the State is called upon to strengthen its role in the fight against the tampering with measuring instruments and ensure the protection of the parties involved in commercial transactions.

The experience gained from 2003 to date with regard to metrological control and the evidence presented in this study demonstrate the importance of the role of the State in guaranteeing transparency in commercial transactions between the parties involved, whether they are consumers, companies, agricultural producers or even the State itself.

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V. Economic impact study of the verification of liquid fuel pumps²¹

*Mariela Saavedra*²²

A. Introduction

The importance of Metrology (“the science of measurements”) goes unnoticed at first sight, but becomes clear as soon as we begin to analyze daily life in detail. Anyone who buys products at the market by weight, anyone who fills his car up with petrol, and anyone who pays his electricity bill depends on correct measurements to ensure fair business dealings. Anyone who has his blood pressure taken at a doctor’s surgery or has clinical tests to determine his cholesterol level depends on correct measurements in order to care of his health. We rely on measurements to know if the air we breathe or the water we drink is free from contaminants. When buying any product, it is the trust in the measurements taken of it that determines our trust in its features. The adding of value to the production of goods and services is supported by innovation, and innovation requires increasingly sophisticated measurements. One example of this is exportable production, which is subjected to measurements that often become technical barriers to trade (TBT). This role of metrology as a basic infrastructure of society is the one that, centuries ago, led States to establish legislative instruments that regulate and promote metrological activity.

According to the sphere of action, and to facilitate its study, metrology is often subdivided into scientific, industrial and legal branches. Within the scope of legal metrology are included those measurements that are regulated by States because they impact on equity, trade, public health, care of

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²² Administrative Coordinator of INTI’s Metrology and Measurement Quality Program. The author gratefully acknowledges the collaboration of Leandro Garcia and Constantino Martinez, who provided the data necessary for the completion of this study. She is also grateful to Dr. Hector Laiz, the Director of Metrology at INTI, for defining the topics of study and for the general supervision of the work.

the environment, or safety. Fraudulent practices that harm the consumer, the producer, the State and other sectors of the community have always existed, either due to ignorance or because they are carried out deliberately through manipulation of the instruments, or their misuse, and have a significant negative impact on competitiveness, quality of life or well-being.

The need for an effective system of legal metrology is unquestionable. Argentina has not been immune to this fact and has undergone a long learning process. The present study aims to give an idea of the magnitude of the economic impact of the work carried out by INTI (National Institute of Industrial Technology) in this area, since the change in legislation introduced in 2003.

Legal metrology varies between different countries in aspects such as:

- The degree of implementation or coverage;
- The nature of the entities responsible for its implementation;
- The nature and content of the requirements and their implementation; and
- The economic and technical development of the country, as well as the importance and the resources given to it.

However, a common element is that within each country it is necessary for the various sectors—consumers, businesses, the State, etc—to be able to understand the importance of the quality infrastructure. In addition, it is essential that all the parties involved begin from the same premises, assign the same meaning to measurements, and agree on the required quality standards.

Based on the analysis of a series of measuring instruments, the present study attempts to identify and quantify the losses caused by the inappropriate use of these instruments. It can be concluded from the study that the State must have a strong presence in national metrological control, and seek to build trust and transparency among the parties involved in transactions, so as to prevent the occurrence of these losses and inefficiencies, which are costly, both economically and socially.

In Argentina, since 2005, INTI has been performing verification of liquid fuel pumps throughout the country. The verification consists of the detection of deliberate tampering with pumps and the measurement of error of the instrument when delivering 20 litres. According to the regulations in force, this error must be less than 120 ml (0.6%).

We will use the term "bias" to refer to the average error of the pumps. If we weight these biases according to each company's market share, we obtain the complete bias of the country's petrol pumps. Table 4 shows these results.

We have demonstrated that analysis of the results obtained from the metrological control carried out by INTI suggests that a company operating with multiple measuring instruments can manipulate them to its own advantage and still be within the maximum error established by the regulations individually for each one of them.

B. Economic impact of the verification of pumps

We will now analyze the economic impact of the intervention of INTI in the verification of liquid fuel pumps.

Since 2005, INTI has been conducting the verification of liquid fuel pumps throughout the Republic of Argentina. The verification consists of the detection of deliberate tampering with pumps and the measurement of error of the instrument when delivering 20 liters. According to the current regulation (Decree N° 5410 of 30 June 1932 and Resolution of the former SCI N° 50 of the 28 March 1988) this error must be less than 120 ml (that is to say 0.6%).

The universe for the study covers a sample of 864 service stations verified during the period from 2006 to 2008, taken at random from a total of 5,000 located in different provinces of Argentina. The number of petrol pumps considered amounts to 14,271, and the information was extracted from each of the periodic verifications carried out on the petrol pumps of the service stations included in the sample. The result obtained was averaged based on the number of petrol pumps per station, including those that were withdrawn for being outside of tolerance.

A petrol pump is considered to be "outside of tolerance" when the measurement error of the pump is greater than the tolerance limit allowed by the regulations, which, as stated, is 120 ml for every 20 litres (0.6% or 6 per thousand). In such case the pump is taken out of operation and must be verified again by INTI to lift the suspension.

The results obtained were grouped together according to the petrol dispensing companies: ESSO, YPF, Shell, Petrobras, non-brand companies and others (Sol, EG3, Rhasa, etc.). Also, from the average obtained per hose and grouped by company, an average is obtained per number of service stations in the sample per company, and the average "bias" (average error of the pumps) is then calculated per company and estimates are calculated for the years 2006, 2007 and 2008 (see table 13).

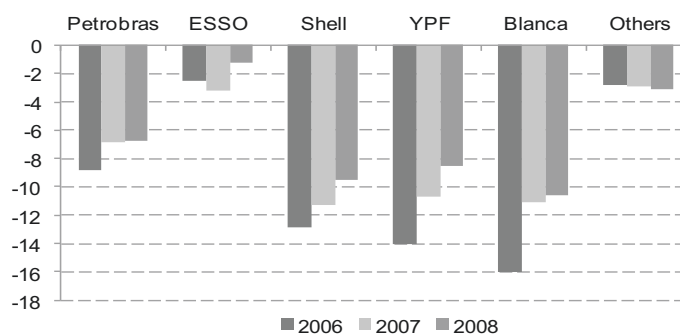
TABLE 13
BIAS PER PETROL PUMP GROUPED BY COMPANIES, 2006-2008

Company	2006			2007			2008		
	Serv. Stat.	Petrol pump	Bias ML /20 l	Serv. Stat.	Petrol Pump	Bias ML /20 l	Serv. Stat.	Petrol Pump	Bias ML /20 l
Petrobras	22	310	-63.5	32	448	-49.2	32	436	-48.6
ESSO	52	873	-21.3	41	747	-27.2	41	757	-11.0
Shell	72	1 433	-75.9	63	1 245	-66.5	63	1 249	-55.7
YPF	109	1 802	-41.1	93	1 804	-31.2	77	1 425	-25.1
Non-brand	51	364	-100.8	30	346	-60.5	24	267	-58.2
Other	43	559	-54.1	11	124	-56.0	8	82	-59.4
TOTAL	349	5 341		270	4 714		245	4 216	

Source: ECLAC-PTB, 2011.

Based on the results found, a trend is observed toward a reduction in the bias per company, in relation to the same company from the 2006 to 2008 period on (see Figure 1).

FIGURE 1
BIAS OF PUMPS GROUPED BY COMPANY



Source: ECLAC-PTB, 2011.

It is clear that, while individually petrol pumps can have errors of up to 120 ml, when we consider the average of many petrol pumps the error should tend toward zero, which in reality is not found to be the case (table 14 shows the average bias by company and by year).

That is to say that all of the companies deliver, on average, less than they should. If we weight these biases according to each company's market share (table 15 shows the market share of each company), we obtain the complete bias of the country's petrol pumps. Table 4 shows these results.

TABLE 14
SUMMARY OF BIASES BY COMPANY AND BY YEAR

Company	2006	2007	2008
	ml /20 l	ml /20 l	ml /20 l
Petrobras	-63.56	-49.23	-48.62
ESSO	-21.32	-27.28	-11.01
Shell	-75.99	-66.54	-55.76
YPF	-41.16	-31.29	-25.09
Non-brand	-100.81	-60.57	-58.21
Other	-54.12	-56.09	-59.43

Source: ECLAC-PTB, 2011.

TABLE 15
MARKET SHARE OF EACH COMPANY, 2008
(As a percentage)

Non-brand	18.26
ESSO	11.60
Petrobras	13.88
Refinor	1.18
Rhasa	0.67
San Lorenzo	0.67
Shell	16.98
Sol	2.13
YPF	34.08
Various (Dapasa, ASP, Líder Gas, Mak, RAM)	0.55
Total	100.00

Source: ECLAC-PTB, 2011.

TABLE 16
TOTAL BIAS OF THE COUNTRY'S PUMPS BY YEAR, 2006-2008

Service Stations	% Of	2006	2007	2008
	Market	(ml /20 l)	(ml /20 l)	(ml /20 l)
Petrobras	13.88	-8.82	-6.83	-6.75
ESSO	11.60	-2.47	-3.17	-1.28
Shell	16.98	-12.90	-11.30	-9.47
YPF	34.08	-14.03	-10.67	- 8.55
Non-brand	18.25	-16.06	-11.06	-10.63
Other	5.19	-2.81	-2.91	3.09
TOTAL	100.00	-57.10	-45.93	-39.76

Source: ECLAC-PTB, 2011.

On the basis of the estimates made, a positive shift is observed in the total bias of the pumps as the verifications progress (from -57.10 in 2006 to -39.76 in 2008). To economically value this bias, we took the total number of litres of fuel sold during 2008 (excluding agriculture and public transport), calculated the number of litres represented by the total average bias and multiplied this number by the average price of the fuels (see table 17).

TABLE 17
ANNUAL FUEL SALES AT SERVICE STATIONS, 2008
(In litres)

Fuel Types	Litres per year ^a
Normal petrol	389 389 000
Super petrol	3 847 246 000
Premium petrol	1 291 511 000
Diesel	9 350 000 000
Total	14 878 146 000

Source: ECLAC-PTB, 2011.

^a Not including fuel corresponding to 3,500,000,000 litres for the agricultural sector and 1,000,000,000 litres per year for public transport.

TABLE 18
ECONOMIC LOSSES DUE TO THE BIAS OF PUMPS

Year	Sales. (In litres)	Bias in ml/20 l.	Difference in l.	Average Price / l.	Losses(in \$)
2006	14 878 146 000	-57.10	-42 477 107	3.35	142 298 308
2007	14 878 146 000	-45.93	-34 167 662	3.35	114 461 669
2008	14 878 146 000	-39.76	-29 577 754	3.35	99 085 477

Source: ECLAC-PTB, 2011.

In other words, the amount of money that should have remained in the hands of consumers but was appropriated by the fuel companies due to bias was \$142,298,308, \$114,461,669 and \$99,085,477 for the years 2006, 2007 and 2008, respectively (at 2008 prices). This means that, due to the progress of the verification, there was an improvement of \$43,121,831.

The figure of \$43,121,831 is an indicator of the annual benefit obtained by consumers by ensuring that measuring instruments gradually tend towards an operating range with zero error and are not systematically calibrated with a tendency to indicate a higher amount sold than has actually entered the user's fuel tank. This amount of money transferred annually to customers, who are the weakest link in this market, is significantly greater than the cost of all the metrological control programs funded by the State.

C. Conclusions

The present study identified and quantified the losses resulting from the improper use of measuring instruments.

The regulations in force establish the maximum permissible errors in the main measuring instruments used in commercial transactions but, through the analysis of the results obtained from the metrological control by INTI, we have shown throughout this study that a company that operates with

multiple measuring instruments can manipulate them to its own advantage and still be within the maximum error established by the regulations individually for each one of them.

As evidence we can argue that at service stations selling fuel, almost all the average biases of the pumps are negative, which is highly detrimental to the consumer.

On the basis of these results, INTI has drafted a resolution to be adopted by the National Secretariat of Internal Trade, which aims to prevent the use of legal tolerances for personal benefit, and thus seek to protect the different parties involved in commercial transactions.

The present study also demonstrates the importance of the role of the State in national metrological control. The role of the State is vital for creating trust and transparency in transactions, in order to prevent costly losses and inefficiencies, both economic and social in nature.

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VI. Impact assessment based on the implementation of Resolution JD 760 of the ASEP with respect to electrical energy meters²³

Gabriela de la Guardia

A. Introduction

In 1995, Panama began to reform its electricity sector with a legislation that allowed the participation of the private sector.

As the Regulatory Authority for this service, it is the job of the National Authority of Public Services (ASEP) to set out the entire regulatory framework to ensure that the service is provided in accordance with the objectives established in the sector's legal framework and other related legislation.

This study analyzes and presents a number of impacts that have resulted from the implementation of these regulations and their respective verification by CENAMEP. The main results to be presented include most notably the obvious improvement in the measurements performed by the electrical energy meters used at the residential level and, consequently, the reduction in incorrect measurement associated with the commercial exchange between companies and residential customers.

By means of Law N° 26 of 29 January 1996, the Public Services Regulatory Body (hereinafter the regulatory body), was created as an autonomous State agency, with the power to regulate and control the delivery of public services for the supply of drinking water, sewage, electricity and telecommunications.

²³ The authors gratefully acknowledge the National Authority of Public Services - ASEP, which authorized CENAMEP AIP, through verifications and audits, to demonstrate compliance with the Technical Regulations, the Authority's Resolution and the verification of residential energy meters. They also thank the University of Technology, specifically the Faculty of Industrial Engineering, as well as the electricity distribution companies, ENSA and EDEMET-EDECHI for their cooperation. Lastly, thanks are due to the German Technical Cooperation of the PTB, the Technical University of Berlin and the other agencies and National Metrology Institutes for their participation.

On 3 February 1997, Law N° 6 was passed, which dictates the regulatory and institutional framework for the provision of the public electricity service. It also establishes the regime governing the activities of generation, transmission, distribution and marketing of electrical energy.

On 10 June 1998, in the Official Gazette N° 23,561 is published the Resolution JD-760 (5 June 1998), by means of which the Public Services Regulatory Body defines the measurement standards applicable to regulated customers, according to which the electricity distribution companies carry out measurements of the consumption of electrical energy by the customers covered by the public service.

The parameters addressed by the Resolution concern to:

- The measurement standards applicable to regulated customers, for the public service of electricity distribution, which is limited to energy meters;
- The concession contracts for the public service of electricity distribution,
- Informing companies that provide the distribution and commercialization service that the regulatory body will ensure compliance with the provisions of this resolution and those set out in their concession contract.

Resolution JD 760 thus determines technical aspects such as acceptance criteria, calibration and maintenance of measuring instruments including energy meters, and transformers; the former being, in the category of residential customers, the ones covered by the scope of the present study. This resolution should be considered as a technical regulation, established by the regulatory and supervisory authority on the matter, which is to say that within the quality infrastructure these documents are an essential part of standardization. In addition, in the standardization body of Panama there is other technical regulation on the matter: DGNTI COPANIT 70:2004 Metrology and Measurement.

Within its supervisory role, the current Public Services Authority (ASEP), previously the Public Services Regulatory Body, must ensure compliance with all the parameters set forth in the aforementioned documents. Therefore, it fulfills the role of an evaluator of compliance in various ways. This study presents the aspect of subcontracting, with regard to which Resolution N° JD-3332 of the Public Services Regulatory Body authorizes SENACYT, through the National Metrology Centre of Panama (CENAMEP), to perform the metrological verification of electricity measuring instruments in accordance with Resolution N° JD-760. This centre thus becomes the technical evaluator of compliance with the parameters set out in the resolution, as well as in later editions of the Technical Regulations DGNTI-COPANIT 70 of 2004.

B. Power generation

In Panama, electricity is generated by either by hydroelectric or thermoelectric generators. According to statistics,²⁴ in 2000, the percentage share of electric power, 49.1% had a hydroelectric source and 50.9% thermoelectric, while for 2010 the share was 47.4% for hydroelectric and 52.6% for thermoelectric.

The distribution of electrical energy in the country is undertaken by three concessionary companies:

- Empresa de Distribución Eléctrica Metro Oeste, S.A. (EDEMET), whose concession area consists of the western part of Panama City, the west of the province of Panama and the provinces of Coclé, Herrera, Los Santos and Veraguas.

²⁴ Ministry of Energy WWW.energy.gob.pa.

- Elektra Noreste, S.A., (ELEKTRA) whose concession area includes the east of the city and province of Panama, the Gulf of Panama, the province of Colon and the isolated systems of Darien and Kuna Yala.
- Empresa de Distribución Eléctrica Chiriquí, S. A: (EDECHI), whose concession area is located in the provinces of Chiriqui and Bocas del Toro. There is also the Bocas Fruit Company, which is a self-producer that sells its surplus to the population of Changuinola, Guabito, Admiral and Las Tablas in the province of Bocas del Toro, under a legal contract that permits such sale without it having a concession area of distribution.

In 2000, there were 523.3 thousand customers throughout the Republic, and by 2010 there were 824.9 thousand. In that same year of 2010, the customers were split among the distribution companies, as follows 43.8% EDEMET; 43.0% ELEKTRA; 13.2% EDECHI. However, out of these totals, EDEMET had 314,838 residential customers, ELEKTRA 325,233 and EDECHI, 96,540, which is to say that in the country as a whole there were 736,611 residential customers. In addition, the sales of electrical energy were divided among the distribution companies and the residential sector as follows: EDEMET - with 910,370 MWh; ENSA - with 872,384 MWh; EDECHI25 with - 191,290 MWh.

During 2010, electrical energy sales in the country amounted to a total of 6,232,480 MWh, and of this total, 1,974,044 MWh corresponded to the residential sector, in other words. 31.7 % of the total energy was sold directly to the sector analyzed in this study. Other sectors covered by energy sales include: the commercial sector—which is the largest with 41.8 % of the total—, industry, government, public lighting, and large customers.

The rates established for customers with low voltage connections, that is to say, those whose voltage is equal to or less than 600 volts, is classified as: i. Simple rate (BTS): customers whose maximum demand is equal to or less than 10kW per month; ii. Maximum demand rate (BTD): customers with a demand greater than 10kW per month; iii. Hourly block rate (BTH): customers whose usage takes into account different prices for different time periods, during peak or off-peak demand periods

The total income received by the electricity distribution companies from tariffs include the costs of the three components of the system: generation (G), transmission (T) and distribution and commercialization (D and C). The actual data that are available refer to the total income received by distribution companies, the value of the income received by the transmission company and the total income received by the generators. The cost of the distribution and commercialization component is obtained from the difference. According to the provisions of the regulations and the lists of rates for transmission, the generation and distribution companies are the ones that pay the charges for the transmission rate. The transmission charge paid by the distribution companies is passed on to the end customers, while transmission charges paid by the generators are already included in the cost of generation. In this respect, for 2003, 58% of the cost allocation corresponds to the electricity generation companies, 8% to the transmission company and 34% to distributors.²⁶

C. Method and interventions carried out

1. Description of interventions

Between 1996 and 1998 started the process of restructuring of State institutions, culminating in the privatization of the hitherto State-owned electricity company responsible for the entire process, from

²⁵ Although more recently the company has operated as EDEMET-EDECHI, the statistics analyzed here refer to when the company was EDECHI.

²⁶ See the report “Prices and Incomes” in <http://www.Asep.gob.pa>.

generation and transmission to distribution. In the case of distribution, concessions were given to three companies for different sectors of the country, with the State nonetheless retaining a percentage of the shares in these three companies.

In March of 1998, the Public Services Regulatory Body (now ASEP), promulgated Resolution JD-219, which approved the tariff regime for the public service of electricity distribution to be applied to all companies providing the service of distribution and commercialization. It then enacted resolutions that set the rate of return applicable to each one of the distribution companies, and in that same year the government signed the 15 year concession contract with three companies for the operation and exploitation of the electrical distribution system, namely: Empresa de Distribución Eléctrica Metro Oeste, S.A. (EDEMET), Elektra Noreste, S.A., (ELEKTRA), Empresa de Distribución Eléctrica Chiriquí, S.A: (EDECHI).

In June of 1998 Resolution JD 760 was enacted, which approved the measurement standards applicable to regulated customers, for the service of electricity distribution, along with Resolution JD 764, stipulating the quality standard of the technical service for the distributors of the public electricity service and for customers connected to it. Also promulgated was Resolution JD 765, stipulating the quality standard of the commercial service for the companies that provide the public service of electricity distribution.

However, it was not until May of 2002, that the public services regulatory body issued Resolution JD 3332 authorizing the National Secretariat for Science, Technology and Innovation (SENACYT), via the National Metrology Centre of Panama (CENAMEP), to perform the metrological verification of electricity measuring instruments in accordance with Resolution JD 760.

Since the publication of this resolution, CENAMEP has been contracted in three different periods (2003, 2007-2008, 2010-2011), to carry out the metrological verification of a representative sample of the universe of energy meters installed in the Republic of Panama (approximately 1,200) to determine their technical compliance. In the same manner and for the same periods, a group of CENAMEP collaborators visited the laboratories of the electricity distributors to attest their technical competence, methods, equipment and infrastructure for performing metrological verifications of energy meters.

2. Expected impacts

CENAMEP AIP seeks to demonstrate scientifically how this transactional system has behaved using the results of three periods of meter verifications, which constitute a random sample of the meters, and extrapolating them to the national level. Another of the impacts it aims to establish and determine is how the errors of each measuring instrument, stipulated in the regulations, can affect the measurement of the energy consumed by each customer and in turn the total amount billed.

Results will be presented in particular with regard to:

- The reduction in incorrect measurement during three consecutive periods, based on the three verifications performed.
- Estimating the economic impact of the incorrect measurements in each period and comparing the periods, by taking the average consumption and price for the year 2010.

3. Results

TABLE 19
ON THE DECREASE IN METERS OUTSIDE OF THE PERMITTED LIMITS.
GENERAL DATA OBTAINED FROM THE VERIFICATION (2003, 2007-2008, 2009-2010)

	2003	2007/2008	2009/2010
Total sample	1208	1186	1093
Total n° of meters not verified	3	12	13
Meters discarded from the sample for being outliers	4	2	1
Number of meters, whose results, were taken into account	1201	1172	1079
N° of electromagnetic meters outside of lower limit ≤ -2	14	18	6
N° of electromechanical meters outside the upper limit ≥ 2	18	12	7
Total n° of electromechanical meters outside limit	32	30	13
	2003	2007/2008	2009/2010
% of electromechanical meters outside the limits	2.66 %	2.56 %	1.20 %
N° of electronic meters outside of lower limit ≤ -0.5 Series	18	2	3
N° of electronic meters outside of upper limit ≥ 0.5	0	0	0
Total n° of electronic meters outside the limits	18	2	3
% of electronic meters outside the limits	1.50 %	0.17 %	0.28 %
Total n° of meters outside the limits	50	32	16
% of the total number of meters outside the limits	4.16 %	2.73 %	1.48 %

Source: own elaboration.

The above table clearly shows how the number of meters outside of the permitted limits has decreased over the periods.

4. Assumptions of the evaluation

To carry out the evaluations, data for 2003 were used, relating to the variables of average annual consumption, per kWh and total customers.

5. Results based on an integrative approach

The economic impact calculations were performed using the same universe of customers/meters for the year 2003 (528,628), since otherwise the variation in the universe might affect the impact. Similarly, the same price per kWh of 2003 (B/.1220) was used to avoid variations due to the different prices in each period. The same average monthly consumption per residential customer for the year 2003 (206 kWh) was also used to avoid distortions. In addition, the average error was obtained from the total sample of meters, with only those meters not verified and outliers in each period being eliminated. That is to say, this approach takes into account at once the universe of meters in the sample and then extrapolates it to the universe.

TABLE 20
ERRORS BY PERIOD AND THEIR IMPACT, WITH AVERAGE ERRORS OF THE TOTAL
SAMPLE. CASE OF ELECTROMECHANICAL METERS

Indicator	2003	2007/2008	2009/2010	Impact of the intervention
Average error in meters with + error	0.55%	0.46%	0.41%	0.14%
Average economic value of the + errors	B/.1.66	B/.1.39	B/.1.24	B/.0.42
Average error in meters with - error	-0.57%	-0.58%	-0.50%	-0.07%
Average of economic value of the -errors	B/. (1.72)	B/. (1.75)	B/. (1.51)	B/. (0.21)
Total economic value of the errors	B/.1 785 568.36	B/.1 658 027.77	B/.1 450 774.30	B/. 334 794.07

Source: own elaboration.

TABLE 21
ERRORS BY PERIOD AND THEIR IMPACT, WITH AVERAGE ERRORS OF THE TOTAL
SAMPLE. CASE OF ELECTRONIC METERS

Indicator	2003	2007/2008	2009/2010	Impact of the intervention
Average error in meters with + error	0.08 %	0.07 %	0.08 %	0.00 %
Average economic value of the + errors	B/.0.24 Paper feed unit	B/.0.21	B/.0.24 Paper feed unit	B/-
Average error in meters with - error	-0.72%	-0.14%	-0.17%	0.55 %
Average of e economic value of the -errors	B/. (2.17)	B/. (0.42)	B/. (0.51)	B/. (1.66)
Total economic value of the errors	B/. 1 275 405.97	B/. 334 794.07	B/. 398 564.37	B/. 876 841.61

Source: own elaboration.

Therefore, the total economic impact, according to this approach, was B/.1 211 635.68.

6. Results based on another differentiator by error type

As in the integrative approach, the economic impact calculations were performed using the same universe of customers/meters for the year 2003 (528,628), the price per kWh for the same year (B/.0.1220), as well as the same average monthly consumption per residential customer for 2003 (206 kWh) in order to avoid distortions.

Based on this approach it would be necessary to analyze the impact on the reduction of errors in the meters, both outside and within the permitted limits, since the improvement in the reduction of errors took place to the whole universe of electricity meters. What were performed separately, therefore, were the impacts on the errors outside of the limits and then, since they were also reduced, the errors within the limits (this is an even better measurement).

The mathematical model developed and used for the calculations in this approach is:

VEE=

Where:

VEE= Economic Value of the Error

= Subsample (# of meters, in the sample, outside of the limits, by type of meter - electromechanical or electronic - and, type of limit - $\pm 2\%$ or $\pm 0.5\%$ -.

= Cost per kWh for the year 2003 (B/.0.1220)

= Absolute value of the error of a meter in the subsample

= Average monthly consumption in kWh, per client, per month, in the year 2003 (206 kWh)

= Time factor for annualizing (12 months)

= Total n° of meters, by type, within the universe (528,628 for the year 2003)

= Total n° of meters, by type, in the sample from the period (electronic or electromechanical)

Where:

= sample - total meters verified in a period -.

= Conversion Factor

= Percentage, of a type of meter, within the sample

= Universe of meters (528,628 for the year 2003)

TABLE 22
ECONOMIC VALUES, BY PERIOD AND THEIR IMPACT, ONLY ANALYZING THE METERS
OUTSIDE OF THE ESTABLISHED LIMITS. CASE OF ELECTROMECHANICAL METERS

Indicator	2003	2007/2008	2009/2010	Impact of the intervention
Economic Value of the + errors	B/. 121 434.37	B/. 47 929.75	B/. 3 201.75	B/. 118 232.62
Economic Value of the - errors	B/. 118 905.59	B/. 99 545.87	B/. 30 850.88	B/. 88 054.71
Total economic value of the errors in electromechanical meters	B/. 240 339.95	B/. 147 475.62	B/. 34 052.63	B/. 206 287.32

Source: own elaboration.

TABLE 23
ECONOMIC VALUES, BY PERIOD AND THEIR IMPACT, ONLY ANALYZING THE METERS
OUTSIDE OF THE ESTABLISHED LIMITS. CASE OF ELECTRONIC METERS

Indicator	2003	2007/2008	2009/2010	Impact of the intervention
Economic Value of the +errors	B/.0	B/.0	B/.0	B/.0
Economic Value of the - errors	B/.39 617.50	B/.1 543.93	B/.3 302.28	(B/. 36 315)
Total economic value of the errors in electronic meters	B/.39 617.50	B/.1 543.93	B/.3 302.28	(B/. 36 315)

Source: own elaboration.

Therefore, the economic impact with respect to all the meters outside the permitted range was B/.242 602.54.

TABLE 24
ECONOMIC VALUES, BY PERIOD AND THEIR IMPACT, ANALYZING THE METERS
WITHIN THE ESTABLISHED LIMITS. CASE OF ELECTROMECHANICAL METERS

Indicator	2003	2007/2008	2009/2010	Impact of the intervention
Economic Value of the + errors	B/. 364 143.80	B/. 286 469.84	B/. 314 625.75	B/. 49 518.05
Economic Value of the - errors	B/. 213 822.72	B/. 326 387.49	B/. 265 726.82	B/. 51 904.10
Total economic value of the errors in electromechanical meters	B/. 577 966.52	B/. 612 857.33	B/. 580 352.57	B/. 2 386.05

Source: own elaboration.

TABLE 25
ECONOMIC VALUES, BY PERIOD AND THEIR IMPACT, ANALYZING THE METERS
WITHIN THE ESTABLISHED LIMITS. CASE OF ELECTRONIC METERS

Indicator	2003	2007/2008	2009/2010	Impact of the intervention
Economic Value of the + errors	B/. 4 945	B/. 3 019.84	B/. 5 703.28	B/. 759
Economic Value of the - errors	B/. 7 340.75	B/. 10 528.63	B/. 13 748.44	B/. 6 408
Total economic value of the errors in electronic meters	B/. 12 285.47	B/. 13 548.47	B/. 19 451.72	B/. 7 166

Source: own elaboration.

The economic impact with regard to all the meters within the limits permitted was B/9 552.05.

While the total economic impact, according to this approach, was B/.252,154.85. This result demonstrates that, increasingly, companies/clients are paid and pay, respectively, for what they sell and/or use. This is a reduction in the unfairness of commercial transactions in this sector.

D. Assessment of the results and conclusions

As we have seen from the results of both approaches, the percentage of meters that are outside the permitted limits, and the economic value it represents, has decreased in each verification period.

It is important to clarify that the average consumption is within the range of the subsidy given to customers by the State, and it can therefore be assumed that most of these impacts do not affect the end-user but rather the money which is paid out by the government.

In addition, it was observed that over the course of the verification periods there appear in the sample various meters that could not be verified and that displayed measurement problems that negatively affect the companies, which provides an incentive for replacing meters.

1. Some recommendations

Some of the recommendations that we presented to the various stakeholders include:

- Updating regulations to require and evaluate conformity on the part of the supervisory authorities on the matter, i.e. that of energy meters, whether it be ANSI or IEC, transformers and for other types of clients, not only residential ones.
- Supporting the development of metrology in Panama, since it is clearly shown that good metrology saves on losses and costs and in the short term these savings can be used for other investments.

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VII. Evaluation of the impacts resulting from the development of certified reference material for ethanol in water: an analysis based on a multicriteria method²⁷

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The objective of this article is to analyze and discuss the impacts related to a technological innovation developed by a public technology institution. To do this, a multi-criteria/qualitative methodology was employed. This methodology was used in the assessment of an Inmetro R&D Project that was aimed at developing a certified reference material (CRM) to be used as input for the execution of the Brazilian Dry Law. Two criteria were analyzed: economic and capacity building. Both criteria were defined as medium positive. It was also possible to observe that the R&D project analyzed achieved the objective, mainly due to the fact that Brazil became self-sufficient in the production of the CRM used in the calibration of breathalyzers.

A. Introduction

This article aims to present and analyze the impacts associated with the research efforts carried out by a public technological institute. In spite of the recent introduction onto the public agenda of debates related to monitoring and assessment practices, this analysis is especially relevant since impact assessment studies on public-sector research are rare and limited due to a chronic lack of data. In that respect, the greatest contribution of this article is related to the fact that it allows for the observation of some of the many possible impacts of public-sector investment in R&D.

²⁷ The authors would like to thank Jorge Goncalves and Jan Peuckert for their contributions to the writing of this article, and exempt them from responsibility for any possible errors or omissions in the final version.

The research project assessed is related to the development of a Certified Reference Material (CRM)²⁸ for ethanol in water, used as a standard for the calibration of breathalyzers, which, in turn, are used to combat drink-driving (“Lei Seca” or the “Dry Law”).

In general, measuring instruments need to undergo frequent calibration to ensure the accuracy of their measurements. How do we know, then, if a ruler or a set of scales is correct? Or, how can we know if the popular breathalyzers are functioning in accordance with what is stipulated in the legislation? Without a standard solution, it would be necessary to find someone who is very drunk and who, by blowing into the instrument, would prove that it is in working order. Since that option is imprecise to say the least, a stable and traceable standard chemical solution is required.²⁹ To simulate the breath of an intoxicated individual, then, we use the CRM, which works as a standard measure or weight applied to the field of chemistry. Thus, this assessment study focuses on the impact of the introduction and development of this reference material.

To achieve the proposed objective, this article is divided in three sections. The first section presents the assessed R&D project, as well as the context within which the reference material is used. The second section analyzes the assessment methodology used, which is mainly based on a method that is already established and well known in Brazil. The third and final section presents and discusses the results found.

B. The assessed R&D project and its context of application

In 2010, 41,678 people died in automobile-related accidents in Brazil. It is estimated that alcohol consumption was responsible for 32.1% of those deaths, i.e., 13,379 victims (Datusus, 2011 and Stampe et. al., 2010).³⁰ In that same context, it is estimated that, in 2008, alcohol consumption was responsible for 176,651 non fatal victims (Renaest, 2008 and Soibelman et. al., 2010).

This correlation between the ingestion of alcoholic beverages and accidents with fatal and non-fatal victims has long since been established. In an article published in the American Journal of Medicine back in 1938, Richard and Holcomb analyzed the relationship between alcohol consumption and traffic accidents. This publication, which was one of the first on the subject, was followed by many others that became increasingly sophisticated and segmented over time. It thus became possible to relate certain factors of influence (age, sex, time and degree of intoxication) with the likelihood of automobile-related accidents. Notably, it is observed that a young age, male gender, night-time hours and a high level of alcohol intoxication are associated with a large number of accidents (Moskowitz and Fiorentino, 2000).

During the 1940s, Brazil began to apply penalties to drivers driving motor vehicles under the influence of alcohol. Since then, the regulations governing the issue have evolved, culminating in the introduction of more severe restrictions—in relation to the use of alcoholic beverages—in the Brazilian Traffic Code [Código Brasileiro de Trânsito] (CBT). These restrictions became popularly known as the “lei seca or dry law”. The most recent modifications to the CBT, dating from the end of

²⁸ In accordance with the definition provided by the International Vocabulary of Metrology, reference material (RM) is that “material, sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in measurement or the analysis of qualitative properties”. Certified reference material is RM accompanied by documentation issued by a recognized body (INMETRO, 2012).

²⁹ Traceability can be defined as a: “property of a measurement result whereby the result can be related to a reference through a documented and unbroken chain of calibrations, each contributing to the uncertainty of measurement” (INMETRO, 2012).

³⁰ Data on maritime accidents caused by the consumption of alcoholic beverages are not available, but it is assumed that they must be significant, particularly in Brazil, a country where such vehicles are widely used for leisure activities, when such substances are usually consumed.

2012,³¹ establish that drivers who have consumed alcohol are subject to penalties set forth by law, which may even amount to imprisonment.³²

The CBT also establishes the permitted mechanisms for measuring a driver's blood alcohol level or exhaled alcohol concentration. To establish the alcohol level, the only mechanism allowed is a clinical blood test. And to establish the exhaled alcohol concentration, the only mechanism permitted is the breathalyzer, which must pass the metrological control of the National Institute of Metrology, Quality and Technology (Inmetro). However, the most recent changes in the CBT also allow the driver's alcohol level to be attested using images, videos, indications, etc. which prove an alteration in the driver's psychomotor capacity.

Within the context of using measuring instruments, given their portability, mobility, non-invasiveness (in contrast to clinical blood tests) and non-subjectivity, the use of breathalyzers is widespread in police roadblocks, which have become the main means of enforcing the “dry law” in Brazil.

Based on the physical-chemical properties of the air exhaled by drivers, breathalyzers measure the concentration of alcohol they have ingested. Since the results of these instruments are used to establish the penalties applied to drivers, a metrological guarantee of such results must be provided, in order to prevent undue penalties (owing to false-positives) and the release of drunk drivers (owing to false-negatives) That is to say, the correct calibration of the instrument is an essential condition to ensure that the effects of the “dry law” are socially desirable.

The process of metrological control of breathalyzers is broken down into the following stages: model approval, initial verification and subsequent verification (performed annually). The model approval is the responsibility of Inmetro's Legal Metrology Department (Dimel). In contrast, the initial and subsequent verifications (per unit) are generally performed by Inmetro's delegate bodies of (e.g. National Institutes of Weights and Measures).³³

To implement such control, specific regulations require the use of a standard for the performance of tests carried out on the instruments during the stages of this metrological control. In the case of breathalyzers, the standard used is the alcohol-water solution CRM, which, in Brazil, is only produced by Inmetro and then passed onto the National Institutes of Weights and Measures.

However, when the regulations were established in Brazil, this material did not yet exist. Initially, the strategy adopted by Inmetro for obtaining a CRM to be used in the calibrations was to import the aqueous solution of a brand named GUTH (an American breathalyzer manufacturer), which was not certified. In view of the problems faced during the process of importing the solution, as well as the fact that it was not certified, some Institutes of Weights and Measures tried to develop reference materials, albeit without success. However, the wider adoption of the dry law in Brazil demanded of Inmetro and of the National Institutes of Weights and Measures a volume of calibrations that was difficult to achieve with imported material (even if viable certified alternatives could be found). Thus, to support the Brazilian “dry law”, the country had to produce a standard domestically, and certify it, since otherwise the high cost and time required for importation would prevent the law from being implemented.

Dimel then initiated discussions with the Directorate of Scientific and Industrial Metrology (Dimci) on the development of the CRMs by its laboratories. For that purpose, it was essential to invest in R&D through training, development of methodologies, as well as through the provision of

³¹ Law n°12,760 dated 12/20/2012.

³² According to Law n°12,760 dated 12/20/2012, the driver shall be detained if, through measurements with a specific instrument, he exhibits a level of alcohol in excess of 6 decigrams of alcohol per litre of blood, or a concentration equal to or higher than 0.3 milligram of alcohol per litre of exhaled air.

³³ Inmetro Resolution/MDIC n° 202 06/04/2010 updating the Metrological Technical Regulation approved by Inmetro Resolution n° 06, 01/17/2002.

laboratory infrastructure, and the acquisition of equipment. In relation to the metrological control of breathalyzers for the enforcement of the “dry law”, the objectives of the R&D project were twofold: i) to avoid dependence on foreign supply of a strategic input and; ii) to ensure measurement traceability.

In view of its plan to be able to produce the CRM, Inmetro formalized a partnership with the German BAM Institute (Bundesanstalt für Materialforschung und -prüfung), specialized in the production of CRMs for ethanol in water, which provided the necessary training in early 2003. A team was then set up which, with the knowledge acquired in Germany, was able to establish its own methodology for the production of CRMs suited to Brazilian needs and specificities. The first batch of these CRMs was ready by the end of 2004 and, from then on, Dimci started to produce them on demand from Dimel, which in turn passes them on to the National Institutes of Weights and Measures.

The investment made by Inmetro’s scientific metrology department demanded the assembly of a complex structure that was later used for the production of other CRMs. By the end of 2011, Inmetro was producing 50 different types of CRMs, all of them associated in some way with the pioneering production efforts of CRMs for ethanol in water. Those pioneering investments also merged into the creation of the Chemical Metrology Division itself, a strategic scientific area within the field of international metrology. From there on, Inmetro began working in the area, enabling it to participate in and even coordinate specific inter-laboratory comparisons³⁴ on the subject, thus widening its network and increasing its international credibility.

In that respect, it can be anticipated that the project achieved its goals and enabled the effective support of the law enforcement efforts. According to the data obtained, together with the coordination of Operation Dry Law in the State of Rio de Janeiro, a breathalyzer performs an average of approximately 53.2 tests in one year (Andrade, 2012 and 2012b). Thus, taking into account the number of breathalyzers rejected by the network coordinated by Inmetro, it can be deduced (by extrapolating the dry law application data in the State of Rio de Janeiro to Brazil as a whole) that the metrological control prevented around 4.58 million tests (in the period 2009-2011) from being performed using instruments that did not comply with specifications, which in such cases may result in undue penalties, as well as in the release of drunk drivers that might cause accidents.

Considering that a fine is issued for every 103³⁵ tests, the rejection of breathalyzers had a positive influence on more than 44 thousand infractions in the relevant period of time. By exercising metrological control, Inmetro is thus co-responsible for the reduction in the number of undue penalties and possibly the reduction in accidents caused by intoxicated drivers wrongfully released due to a poorly calibrated breathalyzer.

To assess the impact of the research project, which culminated in the development of the institution’s first CRM, and which enabled the proper implementation of law enforcement activities, we chose to use a multi-criteria qualitative methodology based on the opinion of key actors, which we will present below.

The choice of this methodology is justified by the possibility of observing a wide range of impacts, including those not initially planned. At the same time, it is possible to see differences in the perception of the actors and even map bottlenecks in the internal processes of research management. That is to say, it is a somewhat heterodox tool, which seeks more tacit elements incorporated in individuals, rather than codified, traditionally-used elements. This tool is useful for both the accountability of investments and institutional strategic management. Consequently, its use is of great importance, particularly in a context of growing demand for efficiency, efficacy and effectiveness of public expenditure.

³⁴ Inter-laboratory comparisons may be defined as the “set of operations establishing, under specific conditions, the relationship between the values indicated by measuring instruments or systems, or the values represented by material measures or reference materials.” (Ferreira Junior, 2005).

³⁵ Extracted from the State of Rio de Janeiro Operation Dry Law data for 2011, when alcohol level tests were only performed by means of breathalyzers.

C. Methodology

The methodology used involves a more holistic and systemic perception of the process of technical change, and impacts are thus seen as elements of analysis separate from results. Impacts are more comprehensive than results. The former are impressions that are socially constructed on the basis of effects/results. This fact makes the assessment process subjective and determined by actors, without concern for providing an apparent neutrality, but rather for ensuring that different perceptions may be contrasted in order to obtain a more comprehensive view of the research process.

The multi-criteria assessment method is performed by distributing questionnaires to the actors involved in the development and use of the technology, and to the actors indirectly affected by the assessed technology. Although elegant, the multi-criteria assessment methodology, initially developed by the Study Group on the Organization of Research and Innovation (GEOPI) of the Scientific and Technological Policy Department (DPCT) of Unicamp is somewhat complex and extensive, which is why here we will only present its more specific guidelines, and how they inspired the methodology used in this study.³⁶

Actually, the methodology developed by GEOPI was adapted in order to create an own approach that was more focused on the qualitative aspects of the institution's technical change process. In general, such a methodology stems from the perception that investments in R&D release forces that impact a diverse range of human activities, and not only those initially planned. In fact, the research process, which may or may not culminate in the creation of a new device, is marked by a high degree of uncertainty as to the final results.

The correct assessment of the impacts of a technology thus needs to go beyond the traditional observation of the direct, immediate and limited result. In spite of the loss of accuracy, it must consider the whole range of impacts on the environment in which the relevant actors operate. Therefore, the methodology has a systemic and interactive perspective that is nourished by contributions from the economy of technology, especially from the evolutionary school of technical change.

The development of such a tool is associated with the growing social demand for a more detailed understanding of the consequences of technical change. Consequently, it seeks to go beyond traditional analyses of the cost-benefit kind and incorporate perceptions and contradictions among actors. Thus, this is both a qualitative and quantitative assessment method which, while observing economic impacts, has no obligation to monetize them, although it provides the necessary elements to do so.

In its work, GEOPI usually employs a multi-criteria method called ESAC, which stands for Economic, Social, Environmental and Capacity-building assessment. Obviously, this is just one way to organize the method. Other dimensions may exist, or it may not be useful, feasible or necessary to observe all four of them as a whole. In any case, the ESAC tool is a good example of the application of a multi-criteria method since, in addition to having more than one dimension, it includes dimensions that are very different from each other. The way the data were processed in this assessment largely followed the same methodological guidelines as the ESAC method.

Consequently, when defining the dimensions necessary for this assessment, it was necessary to first determine which dimensions to consider. The basis for this definition was the implicit and explicit objectives of the assessed project. That is to say, the key words contained in the objective of the assessed research project objective were extracted, and on that basis the assessment dimensions were determined.

The dimensions were broken down into criteria, i.e., set of indicators that are grouped together due to their similar functions in the research process. The indicators, in turn, are the least disaggregated elements, which measure the specific impact of a certain element. These indicators, the

³⁶ For a complete analysis of the multi-criteria method used by GEOPI see, for example, Zackiewicz (2005) and Furtado et. al. (2008).

basis of the methodology, were extracted from questionnaires performed on the actors identified as relevant for both the production and use of the technology.

Thus, the indicators were aggregated to form the impact of the criterion, and the criteria, when aggregated, determined the impact of the dimension. The method therefore allows us to observe the behaviour of indicators, criteria or dimensions separately. This provides the method with a great analytical capacity since, even in the event of the dilution of the impacts, they may be observed at less aggregate levels.

As proposed in the work of GEOPI, to construct trees of impact, the following principles were observed: (i) trees are extensive, thus covering the maximum impacts possible (even when not initially planned by the developers of the assessed project); (ii) there is no overlap of indicators, i.e., redundancy was avoided, and; (iii) the trees are cohesive.

Based on these guiding principles, and on the extraction of the objectives, it was possible to identify two dimensions relevant to the analysis: (i) economic and (ii) capacity-building. For each dimension, criteria were selected, and within them indicators.

Once the trees were determined, the collection of information could begin. For that purpose, structured questionnaires were used, with single objective responses: maximum positive impact, high positive impact, medium positive impact, low positive impact, unchanged, low negative impact, medium negative impact, high negative impact, maximum negative impact, and “not applicable”.

As a second stage, the questionnaire responses were converted to a scale of -4 to 4. Thus, the average of indicator responses (within the -4 to 4 range) formed the criterion, and the average of the criteria, the dimension.

The questions sought to contrast the situation prior to the technology, or before the research effort, with the subsequent situation. The intention, therefore, was to observe the variations³⁷. In addition, the scale refers to the perception of the interviewee with regard to the possibilities of the technology in relation to the indicator at that particular moment.

Using the indicator averages, it was possible to identify the impacts at the level of criteria and dimensions. For this identification, the impact interpretation scale shown in table 26 was utilized.

The data collection began around seven years after the R&D effort had ended. That is in line with international practices, which suggest this to be an adequate interval for a developed technology to show most of the impacts related thereto.

Over the course of about six months' work, nine interviews were carried out, three of which were aimed at obtaining a general understanding of the research project to be assessed, and six at the use of the questionnaire. In the first three interviews senior managers were visited, since the approach was focused on the institutional objectives and strategies associated with the research process. The information collected in these preliminary interviews helped to adjust the questionnaires and construct the trees of impact.

Questionnaires structured on a scale of intensity were carried out on six key actors in the process of development and use of the technology. The interviewees were: the director of legal metrology at the time, a researcher sent to Germany for training that was responsible for the creation of the Chemical Metrology Division, the researcher responsible for the production of the CRM, and the two technicians responsible for the calibration of breathalyzers.

³⁷ Examples of the questions used in the analysis are the following: “Taking into account the situation prior to the development of the CRM, has there been any change in the productivity of the work performed for calibration tests? Or, “Taking into account the situation prior to the research effort, has there been any change in the number of knowledge transfer agreements (formal or informal)?”

TABLE 26
IMPACT INTERPRETATION SCALE MEASURED USING THE INDICATOR AVERAGES

Impact	Scale
Maximum positive	3,1 < x ≤ 4.1
High positive	2,2 < x ≤ 3.0
Medium positive	1,3 < x ≤ 2.2
Low positive	0,4 < x ≤ 1.3
Unchanged	0,4 < x ≤ -0.4
Low negative	-0,4 < x ≤ -1.3
Medium negative	-1,3 < x ≤ -2.2
High negative	-2,2 < x ≤ -3.1
Maximum negative	-3,1 < x ≤ -4.0

Source: Own elaboration.

After tabulation, the response averages were extracted in order to form the indicators. The indicator averages then formed the criteria and, finally, the criteria averages formed the impact of the dimension. Using the impacts of each of the 3 levels, a qualitative analysis was performed, based on the details of interviews, which, whenever possible, were monetized and/or quantified.³⁸

The results, therefore, are the consequence of the application of questionnaires, and the collection of qualitative information carried out also, but not only, during the interviews.

D. Assessment results

1. Economic impacts

At first sight, dealing with economic issues without the main intention of monetizing them, that is to say, expressing them as currency, would appear to be at the very least unusual. However, when the data necessary for monetization are not available or when they cannot be separated from other activities, the use of a non-monetary approach enables us at least to observe the general behaviour of selected economic variables. Indeed, this type of heterodox analysis is sufficient when the assessment objective is to analyze the effectiveness of expenditure and not its efficiency.

Important Brazilian institutions and companies have already successfully used such analysis, among which are Petrobras and the Agronomy Institute of Campinas (IAC). Thus, regardless of how surprising a non-monetary economic assessment may appear, it has the advantage of revealing general behaviours based on the perceptions of key actors in the process of development and use of the technology assessed. Of course, we acknowledge that the monetization of such analysis would greatly enrich the results of the study, and this was done whenever possible.

The choice of observing the economic impacts is due to the very context in which the project was immersed, as well as its implicit objectives, namely: to avoid or reduce the transaction costs³⁹ associated with the international purchase of reference material for the calibration of breathalyzers, as well as the need to make better use of public resources.

In that sense, within the economic dimension, three criteria were selected: (i) productivity, (ii) international dependence, and (iii) financial support.

³⁸ Although possible, we chose not to weight dimensions, criteria or indicators in a differentiated manner.

³⁹ “Costs that are necessary for the implementation of purchase and sales agreements of factors in a market made up of formally independent actors” (Sandroni, 2008: 218).

The criterion of productivity is made up of three indicators: productivity of inputs, of capital and of labour. For its part, the criterion of international dependence has only one indicator, and this refers to the trade balance. Finally, the criterion of financial support also depends on the measurement of a single indicator, which is income.

It is important to note that, in this case, each indicator is extracted from a single question. Therefore, the economic dimension can be measured by using five questions.

According to the scale shown in table 27, the economic dimension obtained a medium positive result, with an indicator of 1.4. It is believed that this impact is appropriate for the reality of the research project, given that, despite having avoided the purchase of foreign CRMs, the project demanded the importation of machinery and equipment, as well as some other inputs. In this regard, the international dependence criterion and the trade balance indicator were assessed as medium positive.

A close analysis allows us to state that, in the period from January 2006 to May 2012, imports amounting to R\$ 2.35 million (May 2012 price – IGP-M) of certified reference materials were avoided. On the other hand, internal production of the said CRMs by Inmetro required the importation of approximately R\$ 1.35 million (May 2012 price – IGP-M) of machinery and equipment.⁴⁰ Taking into account both approximations, the net balance shows savings of R\$ 1 million on imports (May 2012 price – IGP-M).

Considering the maintenance of the current demand and a 120-month average depreciation of equipment, it is estimated that in the next four years the net savings on imports will amount to R\$ 1.34 million, thereby allowing a total net saving of R\$ 2.35 million (May 2012 prices – IGP-M) over a 10-year period (2006-2016).⁴¹ Thus, the medium positive impact (almost low – indicator of 1.4) of the trade balance indicator is consistent with the monetary values found based on the details of the interviews.

For the financial support criterion, a low positive impact was observed, since it is associated with a low private domestic demand for the CRM produced by Inmetro. Given that there is a legal requirement for annual verifications, performed by government entities, the usual procedure of companies and institutions that use breathalyzers is to just calibrate their instruments in Inmetro's or the National Institutes of Weights and Measures' own laboratories, and therefore they do not require CRMs for internal calibration. In this regard, it was possible to identify that the income from sales of CRMs of all concentrations was approximately R\$ 10,000 (May 2012 prices – IGP-M) during the period 2006-2012.⁴² This is in line with the low positive impact (1.0) of the income indicator.

The set of criteria that make up this dimension include most notably productivity and, within it, capital and labour productivity. Indeed, these indicators may be considered as high positive, given that the overall result of the dimension —medium positive— is due to the impacts of the other criteria.

With regard to labour productivity, for example, the development of a CRM for ethanol in water promoted the optimization of the technical assessment service of the model based on the reallocation of Inmetro technicians who were previously engaged in activities necessary for the importation of reference materials.

⁴⁰ The goods imported and destined for the production process of the ethanol in water CRM include most notably a gas chromatograph with flame ionization detector, a gas chromatograph with triple-quadrupole mass detector, a coulometric Karl Fischer automatic titrator, and a digital densimeter.

⁴¹ According to a document provided by Dimci, it was considered that the average depreciation period for equipment is 120 months. Taking into account that the purchase of equipment took place in 2006, a new cycle of investment will only be necessary after 2016.

⁴² At the end of 2012, Colombia purchased 12 units of CRMs, thus generating an income from exports, although it is not significant for the analyses carried out here. Albeit not economically significant, the purchase of CRMs by another country is an important indicator of the technical/scientific recognition of the research efforts carried out by the institution.

TABLE 27
IMPACTS OF THE ECONOMIC DIMENSION, BY INDICATOR AND CRITERION

Criteria	Indicator	Impact	Aggregated impact by criteria	Aggregated impact by dimension
Productivity	Physical inputs	0.0	1.7	1.4
	Capital	2.7		
	Labour	2.3		
International dependence	Trade balance	1.4	1.4	
Financial support	Income	1.0	1.0	

Source: Interviews.

A similar situation was observed among the metrologists from RBMLQ-I43 who had tried to produce their own reference material before the CRM development by Inmetro but, given the impossibility of doing so, then imported it from GUTH. After ceasing to import the reference material, these National Institutes of Weights and Measures were able to allocate their metrologists to field activities (initial and subsequent verification of breathalyzers).

The economic impact observed is relevant, particularly when considering the gains in productivity made by the tests performed by Dimel and by the National Institutes of Weights and Measures. Although there has not been a significant reduction in the institution's overall imports, the country has become self-sufficient in the production of CRMs for ethanol in water designed to support the enforcement of the dry law.

2. Capacity-building impacts

We also chose to assess capacity-building impacts, since the research was performed in an area of the institution that is still nascent, an area that uses both knowledge of chemistry and knowledge of uncertainty in measurement and production processes of reference materials (scientific metrology). In fact, the internal development of CRMs for ethanol in water kicked off Inmetro's efforts in the field of reference material production. It is even observed that the metrology of this production is now replicated in the production of other of the institution's CRMs.

The capacity-building dimension was broken down into three criteria and nine indicators, which were obtained through the application of fifteen questions. All three criteria —credibility, scientific capacity-building, and technological capacity-building— sought to exhaust the possibilities of impacts, both direct and indirect, related to the change in the institution's capabilities.

Each criterion is made up of three indicators, with only the number of questions per indicator varying. Thus, in this dimension, an indicator usually needs more than one question to be identified. When this is the case, the response average determined the impact of the indicator.

Considering the scale shown in table 27, the assessed project's impact on capacity-building was 2.1, i.e., medium positive (table 28). Worth highlighting among the set of impacts that make up the dimension are the positive variations in credibility, mainly due to the increase in Calibration and Measurement Capabilities (CMC), which began to be included in the Key Comparison Database

⁴³ Motivated by the great territorial expanse of the country and in view of the Federal Government policy of decentralization of administrative and operating activities, Inmetro opted for a decentralized performance model that, over the years, was consolidated in the delegation of activities in the areas of legal metrology and conformity assessment to National Institutes of Metrology and Quality, thus constituting the Brazilian Network of Legal Metrology and Quality– Inmetro (RBMLQ-I). RBMLQ-I is the executive branch of the Institution throughout the Brazilian territory, in charge of verifications and inspections related to measuring instruments, monitoring of product conformity and control of the accuracy of quantitative indications of pre-measured products, in accordance with the legislation in force.

(KCDB) of the Bureau International des Poids et Mesures (BIPM)⁴⁴ and the increase in the number of inter-laboratory comparisons among countries. In this criterion, the coordination of laboratory comparisons indicator also displayed significant impacts, which are obviously reflected in the increased international credibility of the institution.

TABLE 28
IMPACTS OF THE CAPACITY-BUILDING DIMENSION, BY INDICATOR AND CRITERION

Criterion	Indicator	Impact	Aggregated impact by criterion	Aggregated impact by dimension
Credibility	Inter-comparison	3.3		
	Coordination of inter-comparisons	2.0	3.1	
	Services	4.0		
Scientific capacity-building	Dissemination	1.5		2.1
	Labour	0.0	1.5	
	Scientific domain	3.0		
Technological capacity-building	Technology Transfer	0.6	1.6	
	Networks	2.0		
	Facilities	2.3		

Source: Interviews.

In the context of scientific capabilities, there is a notable increase in knowledge (measured by the scientific domain indicator), especially in the area of chemical metrology, but also in other areas not fully dominated by the institution as yet. Among these, we can highlight knowledge in the field of measurement uncertainty and production process of CRMs. On the other hand, the number of publications, which makes up the dissemination indicator, has not increased as might be hoped. This is perhaps due to the fact that the need to apply the technology developed often acts as an obstacle to the preparation of scientific articles. In addition, the impact index of the journals in which articles were published is low.

However, the CRM for ethanol in water enabled Inmetro to distinguish itself as an expert on the subject, together with different NIM associated with the BIPM. Furthermore, the same methodology used for the development of the CRM for ethanol in water may be replicated for the development of other CRMs in the alcoholic matrix. Injection and samples of volatile compounds, and the gravimetric preparation of solutions for organic analysis laboratories also began to be mastered by Inmetro as a result of the knowledge obtained from the development of the CRM for ethanol in water.

Within the technological capacity-building criterion, the formation of networks and the improvement of R&D facilities are highlighted. As confirmed during the interviews, a cooperation agreement was established with BAM for the research efforts, since using the technology necessitated a great coordination effort with the National Institutes of Weights and Measures.

No significant changes in labour and technology transfer were observed. While on the one hand, the technological initiative did not require the attraction of new Masters or PhD holders (it could be carried out with those Masters or PhD holders already employed), on the other hand, the technology did not demand radical innovations for potential application in other sectors.

In general, it can be said that the impacts of the capacity-building dimension are mainly due to positive changes in services and inter-laboratory comparisons. Thus, they are due to the positive impact on credibility. At the same time, although diluted, the impacts of the scientific domain and facilities indicators were relevant and have to be taken into account for the analysis of the dimension.

⁴⁴ The KCDB database of the BIPM contains all the information related to the mutual recognition agreement of the *Comité international des poids et mesures* (CIPM), by which the equivalence among measurements performed and certificates issued by the signatories of the Agreement is established.

E. Conclusions

This analysis presents an example of good institutional articulation, by which activities with a somewhat different logic, such as legal metrology and scientific metrology, were able to be articulated and provide support for an important public policy. In fact, the support for the dry law was only made possible by the articulation of different assets of the same institution. Consequently, it may be considered that this was a successful public-sector intervention.

It can also be stated that investments in research activities were effective and improved the quality of life of Brazilian society, since they enabled correct metrological control, which, ultimately, helps to reduce traffic accidents.

Furthermore, the institution itself benefited from its strategy to support the dry law. It was possible to observe that in a clear demonstration of demand-pull, the initial technological development not only made it possible to achieve direct objectives, but also to create a stock of knowledge and expertise that may be used in other activities. This know-how was particularly increased in the area of chemical metrology. In fact, the knowledge generated in the field of the assessed project assisted in the process of emergence and consolidation of Inmetro's Chemical Metrology Division.

If Inmetro now produces fifty reference materials, it is also thanks to its investment in the production of the CRM for ethanol in water. Of course, the CRMs that followed the first one were developed through their own research efforts, but it is undeniable that the knowledge acquired with the first CRM reduced the learning curve for all the rest.

In addition, the project has greatly contributed to the international recognition of the institution. This recognition is also extended to other CRMs, particularly those in an alcoholic matrix.

Lastly, the development of the CRM for ethanol in water by Inmetro exceeded its objectives and not only enabled the enforcement of the law, but also integrated the institution into international debates in the field of chemical metrology. In fact, it can be said that the Brazilian dry law can only be implemented through the nationalization of production, since otherwise the calibration of breathalyzers, essential for the implementation of police roadblocks, would depend on foreign technology, and on a logistical network that is difficult and costly to coordinate.

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VIII. The contribution of accreditation on exports of marine products from Peru⁴⁵

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*This study describes the impact of accreditation on the dynamism of Peruvian exports of marine products. It also includes an estimate of the evolution that would have taken place in exports of the baby clam species “palabritas” (*Donax obesulus peruvianus*) if a health ban had not been imposed by the European Union in 2008. This approach assumes that the accreditation of laboratories for Hepatitis A testing, among other aspects, could have prevented this situation. The result of this approach shows that Peru would have been able to export an additional US\$ 86 million approximately during the 2009 -2011 period.*

A. Introduction

In 2011, Peruvian exports reached a record US\$ 46 268 million. The sector that demonstrated the greatest dynamism was that of non-traditional fisheries and aquaculture, which achieved a growth of 61% in relation to 2010. According to Promperu⁴⁹, the most-widely exported products in this sector were frozen giant squid, frozen scallops, shrimp tails and frozen parrot fish. In addition, according to information from the National Fisheries Association, the number of companies exporting frozen fish and shellfish increased from 194 in 2000 to 303 in 2011.

⁴⁵ The contents of this document correspond to a summary of Working Paper No. 2-2012 produced by the Economic Studies Bureau and the National Accreditation Service of INDECOPI, available at the following web link: <http://www.INDECOPI.gob.pe/repositorioaps/0/0/jer/docstrabajo/doctrabn02-2012.pdf>. The views expressed in this document are the responsibility of its authors and do not necessarily express the views of senior management and/or the executive bodies of INDECOPI.

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The major challenges faced by Peruvian exporting companies when commercializing fish products include sanitary and phytosanitary requirements. Some countries require the submission of export health certificates issued by the official body. In Peru, the agency responsible for issuing these certificates is the National Service for Fishery Health (Sanipes). In addition, private laboratories authorized by Sanipes and accredited by the National Accreditation Service (INDECOPI-SNA), have the responsibility of carrying out the methods and testing necessary to ensure that export products are fit for human consumption.

The aim of this document is to analyze the benefits arising from the use of testing methods accredited by INDECOPI-SNA, by companies exporting marine products from Peru.

Considering the proposed objective, the present document first of all describes the characteristics of the export process and the role of INDECOPI-SNA. It also highlights the limitations of access to information that might enable an impact assessment to be conducted. In light of this difficulty, the impact is estimated on the basis of the evolution that would have taken place in exports of baby clams (*Donax obesulus - peruvianus*)⁵⁰ if a health alert had not been issued by the European Union in 2008. It should be noted that the alert took place because the product was found to be contaminated with Hepatitis A. In this particular case, no laboratory in Peru had an accredited testing method for prior analysis of Hepatitis A, and it can therefore be inferred that the accreditation of this testing method, among other factors, would have been able to contribute to its early detection and prevent the resulting ban. The document also presents a qualitative analysis of the benefits of accreditation for the evolution of fishery exports.

B. The intervention and its context

In Peru, accreditation was initiated in 1993 with the creation of INDECOPI,⁵¹ the government agency whose functions include that of being the Peruvian Accreditation Body. The purpose of the accreditation system is to provide economic actors with mechanisms that allow them to control the quality of their products and services, and facilitate the State's monitoring and control functions.

It is INDECOPI's National Accreditation Service (INDECOPI-SNA) that issues accreditation, which is a voluntary rating that can be obtained by private or public entities to provide State recognition of their technical competence in the provision of conformity assessment services. These services are testing, calibrations, inspections and certifications in their different variants: products, management systems and staff.

Accreditation is governed by international standards and guidelines in the framework of the WTO Agreement on Technical Barriers to Trade, and international agreements on the matter. Accreditation is not granted on a generic basis but instead strictly delimits the universe of tests covered by this recognition, including those of a chemical, physical, biological and microbiological nature. The same applies to products or services or to calibration procedures.

Since the implementation of accreditation services in Peru, public entities belonging to various sectors began to use this system managed by INDECOPI, primarily for: a) the control and monitoring of the technical regulations under its responsibility, b) government purchases and c) the issuing of certification for export products.

⁵⁰ Corresponds to the scientific name of the marine species "*palabritas*", as indicated by the Integrated Foreign Trade Information System of (SIICEX) and published in the document <http://www.siicex.gob.pe/siicex/resources/fichaproducto/palabritas%20congeladas.pdf> (Access: 22/02/ 2013).

⁵¹ National Institute for the Defense of Competition and the Protection of Intellectual Property. Upon completion of this study INDECOPI was the National Agency responsible for promoting Quality Infrastructure in Peru. The Law N. 30224 (July 3, 2014) created the National Quality System and the National Quality Institute (INACAL) as the technical specialist public body in charge of promoting and ensuring compliance with the quality policy. The INACAL began its operations on 1st January 2015, and will gradually absorb the functions previously handled by INDECOPI regarding Quality Infrastructure (Decreto Supremo No. 008-2014-PRODUCE).

In relation to this last point, which is the one dealt within this study, in 1994, the Ministry of Health issued Supreme Decree N° 05-94-SA, by means of which the "Regulations on health certification for the export of marine products for human consumption and for fishmeal" were adopted. These regulations established that (...) *The General Directorate of Environmental Health (Digesa) will issue the health certificates requested by exporters, in compliance with the regulations established by the countries of destination whenever the participation of the national health authority is required. These documents will be termed "Export Health Certificates". To issue these certificates, Digesa will use the laboratories accredited by INDECOPI to carry out the necessary tests (...).*

In addition, the aforementioned regulations established that (...) *the laboratories accredited by INDECOPI which conduct the analyses necessary for issuing of export health certificates shall be subject to the control and supervision of INDECOPI. It was also established that (...) at the request of exporters, Digesa shall, as the health authority, grant authorization for plants to process marine products for human consumption and fish meal, according to the international standards required by the destination countries.*

Digesa ceased to be the entity responsible for issuing Export Health Certificates in 2005, when the National Service for Fishery Health Act (Ley del Servicio Nacional de Sanidad Pesquera – Sanipes) was passed. This law designated the Ministry of Production as the governing body of Sanipes, which was responsible, among other functions, for establishing the policy on fishery health and quality. The Institute of Fisheries Technology - ITP was also appointed as a competent authority of Sanipes, with the responsibility of providing official certification on the health and quality of resources and/or marine products, within its sphere of competence.

In September 2005, by means of Supreme Decree N° 025-2005-PRODUCE, the Regulations of the National Service for Fishery Health Act were adopted. These regulations establish that (...) *the official health and/or quality certification of resources and/or products within the functional competence of Sanipes, shall be governed by the rules and procedures set out in the relevant treaties and/or international agreements signed by Peru, as well as the rules and procedures established by the competent authority, without prejudice to the application of other complementary rules corresponding to the legal provisions in force.*

Until April 2012, there were 434 testing methods authorized by Sanipes to be executed by laboratories accredited by INDECOPI-SNA, which were distributed as follows: Microbiological (223), Biological (12), Sensory (47), Physico-chemical (152).

The accredited testing methods mainly cover: marine products, bivalve molluscs, fish meal, and canned products of marine origin.

In order to achieve international recognition of their systems, the accreditation bodies apply the criteria and procedures contained in the international standards and guidelines of ISO, IEC, and ILAC.⁵² The aim is that this recognition will make the results of the accredited laboratories more readily accepted in overseas markets, thereby reducing the costs for manufacturers and exporters who use the services of these laboratories, by reducing or eliminating the need for re-testing in another country.

Furthermore, INDECOPI-SNA, currently has the international recognition in the field of accreditation of management system certification bodies, and after having undergone the appropriate evaluations, is now waiting to receive the results for international recognition in the fields of testing and calibration laboratories, inspection bodies and certification bodies.

⁵² ISO: International Organization for Standardization, IEC: International Electrotechnical Commission, ILAC: International Laboratory Accreditation Cooperation

It is in the context described that exports of fish products reached US\$ 3 146 million⁵³ during the year 2011. Traditionally, the products with the highest share of fishing exports are fish oil and fishmeal, with Peru being the main supplier of fish meal at the global level.⁵⁴

It should be noted that, according to ADEX,⁵⁵ in 2011 the main destination country of Peru's exports of traditional and non-traditional fishery products was China. In terms of supply, the major exporters of traditional fishery products during 2011 included Tecnológica de Alimentos (TASA), Corporación Pesquera Inca (Copeinca), Pesquera Diamante, Austral Group, Pesquera Exalmar and Pesquera Hayduk. Among the main companies involved in non-traditional exports were Seafrost, Corporación Refrigerados INY, CNC, Tecnología de Alimentos (TASA), Austral Group, Productora Andina de Congelados.

In 2011, 66.72 % of the value of fishery product exports (FOB value in dollars) corresponded to fishmeal and fish oil with relative shares of 56.15 % and 10.57 %, respectively. Other exported products were: molluscs (12.37 %), fish preparations and conserves (9.81 %), frozen fish (6.69 %), dried fish (0.99 %) and other products (3.42 %).

In Peru, during 2000 and 2011, the FOB value in dollars of exports of molluscs⁵⁶ recorded a cumulative growth of 546 %, while the growth expressed in metric tonnes recorded a cumulative increase of 200 %.

In 2011, the main target markets for exports of molluscs⁵⁷ were Spain (22.52 %), France (21.62 %), the United States (9.77 %) and China (6.88 %). In Peru, there are three groups of products that account for 99.3 % of the exports of molluscs: giant squid and squid, scallops, and octopus. For the most part, these products are exported frozen.

Exports⁵⁸ of cuttlefish (jibia and globito varieties), squid and giant squid during 2011 showed an increase of 3.28 % in relation to 2010 and recorded an FOB value of US\$ 232.37 million. Most of these products went to Asia, driven by exports to China, while most of the exports to Europe were destined for Spain.

In recent years, scallops have gained importance in the Peruvian economy since they find a great demand abroad⁵⁹ (Europe, America and Oceania). During 2011, Peru exported scallops to 28 countries with the main destination being France. Exports of Peruvian scallops have shown a steady increase since 2002, reaching US\$ 136.5 million in 2011.⁶⁰

⁵³ FOB value given in dollars FOB. The share of traditional fishing exports (mainly fishmeal and fish oil) in total exports of traditional products was 5.86 %; while the share of non-traditional fishing exports (frozen crustaceans and molluscs; frozen fish; fish preparations and conserves; dried fish; among others) in the total non-traditional exports accounted for 10.34 %.

⁵⁴ Produce (2010); PESEM 2011 - 2015.

⁵⁵ Fisheries and Aquaculture Newsletter, February 2012 edition, ADEX, p. 16 - 17. Available at: <http://www.adexdatatrade.com/boletines/boletines%202011/pesc2011-12.pdf> Accessed 11/05/2012.

⁵⁶ Includes all the products contained in heading n° 0307 of the Harmonized System

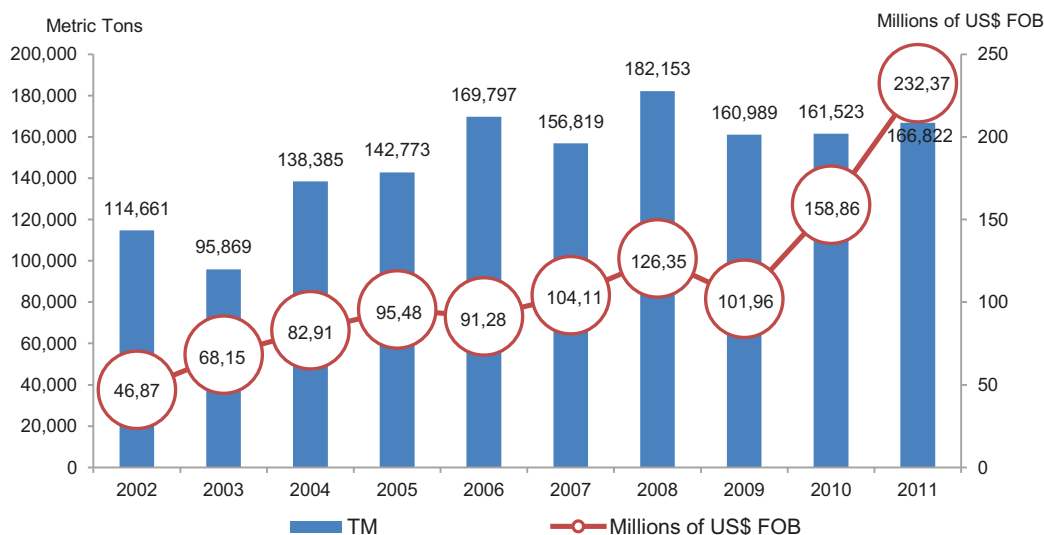
⁵⁷ Idem.

⁵⁸ According to the Ministry of Production, in 2010, 369.82 thousand tonnes of giant squid were caught, while for the same period 161.52 thousand tonnes were exported. The fall in catches of giant squid in 2010, was due to a particular irregularity of that year with good catches during the first few months and very low volumes in later months. Annual Report 2010, "Desarrollo del Comercio Exterior Pesquero" - Promperu, p. 17.

⁵⁹ After cephalopod molluscs, such as giant squid and squid.

⁶⁰ Data obtained from information provided by Veritrade.

FIGURE 2
EXPORTS OF CUTTLEFISH AND SQUID, 2002-2011



Source: Veritrade. Elaboration: Office for Economic Studies (Gerencia de Estudios Económicos) of INDECOPI.
Note: Includes all the products contained in heading n° 0307 of the Harmonized System.

It should be noted that the evolution described in exports of marine products has taken place in the framework of compliance with the sanitary regulations required by the destination country or trading bloc. The main requirements include the following:

- European Union: Sanitary authorization (HACCP61-plant) and authorized areas (bivalves). An official export certificate is also required.
- U.S.62: Implementation of HACCP, Bioterrorism (deliberate contamination). No official health certificate is required.⁶³
- Brazil: Authorization - Health Protocol⁶⁴ which establishes mutual recognition in accordance with the rules laid down in the agreement on the authorization of registered establishments by the exporting country (Peru), and remains subject to evaluation by the health authorities in Brazil.
- China: Requires a health certificate for the entry of fishery products. In addition, it has a protocol for speeding up exports of fishmeal and fish oil from Peru.

An official export health certificate is an official document that guarantees in writing that a particular batch of food for export is fit for human consumption and complies with certain health requirements. The process for obtaining the certificate involves a test or analysis report conducted by a laboratory approved by Sanipes and accredited by INDECOPI. This analysis pertains to selected samples taken from the respective batch of shipment, and is carried out according to the regulations in force.

⁶¹ HACCP is a quality assurance system that ensures food safety. It consists in identifying specific risks (risk analysis), determining the critical points in the production process and taking measures to control them.

⁶² Portal on food safety in the United States: <http://www.foodsafety.gov/blog/fsma.html>

⁶³ The FDA carries out an inspection at the time of importation, according to information provided by Promperu (2010), "Requirements for exporting to USA".

⁶⁴ Under the Health Protocol signed in 1990 between the national health authority (Digesa) and that of Brazil (Dirección de Importación de Productos de Origen Animal del Ministerio de Agricultura y Ganadería - Dipoa).

C. Methodology and methodological challenges

It should be noted that, unlike other fish products, bivalve molluscs require the application of chemical and microbiological tests, since these products absorb sea pollutants to a greater extent and must go through a process of purification before being consumed. Moreover, the European Union establishes specific requirements for the export of bivalve molluscs, such as the presentation of health certificates issued by the official body, through a process that involves the participation of laboratories accredited by INDECOPI. These laboratories are responsible for performing the methods and testing necessary to ensure that the export product is fit for human consumption.

This is why it is important to carry out an impact assessment of the accreditation of testing methods for fishery export products, particularly bivalve molluscs. The application of impact assessment techniques requires information about companies that request accredited laboratory tests (testing methods) for the purpose of exporting marine products.⁶⁵ However, such information is neither available nor systematized in a database showing the volume of exports, exported product type, country of destination, number of testing methods requested, export certificates issued by company, or other variables.

For this reason, it has been considered appropriate to estimate the evolution, using an econometric model that captures the trend in the amount of baby clams that would have been exported if a health alert had not been issued by the European Union in 2008. It should be noted that the alert took place because the product was found to be contaminated with Hepatitis A. In this particular case, no laboratory in Peru had an accredited testing method for prior analysis of Hepatitis A, and it can therefore be inferred that the accreditation of this testing method, among other factors, would have been able to contribute to its early detection and prevent the resulting ban.

In addition, a qualitative analysis has been made of the effect accreditation has had on exports on the basis of extensive interviews conducted with the actors involved in the quality infrastructure within the fishery sector.

D. Impacts

Failure to comply with the requirements for the export of fishery products to the European Union leads to the rejection of the goods in question. The rejected merchandise may be seized and reprocessed (for example, for animal feed); it also has the legal authority to destroy products or return them to their country of origin.

The European Union has put in place import alert systems provided by the following entities: Animal Health (ADNS), Consumer Safety (RAPEX), Food Safety (RASFF),⁶⁶ community alert network for food and feed.

According to statistics from the RASFF, between 1997 and 2011, a total of 29 alert notifications were issued for exports of Peruvian molluscs to Europe. When broken down by country, Spain reported 19 notifications, Italy 5, France 4 and Greece 1.

Between 2004 and 2007, a significant quantity of the molluscs called "palabritas" (baby clams) were exported to the European Union. However, exports to the EU fell dramatically following

⁶⁵ To get an idea of the information requirements for carrying out impact studies on the quality infrastructure in various markets see section 2 of Working Paper No. 2-2012 drawn up by the Office for Economic Studies and the National Accreditation Service of INDECOPI, available at the following web link: [Http://www.INDECOPI.gob.pe/repositorioaps/0/0/jer/docstrabajo/doctrabn02-2012.pdf](http://www.INDECOPI.gob.pe/repositorioaps/0/0/jer/docstrabajo/doctrabn02-2012.pdf).

⁶⁶ Acronym for the Rapid Alert System for Food and Feed - RASFF.

the health alert of 2008 issued by the RASFF (specifically for the species of bivalve molluscs: *Donax* spp - baby clams, *Ensis macha* - razor clams and *Transennella pannosa* - clams, among others).

The decision of the Commission of the European Communities established that the contaminated bivalve molluscs were baby clams (*Donax* spp.) and that the source of the infection was probably a viral contamination of the waters in the production areas, and for that reason other bivalve molluscs could be contaminated as well.

This measure was imposed following a Hepatitis A epidemic in Spain⁶⁷ resulting from the ingestion of frozen bivalve molluscs from Peru. For this reason, the EU Directorate-General for Health and Consumers (DG-SANCO) banned imports of bivalve molluscs from Peru, a measure that was put in place in all the countries of European Union.

It should be highlighted that, although the accreditation system had already been introduced in Peru during the period in which the European Union prohibition was enforced, there were no laboratories with accredited testing of the Hepatitis A virus, the cause of the ban on baby clams. Since then, four laboratories have been accredited by INDECOPI for the verification of hepatitis A testing.⁶⁸

The following table shows the evolution of certified exports of molluscs and highlights the fact that certified exports of the baby clam variety called “palabritas” fell dramatically, from 1 795 tonnes in 2008 to 14 tonnes in 2009, 17 tonnes in 2010 and 84 tonnes in 2011, due to the ban imposed by the European Union.

TABLE 29
CERTIFIED EXPORT OF MOLLUSCS AND CRUSTACEANS, 2007-2011 (MT)
(Metric tonnes)

Product	2007	2008	2009	2010	2011	Dist. % 2011
Total	176 085	219 555	158 065	153 926	181 419	100.0 %
Cephalopod Molluscs	164 167	208 234	147 801	139 483	166 101	91.6 %
Giant squid	153 378	204 081	139 468	136 077	164 077	90.4 %
Squid	9 713	2 299	7 690	2 157	838	0.5 %
Rest	1 076	1 855	643	1 250	1 187	0.7 %
Bivalve Molluscs	9 072	8 217	7 082	10 775	9 954	5.5 %
Scallops	3 348	4 624	6 945	10 758	9 736	5.4 %
Baby clams	2 994	1 795	14	17	84	0.0 %
Rest	2 729	1 797	123	1	134	0.1 %
Crustaceans	2 847	3 103	3 182	3 667	5 364	3.0 %
Shrimp	2 781	2 848	3 126	3 357	4 200	2.3 %
Rest	66	255	56	310	1 164	0.6 %

Source: Sanipes - ITP.

Also the United States also have a system of alerts and rejections called import refusal reports implemented through the FDA’s Operational and Administrative System for Import Support (OASIS).⁶⁹ During 2010, 86 rejections were imposed on Peruvian exports mainly due to the presence of dirt and pesticides.

⁶⁷ Detected by the Public Health Service of the Community of Valencia in Spain.

⁶⁸ These laboratories include: Cerper S. A. (2010), Inspectorate Services Peru S.A. C. (2011), ITP (2012) and Laboratorios Acuicolas (2011).

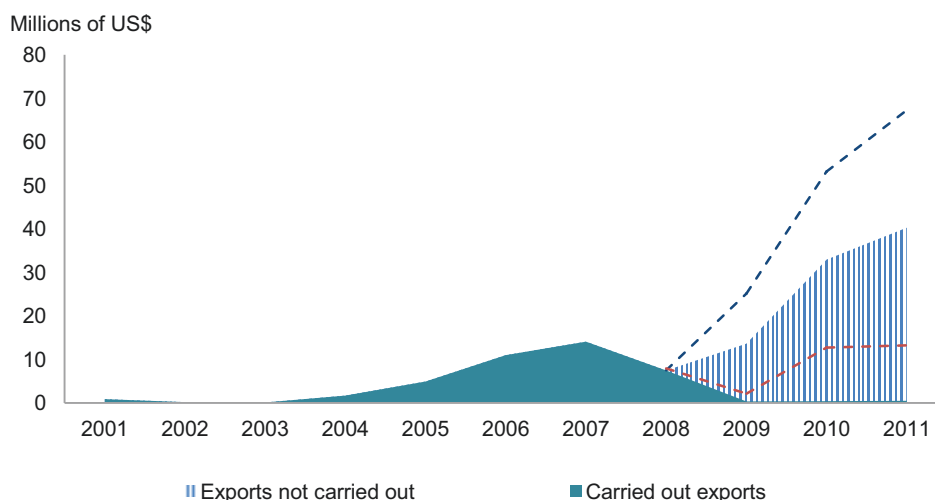
⁶⁹ According to [Http://www.accessdata.fda.gov/scripts/importrefusals/ir_index.cfm](http://www.accessdata.fda.gov/scripts/importrefusals/ir_index.cfm), Last Accessed 14 April 2012.

1. An approximation of the costs of the ban on baby clams in the European Union

In order to be able to estimate the value of exports that Peru would have conducted in the event that the health alert had not been issued, an econometric model was used, which picks up the trend in exports of baby clams until before the alert was issued in 2008 and incorporates the effect of the international economic crisis during the years 2008 and 2009, keeping the rest of the factors constant.⁷⁰ The objective of this estimate is to gauge the role of accreditation, among other factors, in warning of the existence of safety problems and avoiding problems of bans on Peruvian products destined for other countries.

The result of the estimate described is shown in figure 3.

FIGURE 3
ESTIMATE OF PERUVIAN EXPORTS NOT CARRIED OUT OF OTHER MOLLUSCS^a DESTINED FOR THE EUROPEAN UNION, DURING THE 2001-2011 PERIOD (IN MILLIONS OF US\$)^b



Source: Veritrade. Elaboration: Office of Economic Studies of INDECOPI.

^a The category "other molluscs" mainly includes exports of the molluscs called "palabritas".

^b The series of data and the result of the estimate can be found in greater detail in Appendix 1.

The result of this approximation shows that, in the event that the European Union had not issued a health alert with regard to Peruvian exports of baby clams in 2008, Peru would have been able to export approximately US\$ 86 million during the 2009 -2011 period, an additional US\$ 13.27 million in 2009, US\$ 32.54 in 2010 and US\$ 39.77 in 2011.

Therefore, between 2007 and 2011, Peruvian exports of baby clams to the EU could have grown at an average annual rate of 29.71%, in contrast to the average annual reduction of 46.77 % they underwent for that period. As a conservative estimate, considering the difference between the FOB value of exports of baby clams and the lower limit of the projection, Peru probably failed to export approximately US\$ 27 million during the 2009 - 2011 period.

⁷⁰ Annual data were used to estimate this model. The coefficients associated with each of the variables considered showed the following probabilities of significance: probability of T (trend): 0.0073, probability of T1/5 (trend increased to 1/5): 0.001 and probability of D (dichotomous variable which takes the value 1 for the years 2008 and 2009, and zero in other cases): 0.0005.

2. Qualitative Analysis of the role of the accreditation of laboratories in Peru

The accreditation of laboratories aims to assure their customers that the results of the testing or calibration carried out by the laboratories are correct and reliable. This is made possible by the formal recognition of the technical competence of the laboratories, awarded by the national body (NAS).

In practice, although accreditation does not constitute a compulsory rating, accredited services occupy a significant market position in comparison to others of the same kind, and are therefore sought after to test the compliance of technical regulations, the bases set out in public tenders and international quality requirements in foreign trade operations.

The National Accreditation Service (INDECOPI-SNA) thus contributes to improving the competitiveness of economic actors in Peru, as well as ensuring the appropriateness and safety of the products and services that are offered in the market and taking advantage of the trade liberalization resulting from agreements on trade preferences. For this reason, INDECOPI-SNA enjoys technical, functional and administrative autonomy, in order to comply with international technical standards with a view to obtaining recognition.

Accreditation plays a key role in the export of fishery products, particularly in the case of molluscs. This product has the characteristic of absorbing biological and/or chemical substances that could prove dangerous for human consumption.⁷¹ This is why Sanipes has a regulation based on conformity assessment procedures. For this purpose there is a specific health standard for live bivalve molluscs,⁷² as well as a national health monitoring program for bivalve molluscs,⁷³ which made it possible to increase sales of these products to the European Union (FAO, 2005).⁷⁴ In spite of this, from 2009 on exports fell due to the export ban imposed on baby clams.

In order to export to foreign markets, in addition to the export health certificate issued by Sanipes, it is necessary to be in possession of a series of certifications such as FEMAS certification (feed ingredients), HACCP, ISO 14000, IFFO, and environmental sustainability certifications, among others. In other countries such as the United States, the FDA conducts periodic inspections of companies.

On the other hand, according to interviews with the exporters union, the fishing companies appear to not fully understand the role of the accreditation of testing methods in the fishery sector and limit themselves to complying with the regulations in this regard by hiring a laboratory approved by Sanipes that offers laboratory testing in addition to other services in the export logistics chain (such as for example SGS which has branches in several countries), that is to say, they purchase a service package.

With regard to the domestic market, certain challenges exist in relation to accreditation. Sanipes operates a scheme that consists in monitoring the sanitary conditions of the marine waters of the different areas from which marine resources are harvested then comparing these sanitary conditions with the levels previously determined to be appropriate.⁷⁵ Later, when harvesters unload their products at the fishing terminal, they are asked to fill out a sworn statement indicating the area

⁷¹ Bivalve mollusks (i.e. baby clams, clams, scallops and non pectinidae) have to pass through a de-sanding plant which is why it is necessary to assure the water quality.

⁷² Supreme Decree 07-2004-Produce “Norma Sanitaria de Moluscos Bivalvos Vivos”.

⁷³ Launched in 1999 and redesigned in 2001. The work of the Sanipes - ITP with respect to the bivalve mollusks include, among other activities, carrying out sanitary control procedures in production areas to monitor microbiological and chemical indicators.

⁷⁴ FAO - WHO “Análisis del sistema nacional de inocuidad de alimentos” FAO/WHO Regional Conference on Food Safety for the Americas and the Caribbean. San Jose, Costa Rica, December 6 2005. Available at: <http://ftp.fao.org/docrep/fao/meeting/010/af178s.pdf>. Accessed 02/08/2012.

⁷⁵ Sanipes - ITP also analyzes natural banks of marine resources and the cost of such monitoring is borne jointly with the fishermen's unions.

where the products were harvested. Consequently, when it comes to molluscs destined for the domestic market, procedures to assess the quality of the products produced and marketed locally are not required in the same way that they are for the international market.

3. Analysis of certified exports according to country of destination

According to the information provided by Sanipes, between 2007 and 2009, certified exports of giant squid were mainly shipped to Asia (55.64% of the volume of certified exports of giant squid), largely consisting of exports to China.⁷⁶

During that same period, the vast majority of certified exports of scallops were destined for Europe (96.43% of the volume of certified exports of scallops), which mainly consisted of certified shipments to France and Spain.⁷⁷

With regard to prices, the United States would appear to have the highest average export price for cuttlefish (*jibia* and *globito* varieties), squid and giant squid, while Europe, China and Japan had the lowest average export prices for these products. However, the prices of products exported to Europe and China prove to be higher than the prices of products exported to Japan, which could be related to the fact that the first two countries usually require Sanipes-ITP certification, among other factors that might explain the prices indicated.

The average export price of scallops registered in Europe appears to be the highest, followed by those registered in the United States and Asia.

This would appear to be in line with the fact that most of the scallops certified by Sanipes are destined for Europe which would mean that scallops that have been certified (and hence subjected to accredited tests) and are shipped to Europe have a higher value than those that are exported to other destinations or do not require a export health certificate.

TABLE 30
CERTIFIED EXPORTS OF MARINE PRODUCTS, ACCORDING TO INDUSTRIAL ACTIVITY,
2007 - 2009 PERIOD
(In metric tonnes)

Product	2007	2008	2009	Dist. 2009
Certified Exports	1 514 692	2 474 322	2 009 533	100.0 %
1. Direct human consumption ^a	245 353	312 474	222 240	11.1 %
2. Indirect Human consumption	1 269 339	2 161 848	1 787 294	88.9 %
Fishmeal	1 029 739	1 978 720	1 467 982	73.1 %
Fish Oil	239 600	183 128	319 312	15.9 %

Source: Sanipes - ITP (2010).

^a Includes: canned, frozen, cured and others.

⁷⁶ Although significant volumes of giant squid are exported to countries like the United States (around 2 %) and Japan (nearly 30 %), most of these exports are conducted without the need for certification by Sanipes-ITP since they are subject to a certification regime in which the official Peruvian body does not participate.

⁷⁷ It is noteworthy that Europe (mainly France) purchases around 70% of Peru's exports of scallops, while the United States is the second destination country with around 20% of the export share.

TABLE 31
CERTIFIED EXPORTS OF FISH MEAL, ACCORDING TO DESTINATION, 2007 - 2009 PERIOD
(In metric tonnes)

Destination	2007	2008	2009	Dist. 2009
Total	1 029 739	1 978 720	1 467 982	100.0 %
Europe	254 252	263 206	350 688	23.9 %
Germany	128 542	163 008	219 194	14.9 %
Spain	26 594	32 052	29 377	2.0 %
Rest of Europe	99 116	68 146	102 117	7.0 %
Asia	716 966	1 621 408	1 065 474	72.6 %
China	458 665	1 306 928	753 285	51.3 %
Japan	128 759	138 414	115 360	7.9 %
Rest of Asia	129 542	176 066	196 829	13.4 %
America	42 546	67 779	25 516	1.7 %
Canada	23 760	24 661	12 652	0.9 %
Chile	11 919	34 663	5 804	0.4 %
United States	1 060	380	1 781	0.1 %
Rest of America	5 807	8 075	5 279	0.4 %
Oceania	15 499	25 454	26 053	1.8 %
Africa	475	874	251	0.0 %

Elaboration: Sanipes - ITP (2010).

4. Role of the National Accreditation Service (INDECOPI-SNA)

Until 1992, the officially recognized conformity assessment services (certification, testing, calibration) were the responsibility of the Institute for Technological and Industrial Research and Technical Standards (Itintec), a public body attached to the then Ministry of Industry. It performed this role directly or by employing the services of private companies, but ultimately it was always Itintec that issued the officially recognized certificates. It was in 1991 that it began to delegate certification functions via the granting of licenses, by virtue of Executive Resolutions issued under interpretations of its operating rules.

The transition from Itintec to INDECOPI, along with an institutional change, marked a turning point in the policies that dealt with its fields of competence. At the global level, for example, while during the time of the former institution certification was granted directly by the State, during the latter era it became a voluntary system of adoption. With the creation of INDECOPI, the official conformity assessment services began to be outsourced.

The National Accreditation System has now grown and becomes increasingly comprehensive, since, in addition to the certification of products, it also covers the certification of specific processes relating to environmental and quality management systems and inspection. At the same time, market needs and demand have also increased, in response to which additional requirements have emerged such as the regulation of new fields of certification and the expansion of the operational number of testing and calibration laboratories that ensure the sustainability of the system.

C. Conclusions

Peru has demonstrated significant growth in fishing exports in recent years, with bivalve molluscs in particular having displayed dynamism in exports to the European Union and Asia. Before shipping their products abroad, exporting fishing companies must obtain an export health certificate from Sanipes for which they are required to submit the results of laboratory tests showing the quality and

safety of their products. The laboratories that are authorized to perform such work have had their testing methods accredited by the NAS - INDECOPI and are among the agencies supporting Sanipes.

For that reason, the accreditation of laboratory tests by the SNA - INDECOPI is one of several factors that might explain the evolution of fishing exports in recent years. However, in order to estimate the impact of accreditation from a quantitative point of view, it is necessary that the institutions linked to the register of international trade operations (customs, Sanipes, laboratories and exporting fishing companies) provide information about specific products, and that this information is comparable from institution to institution.

With regard to private laboratories that have authorization to provide services for the fisheries sector, the company Cerper has stated that demand for laboratory testing services depends on the requirements of countries such as the those of European Union, since without accreditation it is not possible to export to the mentioned trade bloc.

In the case of the corporate sector, fishing exporters appear to limit themselves to comply with the regulations in this regard by hiring a laboratory approved by Sanipes that provides them with laboratory tests in addition to other services in the export logistics chain.

In the case of the domestic market, Sanipes implements a scheme that consists in monitoring the sanitary conditions of the marine waters of the different areas where marine resources are harvested, and then comparing these conditions with levels previously determined to be appropriate. Later, when harvesters unload their products at the fishing terminal, they are asked fill out a sworn statement indicating the area where the products were harvested. Finally, Sanipes verifies that the declared harvesting area is one of the areas monitored.

It should be noted that the failure to comply with the requirements established for the export of fishery products leads to the rejection of goods, which might be seized and turned into animal feed, destroyed, or returned to the country of origin. For example, on 10 September 2008, a health alert was issued in the European Union against Peruvian bivalve molluscs (baby clams and clams) and a ban on exports was imposed, which has yet to be lifted. This measure was imposed due to an epidemic of Hepatitis A in Spain resulting from the ingestion of frozen bivalve molluscs from Peru. Thus, from 2009 to 2011, the ban on exports of these products it was here estimated to have created a loss of US\$ 86 million worth of exports, causing financial losses for the export sector.

It is suggested that an evaluation be made of possible reforms to the quality assurance system for products that are sold in the domestic market; with special emphasis on fresh, frozen or chilled products, such as marine products. In this respect, it may be possible to follow the example of countries such as those in the European Union, which gives special attention to fishery products in view of the fact that these products are likely to be vulnerable to contamination at the various stages of the production chain, which could generate a degree of risk to human health.

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Appendix

TABLE A1
PERUVIAN EXPORTS OF BABY CLAMS AND OTHER MOLLUSCS DESTINED FOR THE
EUROPEAN UNION 2001 - 2008 AND PROJECTED VALUES 2009-2011
(In dollards)

Real Value	Estimated values		
	Lower Range	Mid Range	Upper Range
850 162.800			
165 035.900			
90 590.790			
1 665 512.600			
4 899 880.650			
10 959 339.310			
14 052 497.940			
7 435 379.130			
320 970.570	2 091 396.229	13 594 804.023	25 098 211.818
378 541.890	12 714 201.229	32 915 340.000	53 116 478.771
468 161.610	13 224 021.218	40 240 063.760	67 256 106.303

Source: Veritrade. Elaboration: Office of Economic Studies of INDECOPI.

IX. Impact of the quality infrastructure on the dairy chain in Uruguay⁷⁸

Claudia Santo⁷⁹ and Elizabeth Ferreira⁸⁰

A. Introduction

This article looks at how the actions systemically undertaken by the different actors in the quality infrastructure in Uruguay have boosted quality throughout the production chain and achieved the desired effects of improving dairy products in the country to promote their introduction into the international market.

The actors in the quality infrastructure with regard to the Uruguayan dairy sector are:

- the Ministry of Livestock, Agriculture and Fisheries (MGAP) in its role as regulator and certifier of plants and dairy farms;
- the Technological Laboratory of Uruguay (LATU), in its roles as the certifier of dairy products for export, the National Metrology Institute (NMI) and as the accredited laboratory for the analysis of dairy products;
- and other laboratories performing analysis of dairy products at the national level that carry out measurements for the quality-based payment system for milk, together with the dairy industry and Uruguayan milk producers.

The joint action of these institutions, agencies and companies has positively impacted producers, industry and the national economy.

⁷⁸ Chapter based on the publication *Impacto de la Infraestructura de la Calidad en América Latina*, ECLAC-PTB, 2011.

⁷⁹ Directora de Metrología Científica e Industrial, LATU.

⁸⁰ Jefa del Departamento de Metrología Química, LATU.

B. Methodology

The aim is to include in this assessment the relevant aspects of the support provided by the Uruguayan Quality System as a whole to the dairy production chain in Uruguay.

The study was carried out using information available on the dairy industry's production and export results (particularly from MGAP), international market requirements, current regulations and their evolution, as well as the role and interventions of the agencies responsible for the quality infrastructure.

To assess the impact of the quality infrastructure on the dairy production chain the following elements were taken into account:

- The importance given by international markets to the quality of dairy products and the technical impossibility of exporting products of insufficient quality.
- The introduction of national regulations (by the Regulatory Authority, MGAP) focused on improving products in the primary sector.
- The importance of regulations, industrial policies and the support of LATU, as the NMI, in improving the measurement uncertainty of the quality parameters in dairy control laboratories. Also, the economic importance of the improvement in measurements from the point of view of fairness in commercial transactions.
- The importance of the existence of a reliable conformity assessment system for products (made up of the Regulatory Authority -MGAP- and LATU —as certifying body— and a testing laboratory) as a necessary condition for access to international markets.

Finally, a matrix was developed specifying which interventions were responsible for each impact, and the indicators that are necessary to estimate these impacts.

C. The national quality infrastructure in support of the dairy chain

According to the FAO (2001), it is the responsibility of the food industry in all the countries to comply with regulatory requirements with regard to the quality and safety of food from rural farms, transport, storage, processing and sale to the final consumer ("from farm to fork").

As the history of interventions shows, there has been a tendency in Uruguay to take a systemic approach to quality in the dairy production chain. The impact of these actions has been greatest when the following stakeholders have acted in a coordinated manner: the government, the institutions of the quality infrastructure (standardisation, metrology, accreditation, and certification), and the private sector (i.e. industry and rural producers).

D. Quality assurance of dairy products in Uruguay: Public policies and the role of the private sector

1. Public policy and the development of the quality-based payment system in Uruguay

Since the middle of the last century, at both government and company level, Uruguay has been implementing policies designed to improve the quality of the milk produced in the primary sector (dairy farms).

In the 1990s, the quality of raw material was viewed by the primary sector as a problem for the dairy industry. From March 1996 the CONAPROLE cooperative began to test milk on receipt.

In 1995, an executive decree set out the generic regulations for the establishment of a National Milk Quality System headed by the National Milk Board (Junta Nacional de Leche), which would be implemented in the country to assess the product and which entered into force on 1 March 1997, with updates and modifications: Executive Decree N° 39/996 and Decree N° 345/997. Thus was set up the National Milk Quality System, which requires the industry to classify milk according to objective parameters and make payments accordingly.

Over the following years, certain adjustments were made until 1 March 1999, when the system that remains in force today was concluded.

At the same time, the industry itself began to implement payment systems based on additional parameters such as the percentages of fat and protein. These payment systems do not operate within the regulated sphere, depending instead on the policies of each one of the industries.

Their application is based on the fact that, in a dairy market that is increasingly competitive as well as uncertain and fluctuating, greater control over those variables that govern the production and commercialization of milk is an indispensable tool for determining the economic outcome of the activity and its future.

2. Control laboratories for the industries' raw materials

The implementation at the industry level of the quality payment system has meant that the industry has invested in laboratories in order to monitor and classify milk from the primary sector and pay for it according to the quality parameters defined.

This explains the investment made by the industry in improving the measurements involved in milk payment, since a reduction in the uncertainty of these measurements is associated with money that the industry is overpaying or that producers are being underpaid.

Over the years we have thus seen the introduction of rapid methods with an increasingly lower level of uncertainty for measuring the various payment parameters, for example, fat and protein.

3. Industrial measures to support the productive dairy sector

Markets have not only begun to focus on the industrial plant that processes milk, they also want to know how it is produced on the farm, what measures are taken to ensure the safety of the raw material and whether the production process respects the environment, as well as the non-renewable resources that are used.

In this context, an important tool is the Safe Dairy Farm Program (Programa Tambo Seguro), which was initiated by CONAPROLE in 2002 in cooperation with the government, which was created to set up a Quality Management System at the dairy company level, primarily in the processes related to milk quality and safety. Developed by CONAPROLE and the Farming Plan (Plan Agropecuario), and with financial assistance from Farming Services (MGAP), the Safe Dairy Farm Program was disseminated through an agreement between the MGAP and the National Development Corporation (CND).

4. The role of the Technological Laboratory of Uruguay (LATU) in support of the dairy production sector

As stipulated in its Decree of Creation of 1965 and the Budget Act of 1967, LATU is responsible, among other tasks, for the quality control of exports. In this regard, the Executive passed a series of decrees to classify dairy products that entrust LATU with the mandatory certification of these exports. It complies in this regard with the guidelines of ISO Guide 65:1996 for product certification bodies.

LATU has at its disposal a significant number of accredited laboratories for carrying out the tests to support the certification process. It also has fully equipped pilot plants to support the dairy industry in matters relating to product control and development.

LATU's participation in the areas of quality control, consultancy, training and export certification has thus contributed to the development of export activity, by facilitating access to new markets, and to recognition by the authorities of other countries with which it maintains links.

In addition, it is necessary to highlight LATU's role as the National Metrology Institute. For this purpose, the Scientific Metrology Department (Dirección de Metrología Científica) keeps a series of measurement standards that are periodically compared abroad, so as to maintain the traceability of calibrations to primary reference standards, with levels of uncertainty in accordance with the industrial requirements of the country.

The acceptance of different dairy products in international markets is directly related to the quantification of various parameters that define product quality. The same applies to the acceptance of and payment for raw milk in the industry. Accurate measurement of these parameters for the classification of milk and milk products facilitates trade at both the national and international level. LATU's role as a Metrology Institute is therefore important in providing traceability for these measurements and reducing their uncertainty.

E. Analysis of results

1. Measuring the impact of actions taken in the primary sector

Interventions:

- Establishment of policies aimed at improving the quality of the milk and in particular the establishment of a National Milk Quality System from 1 March 1997 onwards.
- Policies at the national and industrial level implemented in 2002.

Following the establishment of the National Milk Quality System, the quality of the milk produced at dairy farms -which had already been improving thanks to previous interventions - continued to improve. In addition, with the establishment of policies at the national and industry level in 2002, the improvement in the quality of the milk produced at dairy farms was further boosted, which enabled the sector to overcome the stagnation brought about by the economic crisis of 2002 and continue the process of sustained growth.

Hypothesis

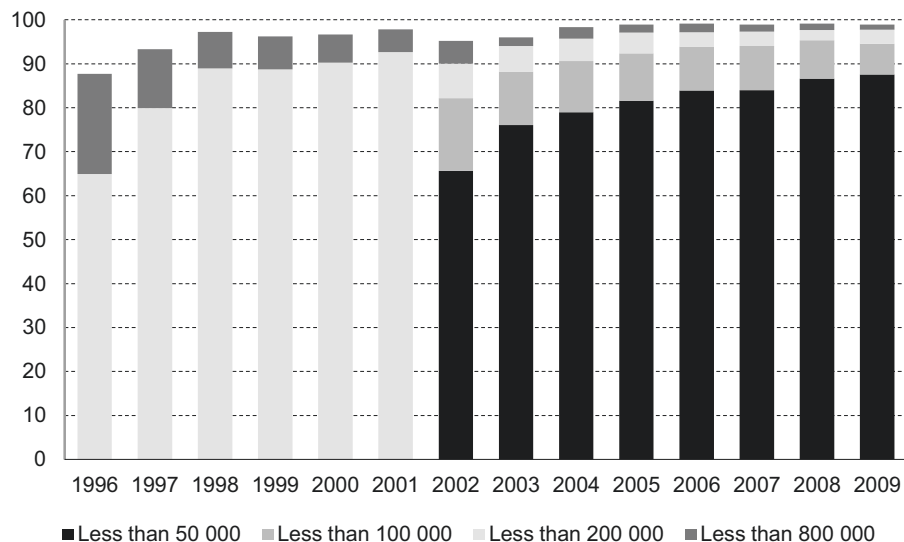
Better control of milk quality at dairy farms is expected to have the following effects:

- An improvement in the quality of the milk produced.
- An increase in productivity measured by the amount of milk produced per hectare.
- An increase in the price of milk.
- A decrease in the number of producers in the market, due to the fact that not all producers will be able to adapt to the new requirements.
- An improvement in the income of the producers.

The following impact indicators will be evaluated:

- Quality of the milk produced, through the number of colony forming units (quantification of bacterial count).
- Improvement in the income of producers, through the number of somatic cells.

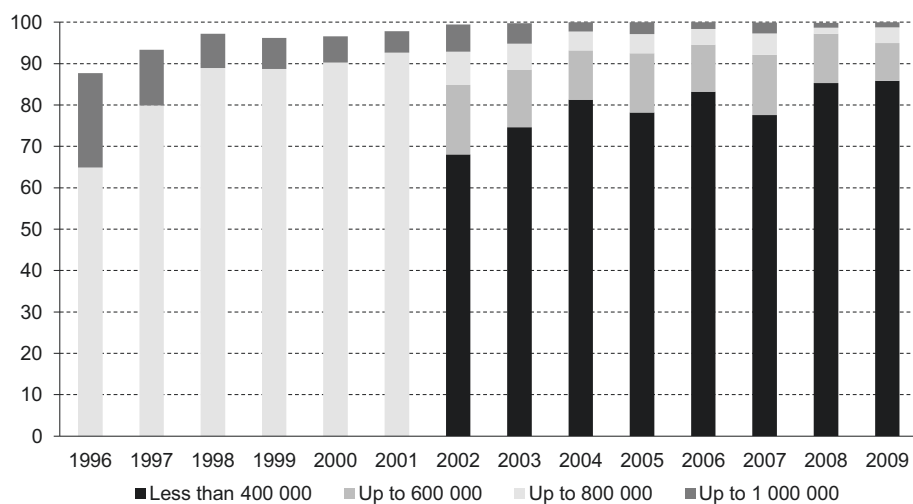
FIGURE 4
NUMBER OF COLONY FORMING UNITS^a



Source: ECLAC-PTB, 2011.

^a Since 1996, there have not been a significant number of milks with cfu above 800,000. The values shown as less than 800,000 mean values between 200,000 and 800,000. Similarly, those below 200,000 mean values between 100,000 and 200,000 and so on.

FIGURE 5
NUMBER OF SOMATIC CELLS^a

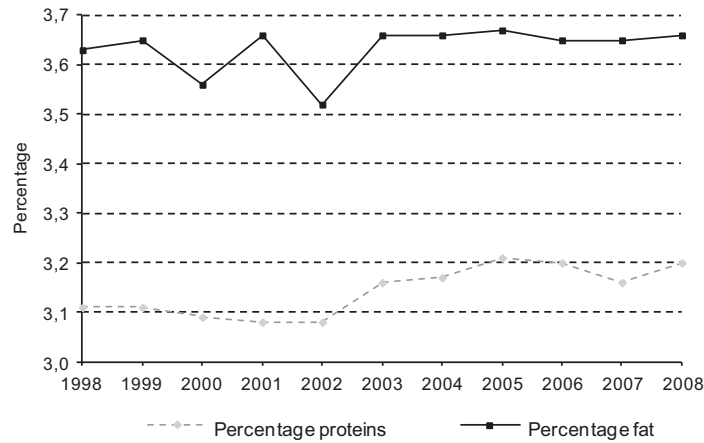


Source: ECLAC-PTB, 2011.

^a Since 1996 there have not been a significant number of milks with values of somatic cells greater than 1,000,000, for this reason the values shown as less than 1,000,000 mean values between 800,000 and 1,000,000. Similarly, those less than 800,000 mean values between 600,000 and 800,000 and so on.

Figures 4 and 5 show a significant increase in milk quality, which (according to the provisions of the payment systems) necessarily leads to an increase in the price of milk, resulting in a benefit for the producers.

FIGURE 6
PERCENTAGE OF FAT AND PROTEIN IN MILK



Source: ECLAC-PTB, 2011.

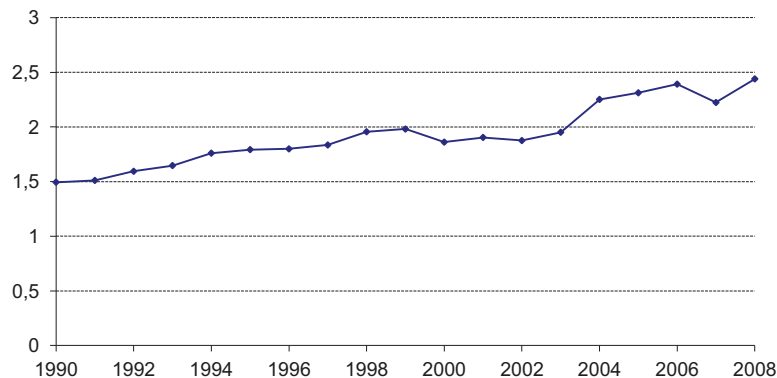
There was a 2.3% increase in the price of milk due to the increase in protein and a 0.4% increase due to the increase in fat, making in total a 2.7% increase in the price of milk. These increases can be clearly observed from 2002 on (Source: MGAP).

2. Improvement in the income of the producers

Figure 7 shows the growth in the productivity of livestock in thousands of litres of milk per head up to the year 1998. This then levelled off until the year 2002, when new growth can be observed with a steeper curve. Similarly, figure 8 records the increase in productivity measured in thousands of litres per hectare up to 2001, which levelled off until 2003 and then grew again from that year on.

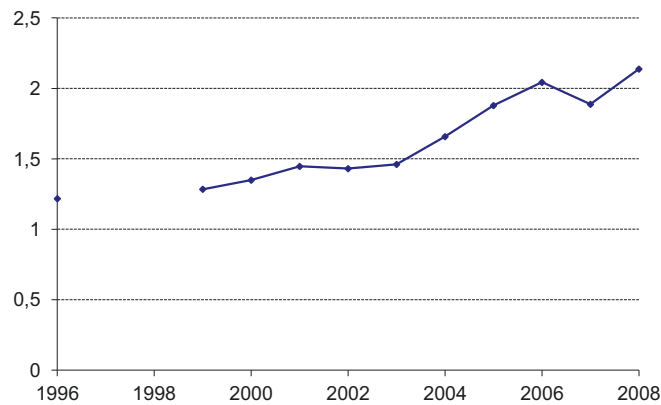
The levelling off may be due to the economic crisis that reached its peak in 2002, since the increase in productivity is associated primarily with the feeding of cattle, which was affected by the crisis of that year. As the economic situation improved, it was possible to gradually increase the quality of the feed and return to the previous levels of production.

FIGURE 7
LIVESTOCK PRODUCTIVITY
(Litres of milk per hectare per year)



Source: ECLAC-PTB, 2011.

FIGURE 8
PRODUCTIVITY OF THE LAND
(Litres of milk per hectare per year in thousands)



Source: ECLAC-PTB, 2011.

The obligatory licensing laws and quality systems introduced in production and processing then led to an increase of approximately 30% in the productivity of livestock between 2002 and 2008. This steady increase in productivity, combined with an improvement in the quality and therefore the price of milk per litre for the producer, led to an improvement in the income of the milk producers for the same production costs.

TABLE 32
IMPROVEMENT IN PRICES
(US\$ per litre of milk on average)

Year	Quota	Industry	Average	Quota	Industry	Average	Quotient (Quota /Industry)
	In current \$			In cents of current US\$			
1996	2.05	1.35	1.54	25.67	16.91	19.33	1.52
1997	2.37	1.61	1.81	25.02	17.05	19.17	1.47
1998	2.54	1.45	1.61	24.27	13.95	16.11	1.75
1999	2.69	1.32	1.61	23.75	11.64	14.09	2.04
2000	2.97	1.49	1.8	24.49	12.08	14.83	1.99
2001	3.13	1.68	1.96	23.41	12.43	14.57	1.86
2002	3.35	2	2.27	16.75	9.35	10.82	1.88
2003	3.97	3.49	3.58	14.04	12.22	12.59	1.14
2004	4.72	4.12	4.24	15.58	14.42	14.7	1.08
2005	4.85	4.11	4.23	19.82	16.72	17.28	1.08
2006	4.94	4.04	4.21	20.5	16.8	18.5	1.22
2007	5.69	6.07	6.01	24.31	25.92	25.65	0.94
2008	6.62 ^a	7.3	^b	31.0 2	35	^b	^b
Var. 2008/07 (%)	1.16	1.2	^b	1.28	1.35	^b	^b

Source: ECLAC-PTB, 2011.

^a Valid only in January and February, and ^b Not applicable.

This table shows a steady increase in the industry milk price (price controlled by the industry and not by the government, as is the case of quota milk, the one destined for the domestic market and consumed as raw milk, for which the government sets the consumer price), except for the years 2002-2003. The sharp increase in 2008 occurred due to a rise in international prices for dairy products, but indirectly it can be linked to the implementation of policies designed to ensure the quality of dairy products, since otherwise they would not be exportable.

3. Measurement of the impact of actions taken in the industrial sector

The high degree of vertical integration with the primary sector is one of the main features of this sector.

An increase in quality in the primary sector is therefore an increase in the quality of the raw material entering the industry, which enables a reduction in processing costs and the possibility of using the raw material in products with a higher demand and higher added value. The improvement shown in the quality of the milk sent for processing was a result of the impact of the different quality policies implemented, and also has an economic effect on the industrial sector, by lowering the costs for reclassification and losses, as well as the rejections of milk by the foreign markets.

4. Impact of controls carried out by the regulatory agency MGAP and the certification of dairy products carried out by LATU

4.1 Increase in the amount of milk sent for processing and for export

Intervention:

System implemented in Uruguay for the quality certification of dairy products.

Hypothesis:

The system implemented in Uruguay for the quality certification of dairy products is effective in ensuring the smooth integration into the international market of all the dairy products produced for export purposes, supporting their continuous growth.

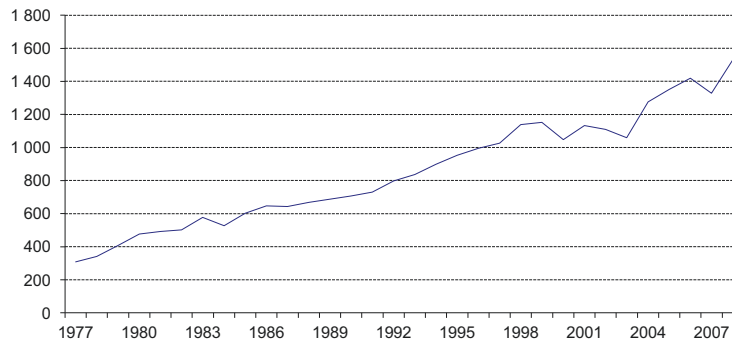
The following are taken as impact indicators:

- Quantity of milk sent to industrial plants.
- Exports in FOB US\$.
- % of production destined for export in comparison with other countries in the world.

The evaluation of the indicators can be described as follows:

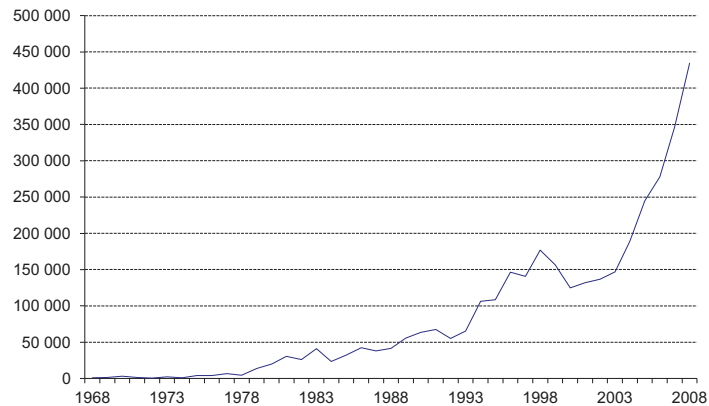
- Quantity of milk sent to industrial plants
- Exports of dairy products in Uruguay 1968-2007 (in USD, FOB)

FIGURE 9
MILK SENT TO INDUSTRIAL PLANTS
(Thousands of litres sent)



Source: ECLAC-PTB, 2011.

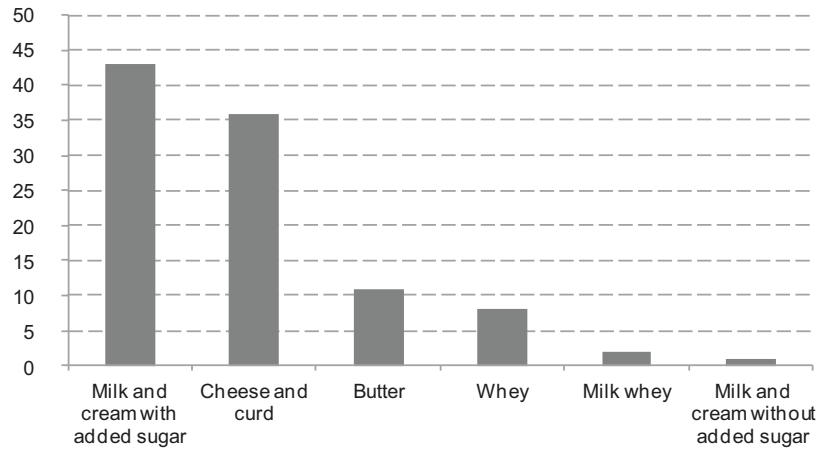
FIGURE 10
EXPORTS OF DAIRY PRODUCTS 1968-2007
(In thousands of dollars, FOB)



Source: ECLAC-PTB, 2011.

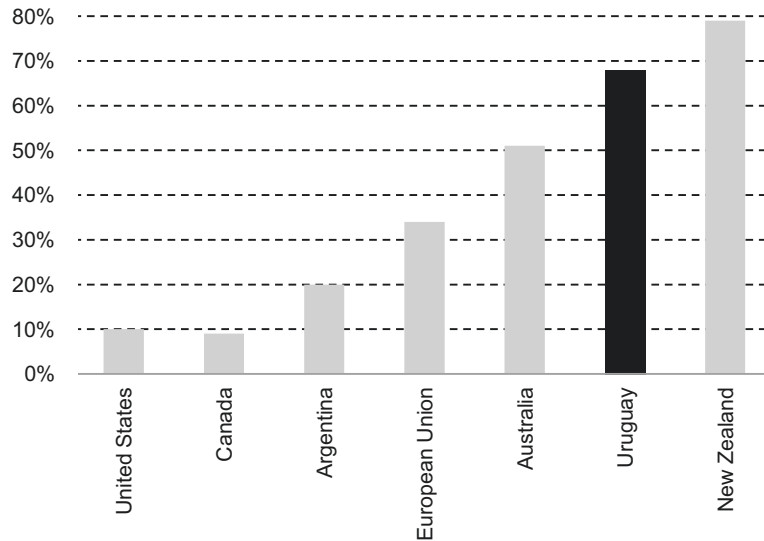
This growth is partly a result of the growth of the export volume. It is largely the result of the price rise based on assured quality, but is also due to the expansion of the range of dairy products. The export of these products also requires a product conformity certificate.

FIGURE 11
EXPORTS BY PRODUCT TYPE, 2009
(As a percentage of the total)



Source: ECLAC-PTB, 2011.

FIGURE 12
EXPORTS OF DAIRY PRODUCTS, AVERAGE 2006-2008
(Percentages of production in milk equivalent)



Source: ECLAC-PTB, 2011.

The graph shows very clearly that the permanent improvement in the quality assurance system, aimed at better meeting the requirements of international markets, improved Uruguay's position among world exporters.

4.2 Diversification of destination countries

Intervention:

System implemented in Uruguay for the quality certification of dairy products.

Hypothesis:

The system implemented in Uruguay for the quality certification of dairy products is effective in ensuring smooth integration into the international market

The following data were used as indicators:

- Percentage of effective missions carried out by destination countries to audit the Uruguayan certification system.
- Diversification of the countries importing Uruguayan dairy products.

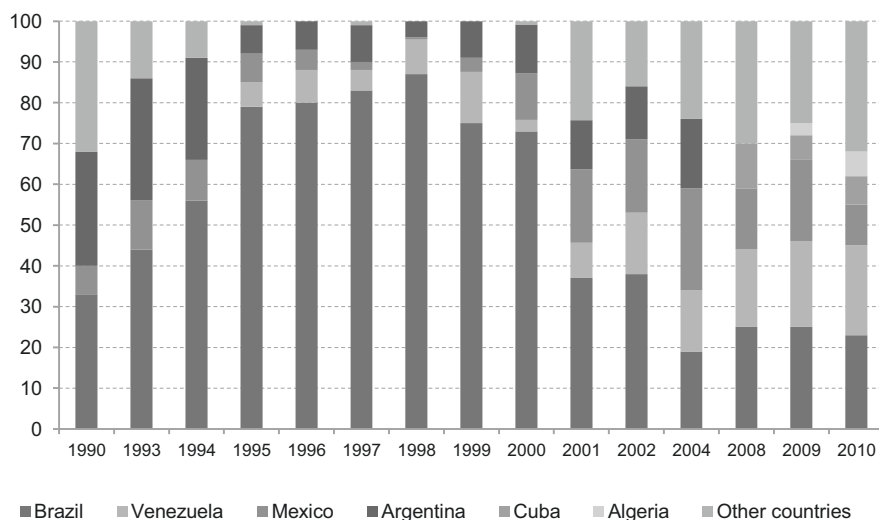
Different agreements are entered into with each country regarding the recognition of the quality of the dairy products produced at plants, each with different types of evaluations for recognition. These agreements make it possible to export Uruguayan products to different destinations:

- Brazil
- Argentina
- Israel
- Venezuela
- Cuba
- Peru
- Mexico
- United States
- Paraguay
- Russia
- Algeria
- China
- Other countries with missions in Uruguay: Costa Rica, Colombia, South Korea, Indonesia, Malaysia
- European Union: there is a pre-established list with two authorized plants.

Diversification of the countries importing Uruguayan dairy products

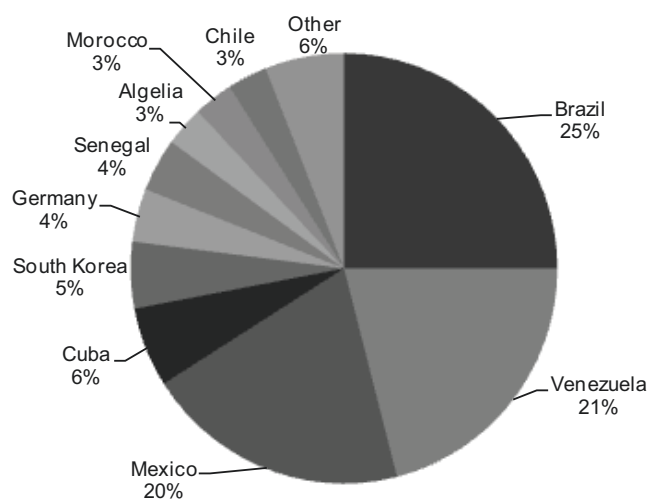
It can be observed, in particular, that Brazil's importance as an export destination is decreasing, as is that of Argentina. On the other hand, the importance of Venezuela and Mexico is increasing. But Brazil, Mexico and Venezuela still account for more than 60 % of Uruguayan dairy exports.

FIGURE 13
EVOLUTION OF THE SHARE OF THE MOST IMPORTANT DESTINATION COUNTRIES IN
THE EXPORT OF DAIRY PRODUCTS FROM URUGUAY
(As a percentage)



Source: ECLAC-PTB, 2011.

FIGURE 14
MAIN DESTINATIONS FOR EXPORTS OF URUGUAYAN DAIRY PRODUCTS, 2009



Source: ECLAC-PTB, 2011.

Like the other main milk producers (including New Zealand and Chile), Uruguay seeks to have access to new markets on other continents. Thus, it began exporting to Russia and also to African countries such as Egypt, Nigeria, Senegal, Algeria and Morocco. Asia (South Korea) is also seen as a future market.

4.3 LATU's role as the NMI. The improvement in the measurement uncertainty of proteins

Intervention:

Reduction in the uncertainty of routine measurements of protein carried out by control laboratories.

Hypothesis:

By reducing uncertainty, a fairer exchange is achieved between the company and producer, thereby minimizing potential losses for both parties. The improvement in the quality of the measurements carried out by dairy control laboratories according to which payment is made to producers results in fairer trade.

The amount of money involved in the possible decrease in uncertainty is used as an indicator:

- Case 1: Measurement uncertainty of 0.1% (for a value of 3% on average of domestic production):
 - Associated price uncertainty: 2%.
 - At a price to the producer of US\$ 0.25 /l of milk and a production of 1,531 million liters in 2008, this involves an associated annual cost of US\$ 7.6 million.
- Case 2: The measurement uncertainty is reduced from 0.1% to 0.02%:
 - Price uncertainty associated: 0.4%.
 - At a price to the producer of US\$ 0.25 /l of milk and delivery to plants of 1,531 million liters in 2008, this means an associated annual cost of US\$ 1.5 million.

The support provided to the industry by LATU as the NMI to reduce the measurement uncertainties of the control parameters for milk, either through proficiency testing or by providing reference materials for the calibration of frequency measuring equipment, has a significant impact on promoting transparency in the commercial exchange between industry and producers.

F. Conclusions

Uruguay has been developing policies to promote quality in the production of dairy products for export since the 1970s. These policies have had a greater impact when there has been coordinated action by the different public and private actors: Health Authority, Certification Bodies, Standards Bodies, NMI, industry and others, and when these actions have been geared toward the requirements of the world market and international regulations and good practices.

Taking this into account as good practice, and with a view to future activities involving the dairy chain or other production chains, it is important to evaluate from the outset the implementation of promotion policies, the interrelationships and possible synergies between the actors mentioned in order to foster the desired results.

Uruguay's integration into quality infrastructure international networks, which enabled the international recognition of the certificates issued in the country after the signing of the respective mutual recognition agreements (especially LATU as NMI and the Uruguayan Accreditation Agency-OAU) is an example of the application of international practices. LATU plays a vital role in this quality certification framework, since the system implemented to carry out certifications is based on a certification body that evaluates product data provided by independent accredited laboratories, giving to the system the guarantees necessary for it functioning.

On the other hand, one problem that was identified during the present study was the lack of availability of certain data that would have enabled a deeper analysis of some of the proposed

indicators or even the presentation of other indicators. For this reason, it is advisable to put forward an impact theory when proposing policies, since if the impact indicators are defined in advance, actions can be taken to make the data available for evaluation.

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Webportal: Website of the Ministerio de Ganadería, Agricultura y Pesca: www.mgap.gub.uy.

X. Impact study on the services provided by LATU in the framework of the national quality infrastructure to the uruguayan wine sector

*Martín Fossati*⁸¹

A. Introduction

The Technological Laboratory of Uruguay (LATU)⁸² has been playing a significant role in the development and modernization of the national wine industry since the early 1970s, with the analytical characterization of domestic wines and the establishment of pre-export certification, and, particularly in recent years, with the delivery of the following services: proficiency testing, instrument calibration services, voluntary testing of wines and bespoke training courses.

The services provided by LATU to the winery sector fall within the framework of the various components of the quality infrastructure (QI), both because of the very nature of the services provided and because of the infrastructure necessary to provide each one of them.

This article examines the impacts of the services offered by LATU to the Uruguayan wine sector within the framework of the QI and is structured as follows. First, it presents a brief overview of the importance of the proper functioning of the QI for the development of productive activities. It then describes the services provided, together with the reasons that led to them being carried out. The article then goes on to detail the expected impacts and the methodology employed to identify them, before presenting a brief summary of the results found. It concludes by presenting the study findings.

⁸¹ Adviser at LATU.

⁸² LATU was created in 1965 as a joint effort by the government and private sectors. Its mission is to promote the country's sustainable development and its international insertion, through innovation and the transfer of value solutions in analytical, metrological, technological and management services and conformity assessment in accordance with applicable regulations. The LATU national reference metrology laboratories fulfill the function of the National Metrology Institute in Uruguay.

B. The importance of a national quality infrastructure system

In a globalized world, technical rules and regulations play an increasingly important role both for accessing international markets and for becoming integrated into global production chains, meaning that the importance of the correct functioning of the QI is growing.

Recent studies by the International Trade Center (2011) show that most of the problems that currently affect exports are related to non-tariff barriers resulting from technical regulations, conformity certifications in production processes, and sanitary and phytosanitary restrictions.

Conformity assessment procedures in general, and pre-export certification processes in particular, must therefore ensure that export products comply with both the quality standards established in the target markets and national regulations on the matter. Thus, the correct functioning of all pre-certification processes must ensure that certified products are in a position to access target markets without difficulty, as well as preventing the shipment of defective goods that might damage the image of the country's products.

Moreover, the QI is associated with a broad spectrum of positive impacts on both the development and improvement of production activities and on the progress of the wellbeing of society in general, such as: increasing the competitiveness and productivity of companies, encouraging processes of innovation and knowledge dissemination, reducing the heterogeneity of products and processes, and guaranteeing minimum levels of quality and safety of those products and processes.

C. Services provided and expected impacts

In 1972, at the request of the winery sector itself, which was interested in marketing its wines abroad and thus considered necessary to ensure minimum standards of quality for all products exported, the National Government established the mandatory pre-certification for exports of wine, designating LATU as the agency responsible for performing this task from then on.

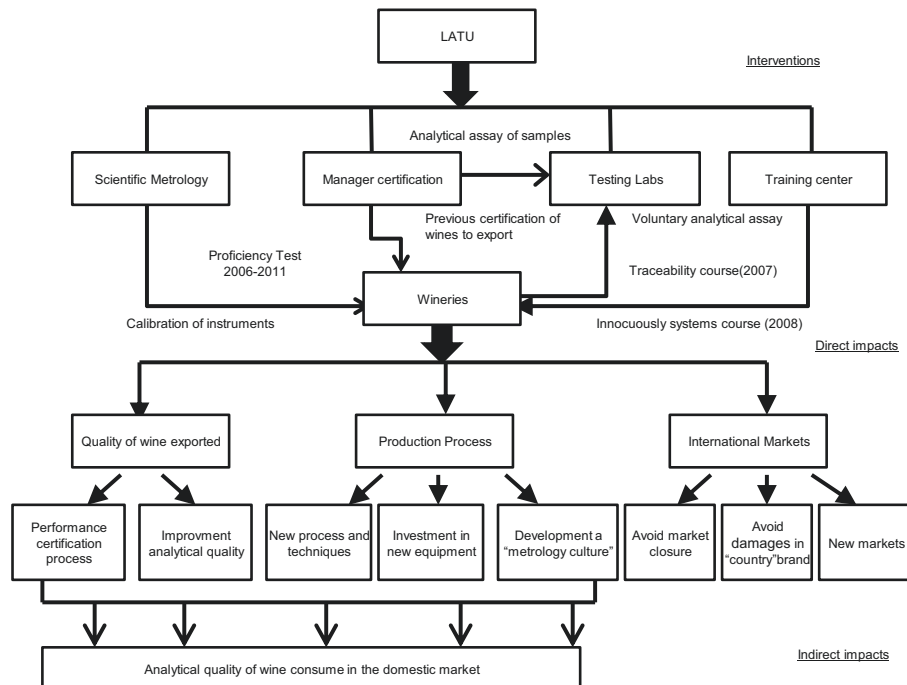
More recently, LATU has also carried out a series of complementary activities to support the winery sector in the voluntary sphere in order to help fine-tune its production processes and improve the analytical quality of both the wines produced as well as its determination at the industry level. These activities are listed below.

Proficiency Testing: Since 2006 to date, in its role as the National Metrology Institute, LATU has been organizing successive inter-laboratory rounds (proficiency testing), in which the conformity of the measurements of the participating wineries' laboratory instruments is assessed using the reference values provided by LATU. **Calibration of instruments:** in its capacity as National Metrology Institute, LATU also provides calibration services for the winery laboratories' measuring instruments.

Training courses: based on the identification of certain weaknesses in the sector's production processes, LATU developed two specific training courses for the sector: Traceability in the Wine Industry (2007) and Implementation of the Food Safety Management System in Wineries (2008).

Analytical tests: a wide range of accredited tests are carried out on Uruguayan wines in the LATU testing laboratories at the request of the wineries

DIAGRAM 6
SERVICES PROVIDED BY LATU, AREAS INVOLVED AND DESIRED IMPACTS



Source: Own elaboration.

Diagram 6 shows the various areas in which LATU is involved in providing these services: Certification Management, various Testing Laboratories,⁸³ the Scientific Metrology Department and the Training Centre, which in turn operate in their different roles as components of the national QI system. It also highlights the interrelation between these areas, their interaction with the winery sector and the expected impacts of the services.

D. Identification of expected impacts

Once the interventions, the relationship existing between them and the various areas of LATU involved in these services had been defined, the next step was to identify the impacts attributable to these interventions, the parties involved, as well as the external factors that might influence whether or not the expected impacts were achieved.

For this purpose, meetings were held with the LATU technicians belonging to the various areas involved in the interventions being carried out, so that the opinions of the main actors in the Uruguayan wine sector could be collected and a review was made of the literature available on the impacts expected from the correct functioning of the QI.

⁸³ The tests carried out on wines during the certification process involve the following Testing Laboratories: Fermented Beverages, Mass Chromatography of Food and Environment, Atomic Spectrometry of Food and Environment and Natural Toxins. It should be noted that the aforementioned laboratories and some of the results of the certification process itself are duly accredited by the United Kingdom Accreditation Service (UKAS), and therefore LATU's technical competence to issue the test certificates that support the certification process is recognized internationally.

Based on the impacts identified, a set of indicators deemed to be appropriate for measuring these effects was also designed, on the understanding that they would make it possible to capture the impacts attributable to the interventions carried out as effectively as possible, while also isolating the impacts from other external factors. For the development of these indicators it was necessary to collect and process information from various sources, as well as field data obtained from a survey to the wineries involved⁸⁴ in the various interventions.

TABLE 33
MATRIX OF EFFECTS

Interventions carried out:	Main Intervention: Mandatory pre-export certification of Uruguayan wines regarding compliance with the analytical characteristics required in the target markets.			
	Complementary or supporting interventions:			
	<ul style="list-style-type: none"> • Implementation of Proficiency Testing with the participation of the wineries' control laboratories, together with the promotion of a culture of metrology (calibration and control of instruments) in these laboratories. • Training Courses for the national winery sector related to the handling of traceability in document production and management and the implementation of food safety systems in the wine industry. • Test analysis on a voluntary basis. 			
Institutions involved:	Technological Laboratory of Uruguay (LATU)			
Geographical location of the intervention	The entire country			
Interested parties and those directly involved	Desired Effects:	Proposed Indicators:	Source of information	
A) Wineries and business associations	1- To establish and maintain the quality image of Uruguayan wines at the international level.	N° of shipments rejected at the destination markets due to non-compliance with the required analytical characteristics. N° of business deals lost (markets closed) due to shipments of wine with analytical non-conformities.	Wineries Survey Wineries Survey	
	2- Improvement in the analytical quality of the exportable supply of fine wines	Reduction in the number of non-conformities and subsequent rejections in the analytical tests carried out in the certification processes over time.	LATU	
	3- Innovation and improvements in production processes	Evolution of the wineries in the Proficiency Tests.	Evolution of the demand for voluntary testing Qualitative assessment by the wineries of the training courses Identification of changes and improvements in production processes	LATU
		Evaluation of the wineries in the Proficiency Tests		Wineries Survey
Evolution of the number of calibrated instruments		Wineries Survey		
4- Increase in the number of destinations to which Uruguayan wines are exported	N° of destinations where Uruguayan wines are sold.	Customs		

⁸⁴ The field survey included some 25 wineries that export fine wines, either on a regular or an ad hoc basis, with particular interest in including those wineries that in addition to requiring the export certification services have made use of other services provided. With regard to the representativeness of the sample, the wineries surveyed were responsible for 97% of fine wine exports in 2011 and 95% for the 2000-2011 period.

Table 33 (conclusion)

B) LATU	1- Reduction in the costs associated with the certification process due to greater efficiency.	Reduction in the time taken by the number of resamplings required.	LATU
Indirect effects:	Affected Stakeholders:	Proposed Indicators:	Sources of information
C) Improvement in the quality of the wine consumed in the domestic market	Uruguayan consumers, the National Institute of Viticulture (INAVI), the wineries	1.1. Qualitative vision of the wineries.	Survey Wineries
External factors that may have altered the effects of the intervention:			
Positive influence:			
The wine industry's process of reconversion.			
Regulations and policies established by the National Institute of Viticulture (INAVI).			
Promotional activities carried out by the industry and the national government.			
Certification of the wineries with ISO standards.			
Negative influence:			
Adverse international macroeconomic situation in recent years.			
Reduction in the consumption of wine in several of the major international markets where Uruguayan wines are sold.			
Unfavorable evolution of national competitiveness			

Source: Own elaboration.

Table 33, corresponding to the matrix of effects,⁸⁵ shows the expected impacts, the interested parties, the selected indicators and sources of information used for its construction. In addition, it identifies the main external factors that could influence whether the expected impacts are achieved.

E. Results of the study

1. Establishing and maintaining the quality image of Uruguayan wines at the international level.

The central objective of the certification process is to ensure that exported wines comply with both the quality standards of the target markets and with the corresponding national regulations. The correct functioning of the certification process must ensure that the certified wines are in a position to access target markets without difficulty, as well as preventing the shipment of defective goods that might damage the image of the country's products.

Based on the survey carried out among the exporting wineries, it was found that none of the wineries surveyed had experienced any rejection whatsoever in any foreign market for failing to comply with the quality standards required, nor had they experienced the total or partial closure of any market as a result of previous shipments of wines with defective analytical characteristics by third-party wineries.

It can therefore be demonstrated that the main objective of the pre-export certification process has been fully met.

⁸⁵ Developed following the methodological recommendations given in Goncalves and Peuckert (2011).

2. Improvement in the analytical quality of the exportable supply of fine wines

With the aim of measuring the evolution of the analytical quality of the fine wines exported, an analysis was made regarding the evolution over time of the percentage of non-conformities in applications for certification with regard to the requirements established in external markets.⁸⁶

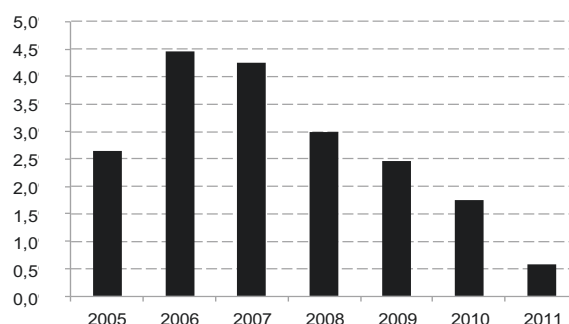
The analysis shows that Uruguayan fine wines successfully comply with the analytical quality standards established in international markets. In fact, in recent years, there has been a reduction in the number of occasions on which non-compliance by Uruguayan wines has been detected with regard to any of the various parameters required in international markets, with only a few isolated and insignificant cases being recorded.

A special mention should be made of the applications for export of wine to the European Union (EU) rejected for not complying with the regulations of this market with respect to the maximum permitted levels of sodium. However, it should be noted that the European legislation with respect to this parameter is significantly more restrictive than that of other markets, and that the wines that did not comply with the requirements of the European market accounted for less than 2% of export applications.

It is worth highlighting that the problems detected in the levels of excess sodium were directly related to techniques (reagents) employed by the Uruguayan wineries in the process of wine preservation. Prior to the detection of problems with excess sodium levels, most of the Uruguayan wineries used sodium metabisulfite as a preservative, which was promptly replaced by potassium metabisulfite. This change enabled the excessive sodium levels to be reduced, making it possible to quickly achieve the quality standards required by European legislation.

Furthermore, when analyzing the evolution of the proportion of non-conformities detected in the labelling of alcohol content in relation to the alcohol content actually present in the wines, it can be observed that the non-conformities of this kind do not represent problems in the analytical quality of the wines produced, but mostly problems with the measurement of the alcohol content in the wineries' laboratories. Nevertheless, this still constitutes non-compliance with the regulations established in international markets, since the difference between the actual alcoholic strength and that specified on the label cannot exceed the maximum tolerances established in the target markets.

FIGURE 15
PROPORTION OF NON-CONFORMITIES IN THE LABELLING OF ALCOHOL CONTENT,
2005-2011 PERIOD
(As a percentage)



Source: Own elaboration.

⁸⁶ The parameters analyzed were: sulphur dioxide, volatile acidity, citric acid, excess sodium, sulfates, ochratoxin A, lead, methyl alcohol, Malvidin (hybrids) and the evaluation of the labelling of alcohol content.

As can be observed in figure 15, from 2006, the year when the first rounds of proficiency testing began to be conducted, the proportion of export applications that displayed non-conformities due to problems with the labelling of alcohol content shows a steady decline over time. In fact, the reduction in the proportion of non-conformities in the labelling of alcohol content can be directly linked to the improvement in the measurement of this parameter in the wineries' laboratories, which in turn, as will be shown below, is directly associated with their participation in the proficiency tests, which have enabled the wineries to increase their accuracy in determining this parameter.

3. Innovation and improvements in production processes

One of the expected impacts of the QI identified by the literature is the contribution to generating improvements and innovations in the production processes of the companies and sectors involved. It is to be expected therefore that as a result of the interventions carried out by LATU, improvements will be seen in the equipment and instrumentation of the wineries as well as in the techniques and procedures used in the production and quality control laboratories.

A set of both qualitative and quantitative indicators was thus chosen to identify and quantify possible improvements and innovations in the productive processes of the wineries.

4. Evolution of the wineries in the Proficiency Testing

Since 2006, successive rounds of proficiency tests have been carried out between the companies in the sector and the laboratories accredited by LATU, which cover most of the tests required during the certification process. Since then, 14 wineries have participated on at least one occasion, six of which have done so continuously for the past four years.

The group of six wineries that have continuously participated in the proficiency testing have in general seen improvements in their measurements as a result of perfecting their measurement methods and increasing the accuracy of their instruments. In particular, this relates to the measurement of alcohol content, since this is the main cause of non-conformities in the certification process, which however, as stated above, have shown a downward trend since these tests have been carried out.

To complement the earlier analysis carried out on the basis of the results of the group of six wineries that have participated on a regular basis in the proficiency testing, a survey was then conducted among the 14 wineries that had participated in these tests on at least one occasion, in order to record their qualitative opinion in this regard.

Of these 14 wineries, almost 80% (11 wineries) stated in the survey that they had improved their performance in the certification process as a result of their participation in the proficiency testing. Furthermore, five out of a total of seven wineries that acknowledged having improved their performance in the certification process and that had also previously shown non-conformities in the labelling of alcohol content, that is to say, 71%, stated that they had experienced reductions in the number of non-conformities in the labelling of alcohol content.

The decrease in non-conformities in the labelling of alcohol content led to reductions in the time required to obtain certification for that group of wineries, and to a lesser extent, reductions in the costs of labelling.

In addition, the wineries that had participated in the proficiency testing were also asked whether they had introduced changes or improvements in their laboratories as a result of having participated, to which 80% of them replied that they had. In turn, 45% of the wineries that had introduced improvements stated that they represented an investment for them, but which all evaluated as profitable.

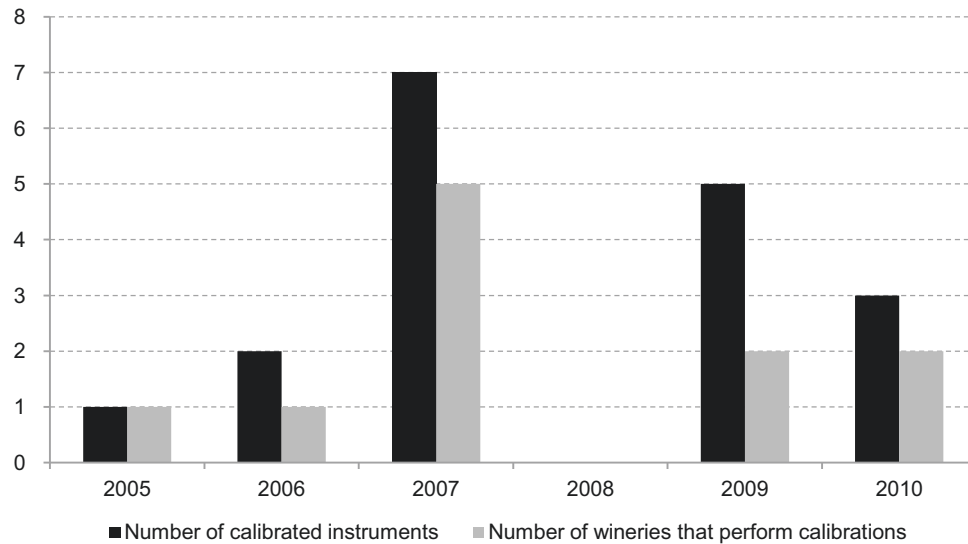
Finally, it is worth highlighting that once each round of proficiency testing has been concluded, the participants are invited to a meeting where the overall results are discussed and the experts from LATU also advise technicians on the possible reasons for the deviations and how to

correct them. These improvements can refer, for example, to improvements in analytical methods or the instruments used (quality, state of calibration, etc.).

5. Evolution of the number of calibrated instruments

Following the first round of proficiency testing, in which errors were detected in a number of measuring instruments belonging to the winery laboratories, mainly in alcoholmeters, there was a significant increase in the demand for calibration services, both in relation to the number of instruments and the wineries involved. However, in subsequent years, the demand for calibration services fell once again. Unfortunately, therefore, it is not possible to state that a “culture of metrology” has developed within the national wine industry.

FIGURE 16
NUMBER OF CALIBRATED INSTRUMENTS AND WINERIES THAT PERFORM CALIBRATIONS, 2005-2010

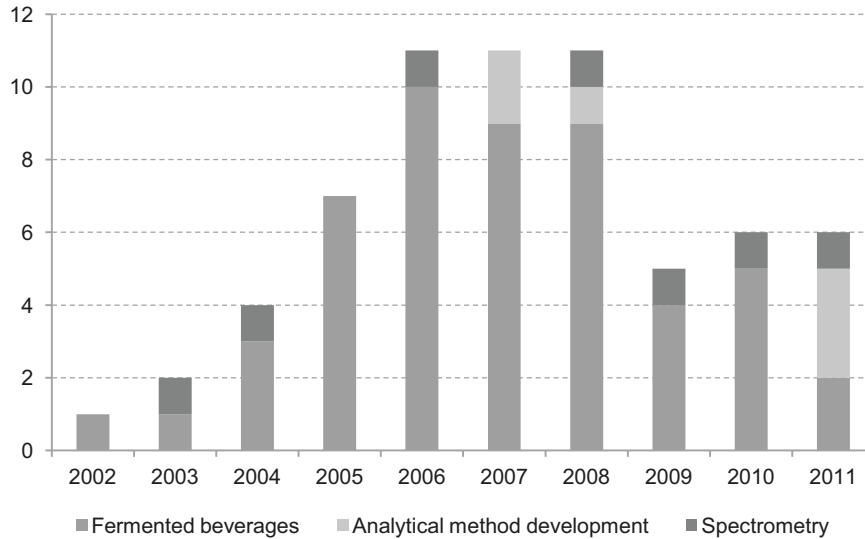


Source: Prepared by authors.

6. Evolution of demand for voluntary testing

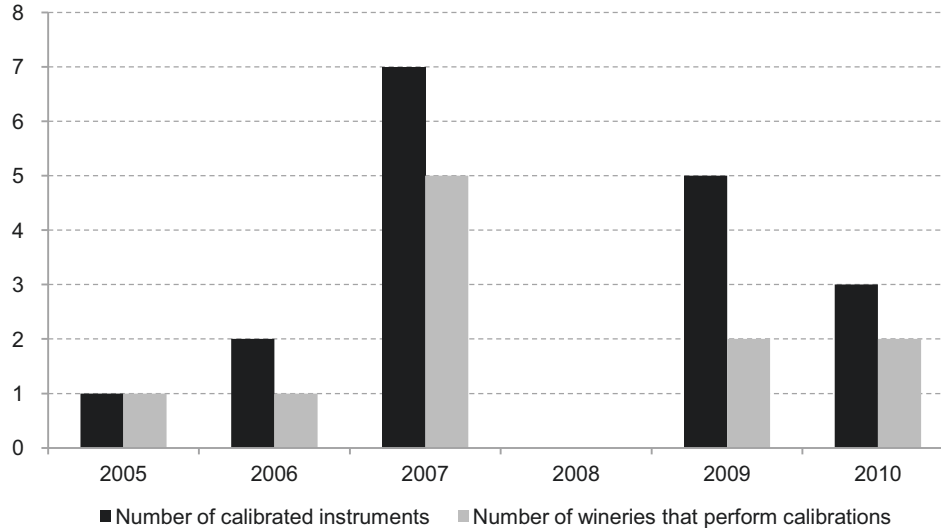
In addition to providing the necessary infrastructure to assess the conformity of the wines to be exported in the certification process, the LATU testing laboratories provide testing services to third parties in the voluntary sphere. Therefore, wineries that wish to test their wines, either because they lack of the necessary infrastructure or want to corroborate the measurements obtained in their laboratories, make use of services such as those provided on a voluntary basis by the LATU laboratories.

FIGURE 17
NUMBER OF VOLUNTARY TESTS (FERMENTED BEVERAGES, USING ANALYTICAL METHOD AND SPECTROMETRY), 2002-2011



Source: Prepared by authors.

FIGURE 18
NUMBER OF VOLUNTARY TESTS (FERMENTED BEVERAGES LAB AND ANALYTICAL METHOD DEVELOPMENT LAB), 2002-2011



Source: Prepared by authors.

Between 2002 and 2008, a growing trend emerged in the demand for voluntary testing. However, in the last three years, the number of wineries requesting tests in the voluntary sphere has fallen. A possible explanation for this is that with the reduction in the number of non-conformities in the certification process, particularly with regard to the labelling of alcohol content, the wineries have less need to make use of the analytical tests provided by third party laboratories.

This last point highlights the importance of having access to accurate and reliable measurements in the winery laboratories, perfected as a result of the wineries' participation in the various rounds of proficiency tests and the voluntary calibration of their instruments. Availability of more accurate measurements enables the wineries to improve the functioning of their production processes, for example, through a better dosage of the amounts of sulphur dioxide, thereby improving the quality of the products obtained. At the same time, it gives the wineries greater certainty as to the analytical characteristics of the wines produced, which particularly affects the declaration (labelling) of the alcohol content.

7. Qualitative assessment of the training courses by the wineries

Of the universe of 25 wineries surveyed, 11 had participated in at least one of the courses offered (Traceability in the Wine Industry (2007) and Implementation of Food Safety Management System in Wineries (2008)), and several of them in both. When asked whether based on the courses offered they had introduced improvements in their companies' production processes, 91% responded affirmatively. Moreover, 80% of the wineries that reported having introduced improvements in their production processes as a result of the training received also experienced improvements in their performance in the certification process, one of the factors that gave impetus to the development of the courses.

8. Identification of changes and improvements in production processes

This article has presented a set of indicators designed to confirm the initial assumptions that the services provided by LATU positively impact the wineries' production processes. For this purpose, both quantitative performance indicators and qualitative indicators based on a survey of the wineries involved were analyzed. In this way, it has been demonstrated that the activities carried out by LATU have contributed to improving the production processes of the wineries.

Lastly, in the survey conducted, the companies in the sector were asked, as far as possible, to detail the changes and improvements in production processes resulting from the various interventions carried out by LATU, which are summarized in the table below.

Changes in techniques and inputs used in production:

- The use of sodium metabisulfite for wine preservation was discontinued. It was replaced by potassium metabisulfite to avoid problems with excess sodium.
- Changes in the dosage of sulphur dioxide.
- Better controls of volatile acidity levels, including the design of monitoring and control systems on this issue.
- Higher standards of hygiene in production (wineries-harvest.)

Investment in equipment and infrastructure:

- Refrigeration equipment.
- Equipment for pH control.
- Temperature monitoring devices.
- Packaging machinery.

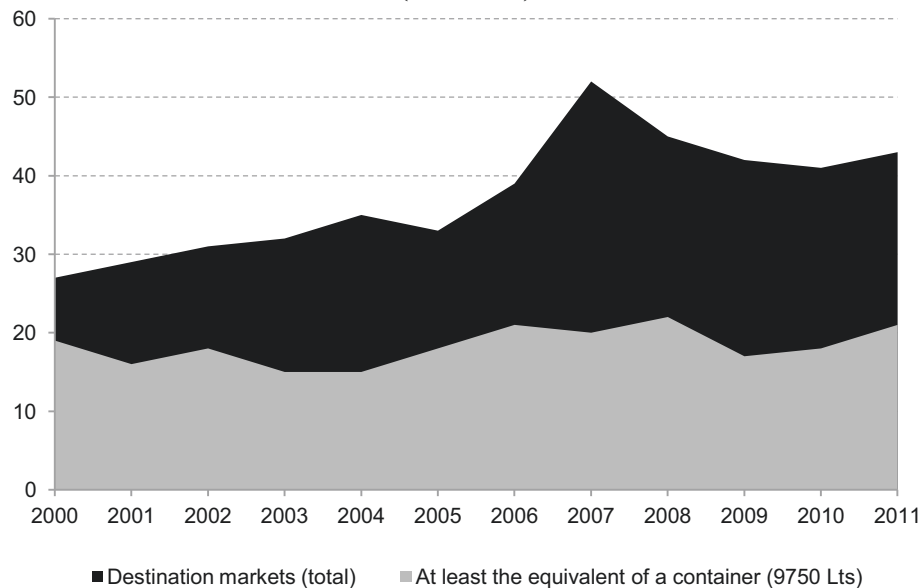
9. Increase in the number of destinations to which Uruguayan wines are exported

Although both public and private sector trade promotion activities play a predominant role in helping companies to access and consolidate new export markets, the QI also contributes to the

accomplishment of this goal. The QI provides the tools necessary to ensure that companies are able to comply with the entry requirements of the target markets and demonstrate conformity.

In general terms, the number of destinations to which Uruguayan wines are exported has been increasing over the past twelve years, reaching a total of 77 different markets, 54 of which have received “significant” volumes.⁸⁷ However, between 2000 and 2011, the number of markets where Uruguayan wines are sold in significant quantities has ranged between 19 and 22, and has not displayed any great variation. Even so, the number of destinations to which the country’s wines are exported is no less than the figure for other products exported from Uruguay.

FIGURE 19
NUMBER OF DESTINATIONS TO WHICH URUGUAYAN WINES ARE EXPORTED,
(2000-2011)



Source: Own elaboration.

10. Reduction in the costs associated with a more efficient product certification process

In addition to contributing to the development of the national winery sector, it is hoped that the various interventions carried out will positively impact the certification process itself, especially through a reduction in the proportion of certification applications that require the extraction and analysis of samples on more than one occasion, leading to a reduction in the costs incurred in the production process.

Unfortunately, despite the fact that the interventions carried out by LATU have contributed to improving the wineries’ production processes, they have not resulted in a reduction in the proportion of resampling conducted during the certification process. It is important, therefore, that an in-depth analysis is carried out by the winery sector, in conjunction with the LATU departments involved in the certification process, to ascertain the reasons why they have not succeeded in reducing the number of resamplings.

⁸⁷ For the purposes of the present study and based on the volume of the sector's exports, market receiving at least the equivalent of one full shipping container per year, approximately 9 750 litres of wine were considered "significant".

11. Improvement in the quality of the wine consumed in the domestic market

Although the interventions carried out by LATU are focused on a group of wineries that sell their fine wines abroad, it is only to be expected that improvements in the production processes of the wineries and improvements in the analytical characteristics of the wines exported will lead to an improvement in the quality of the wine sold in the domestic market.

To test this hypothesis, the wineries surveyed were then asked whether, on the basis of interventions carried out and the changes brought about as a result, they felt that they had improved the analytical characteristics of the wines sold in the domestic market, to which 60% of them responded affirmatively.

F. Conclusions

The study conducted demonstrates the important contribution of the services provided by LATU to the development and modernization of the Uruguayan wine sector.

First of all, it highlights the fact that the two main objectives of the pre-certification process for exporting wines -ensuring that the certified wines can access foreign markets and avoiding the shipment of defective goods, which could potentially damage the image of the country's products- have both been fully met. This has enabled Uruguayan wines to be sold in over 77 different markets.

In addition, the services provided encouraged the wineries to introduce improvements in both their production processes and the analytical characteristics of the wines produced. The improvements in the production processes include most notably:

- Investments in new equipment and the introduction of new production techniques.
- Greater accuracy in the measurements carried out in the winery laboratories.
- This has had a positive impact on:
- Improvements in the analytical quality of the wines produced both for export and for the domestic market.
- Better performance by the wineries in the certification processes.
- Fewer requirements for analytical testing by third-party laboratories.

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Part III
Methodological aspects of impact studies
on the quality infrastructure

XI. Proposal for a set of indicators to measure the performance and the impact of the National Metrology Network and its designated laboratories as a Virtual National Metrology Institute. The case of Chile⁸⁸

Karl-Christian Göthner⁸⁹

Chile has a National Metrology Network that functions as a virtual National Metrology Institute. It is made up of designated laboratories and a Supervision and Coordination Unit that is linked to the National Institute for Standardization (INN). With the aim of measuring the impact of the National Metrology Network on the economy and society, and justifying the State financial allocations it receives, the Ministry of Economy, Development and Tourism (MINECON) commissioned the development of a set of performance and impact indicators to provide continuous validated information on the benefits of the existing National Metrology Network. Developing the two types of indicators and defining a baseline and information sources for the performance of the National Metrology Network did not prove particularly difficult. However, measuring the impacts of the National Metrology Network is a fairly complex matter. The methodology has not yet been sufficiently developed and will require more work in the future.

⁸⁸ This is a slightly expanded and adapted summary of the last part of the study conducted by the INN and funded by the Government of the Republic of Chile "“Levantamiento de Línea Base para la evaluación del impacto de las actividades de la Red Nacional de Metrología Chilena””. GINGKO Consultores Ltda. Valdivia, 15 July 2011. Since 2012, many of the performance indicators have served as the basis for measuring the performance of the NMN as a whole and of the different laboratories designated in the annual contracts between MINECON, the NMN, SCU and the DLs.

⁸⁹ Consultant, PTB.

A. Introduction to the study

The implementation, maintenance and development of metrology as a fundamental pillar of the quality infrastructure (QI) costs a lot of money and for this reason is often questioned by governments, politicians, and business people, especially in developing and emerging countries that do not have a long tradition of metrology.⁹⁰

It is not surprising that politicians wonder about the performance of the metrology institutions and their impact on the economy, trade, society, environment, and technological innovation, etc.⁹¹ The cost of metrology as a public good⁹² competes with spending in other areas (public works, health, education, productive development, etc.) and metrology must therefore prove with concrete data that it is worth investing in.

In public policy, performance describes the output and the effects or results of the action taken by an institution in a given period. Sometimes contracts are signed between the government and the institution regarding the expected outputs (or effects) and the necessary funding made available by the State. Indicators are defined so to be able to measure the output on the basis of which the institution receives funding. Indicators can be quantitative and qualitative. An improvement in performance is often also included in the contract.

Impact is normally defined as the medium- and long-term effects of activities. In order to justify activities financed by public investment it is essential to determine the cost-benefit ratio and whether the impacts are sustainable over time. Impact studies on metrology thus serve to: (a) define what the effect of an investment in metrology was in the long-term (ex-post); and (b) evaluate a desired future effect of an investment (ex-ante).

B. The intervention and its context

In Chile, the responsibility for metrology lies in the hands of the Ministry of Economy, Development and Tourism (MINECON). There is no centralized National Metrology Institute (NMI) with certain designated institutes, but rather a National Metrology Network (NMN) made up of designated laboratories (DLs) under different forms of ownership and the Supervision and Coordination Unit (SCU). The SCU coordinates the development of metrology and is responsible to MINECON for the maintenance and development of national standards and their dissemination, which are undertaken by the DLs. The NMN functions as a virtual NMI.

Since 2010, the NMN has received funding from the Chilean State, through the budget of MINECON. As a basis for evaluating the development of metrology in Chile, and to justify the allocation of financial resources from the State budget to the NMN, the National Institute for Standardization (INN) commissioned a study on the situation of the NMN and the development of a “set of indicators to measure the performance and impact of each one of the DLs and the NMN”.

⁹⁰ It is important to remember that the German National Metrology Institute, the PTB, was founded in 1887 by the famous German physicist Hermann von Helmholtz and the industrialist Werner von Siemens.

⁹¹ See the evaluation of Germany's PTB by the Scientific Council of the Federal Republic of Germany in 2008: www.ptb.de/en/aktuelles/pdf/eval_en.pdf.

⁹² See Richard A. Musgrave and Peggy B. Musgrave (1979) .Public Finance in Theory and Practice.

C. The methodology

1. Performance indicators

First of all it was necessary to define what is meant by performance indicators and which ones can serve as impact indicators. Based on the existing literature and on discussions with the INN, the DLs and experts, it was decided that the performance indicators would be those that measure:

- The development of the quality of the measurement and calibration capabilities of the DLs and the NMN as a whole,
- The level of training and technical competencies of staff,
- The development and expansion of the quantities and their ranges and the reduction in uncertainties in accordance with the needs of the country,
- The provision of services, and
- The international recognition of the DLs.

The performance indicators indicate whether the reliability and comparability of measurement results are assured in Chile, which is the fundamental basis for the recognition of conformity certificates in the international arena. They define the performance of the DLs as components of the NMN and the performance of the NMN as a system. They provide guidance for measuring the quality of the staff and their work and the results of their work in two ways:

On the one hand, they measure qualitative results in the development of the technical competence of the DLs and the NMN as a whole across variables such as staff training, equipment and international recognition.

- a) Alternately, they reflect the quantitative results of their activities within a given period of time (number of calibrations, working standards (WS), reference materials (RM) produced, etc.).
- b) There are no problems found in this area and it is not complicated to establish a statistical record and compare data between the different DLs.

The NMIs and DLs are the institutions that – typically – have the highest technical competence, the most accurate standards (primary or secondary), produce – in the field of chemistry – CRM and RM and make validated analytical methods available for performing measurements in the country. They give traceability to secondary calibration laboratories and industrial firms thus ensuring the reliability and comparability of measurement results. Consequently, the performance indicators of the DLs and the NMN as a whole must refer to the following:

- The maintenance and development of national standards.
- The dissemination of SI units in the country, and
- International activities.

2. Impact indicators

Impact indicators are more complex given that they measure a significant change sustained over time. A differentiation is made between:

- An impact that is intended to be produced by an intervention, and that provides a necessary basis for projects (ex-ante evaluation), or
- An impact that has been obtained by an intervention (ex-post evaluation).

- Certain impacts can be measured immediately, but in most cases it takes longer for them to be observed (3 to 5 years or more).

In addition, it is important to distinguish between:

- Direct impacts, i.e. impacts that are directly attributable to an intervention; and
- Indirect impacts, where the impact is not directly attributable to an intervention but to the effects of a variety of activities.

In the case of metrology, the following impacts are usually discussed:

- Economic impacts at the level of a company, a branch of the economy or at the national level, which are related to technological innovation and an improvement in competitiveness;
- Social Impacts, i.e. the fact that consumers receive the water, gas, electricity, weight and volume of goods that they pay for; an improvement in the health and safety of the population; more jobs and better incomes, a better standard of living, etc. are mostly indirect impacts;
- Environmental impacts due to the more efficient use of natural resources; less pollution of the environment, verified by measurements; climate protection (less production of CO²), etc.;

Policy impacts (Good Governance) through greater transparency based on the comparability of measurement results and effective protection of consumers and the environment. There must be relevant laws and regulations to organize market monitoring and assure metrological controls and verifications based on Legal Metrology.⁹³

It is important not only to think about positive impacts, but also to consider the possible negative impacts of an intervention. Impacts are more difficult to measure because often they cannot be attributed to metrology alone but are the result of simultaneous interventions on the part of different quality services (measurement, accreditation, standardization, testing) and sometimes also of the efforts of these services combined with other interventions. A good example is the development of a country's exports: the entire spectrum of quality services is needed to finally ensure the international recognition of the conformity certificates for products.

But there are other factors that also influence the success of exports: productive development policies, the tariff system, export promotion activities, technological innovations, etc. It is also important not to underestimate the influence of national and international economic conditions and the exchange rate. It can be stated therefore that the problem is quite complex and metrology is not yet sufficiently developed to unequivocally determine the value of impacts.⁹⁴

For this reason, it is difficult to define impact indicators that are easy to capture, since there is no baseline and methodology for doing so. In addition, given the actual situation in Chile, where legal metrology and market surveillance are not yet sufficiently developed, some important social impacts of metrology in the day-to-day lives of consumers cannot be accurately measured (for example the verification of electricity, gas and water meters, scales). Therefore, what is proposed here is the following:

- Certain indicators that are easy to capture and
- A number of studies for the next few years to better define what the impact of metrology (or in a broader sense, that of the QI)⁹⁵ is in Chile.

⁹³ See PTB (2007) "Values and Rules for Global Responsibility. Quality Infrastructure: A Step towards Good Governance", www.ptb.de/de/org/q/q5/docs/broschueren/broschuere_goodgovernance_2008e.pdf.

⁹⁴ Gonçalves, Jorge and Jan Peuckert (2011), pp.27-59.

⁹⁵ See Göthner, Karl-Christian and Sebastian Rovira (2011), pp. 11-26.

In the case of the impact of metrology the indicators should measure:

- The increase in the competitiveness of Chilean companies;
- The reduction in rejections of products that do not conform to international standards and requirements (conformity assessment);
- The number of new products that enter the international market because they comply with quality requirements (conformity assessment);
- The improvement in the economic performance of exports due to the reduction in measurement uncertainty;
- The use of measurements that are reliable and traceable to the NMN by supervisory bodies and other State agencies.

It is not possible to expect to define indicators that can provide information on the continuous improvement of the situation; instead, it is necessary to define where an impact can be observed and develop a methodology to calculate it.

As a consequence of these difficulties, a series of appropriate indicators is proposed for the purpose of promoting impact studies on metrology, so they may provide arguments for the future development of metrology and the NMN and its DLs. For certain indicators, it is not difficult to construct a baseline; for others it is necessary create one.

D. The set of indicators

1. Performance indicators

The set of performance indicators was developed on the basis of a detailed internal study of the specific situation of the NMN. It is divided into two parts: one part is devoted particularly to the DLs for the purpose of setting goals and measuring the output of the activities of the DLs that are agreed each year with the SCU. The second part is concerns to the performance of the NMN as a network with a special section for the SCU, which coordinates its development.

2. Designated laboratories

Maintenance and development of national standards / measurement capabilities

- National primary or secondary standards of quantities with traceability to foreign NMIs that are available to the DLs
- Validated analytical methods that have been applied
- New validated measurement methods to be implemented according to international requirements
- The calibration services that the DLs provide to consumers/customers, and in which quantities, measurement ranges and uncertainties
- Participation in key, supplementary, bilateral and pilot inter-comparisons
 - In how many comparisons and of what type did the DL act as a coordinating laboratory?
 - What quantities, ranges and uncertainties (CMCs) are recognized under the CIPM-MRA and published in the BIPM-KCDB?
- Maintenance and expansion of the range of measurements

- Maintenance of accreditation by a foreign accreditation body (accreditation renewal) and/or peer evaluation (SIM, BIPM)
- Participation in the work of the SIM and the BIPM
 - In which Consultative Committees or Quality Control Working Groups does the DL actively participate and how many meetings does it attend per year?
 - In which SIM Technical Committees (TC) does the DL actively participate and how many meetings does it attend per year?
 - On what TC has the DL placed the Chairperson?
- The plans to extend the quantities and/or add new CMCs in the near future, based on unmet demand and/or predicted development trends.

The data on performance are found in

- The DLs' certificates of accreditation,
- The DLs' annual reports,
- Information from the BIPM/KCDB (www.kcdb.bipm.org) and
- Information from SIM (Inter-American Metrology System) (www.sim-metrologia.org.br).

Dissemination in the country

- Number of calibrations of standards (secondary laboratories, industry)
- Number of certificates issued (not necessarily identical to the number of calibrations)
- Number of RMs and CRMs produced and sold
- Participation of the collaborators as technical experts in accreditation of calibration and testing laboratories (in Chile and the region)
- Participation in technical standardization committees
- Number of complaints lodged
- Number of clients and their growth (or decline) per year
- Number of industrial sectors catered for
- Organization of WS (quantity, number, number of Chilean and foreign participants, number of accredited laboratories and in the process of accreditation)
- Participation in training (number of courses, topics and participants)
- Number of conferences, symposia and seminars the DL attended with a presentation on metrological issues
- Number of publications by the DL (aimed at a broad and/or scientific audience)
- Consulting for companies and secondary laboratories (number of customers, type of consulting)
- Organization and/or participation in awareness-raising events
- Number, quantity and range of requests for calibrations of standards that could not be dealt with.

The data on performance are found in

- The DLs' annual reports;

- Reports on the implementation of WS in the SCU
- Records of the Accreditation Division of INN, and
- Records of the Standardization Division of the INN.

International co-operation and participation

- Number of calibrations of standards of foreign entities (NMI, companies in neighbouring countries, etc.)
- Participation as an auditor in peer evaluations of SIM
- Participation in TC/SIM, number of chairpersons
- Active participation in international events (participation in organizational committees, presentations, leader or participant on panels at congresses etc.)

The data on performance can be found in

- The Records of SIM, CIPM-BIPM and other international organizations of the Quality Infrastructure;
- The reports of the DLs and the NMN.

3. National Metrology Network

The indicators on the NMN can be divided into two parts:

- A compilation of the indicators of the DLs as a part of the expression of the network's performance;
- The indicators that are of the responsibility from the DLs and the SCU, because they are vital for the development of the NMN in line with the growing demand in the country, international trends in the development of metrology, and requirements that arise from technological innovation in Chile.

The compilation of the most important indicators of the DLs to measure the performance of the NMN as such:

- Number and range of quantities represented and requested
- Number of CMCs registered in the KCDB the BIPM
- Participation and representation in international organizations (SIM, CIPM-BIPM, IMEKO, OIML, NSCLI) and international events
- Introduction of new quantities
- Number of DLs recognized by peer evaluations
- Number of calibrations of standards
- Participation of NMN metrologists as auditors in accreditation processes in Chile and in the region
- Participation of NMN metrologists as auditors in SIM peer evaluations

Performance Indicators for the development of the NMN as a virtual NMI

- Awareness-raising events at the national level
- The network delivers traceability to all sectors of commerce, industry, laboratories, regulation and society where there is evidence of a clearly articulated demand. This

includes physical and chemical measurements (for example the needs of environmental, clinical, therapeutic, food safety and security-related areas)

- Is there a need to expand the activities of an existing DL or is it advisable to appoint a new DL to satisfy hitherto unmet demands?
- Are the needs of government policy and technical regulations met?
- Number of users of the web page www.metrologia.cl

The data on performance can be found in:

- The reports of the DLs, and
- Records and reports of the SCU/NMN.

E. Impact indicators

The impact indicators listed below aim at measuring sustainable changes in the medium and long term. They are based on the actual current conditions of the NMN in Chile. The problem is that so far there have been no specific studies on the impact of metrology in Chile.

All that exist are ex-ante calculations by the Fundación Chile regarding the economic damage that can be prevented by developing reference materials for essential foodstuffs for export (salmon, fruit) and by Codelco Norte, regarding the economic significance of too great an inaccuracy of measurement on the tenor of minerals in testing laboratories.

For this reason, the indicators developed must be understood as proposals for future studies that not only serve to determine an ex-post impact, but also to develop methodologies that define ex-ante impacts and cost-benefit ratios for investment projects.

1. Increase in the competitiveness of Chilean companies

Cost reduction of secondary calibrations for laboratories and companies due to the existence of traceability in the country (see appendix). It is recommended to begin one or two studies on the calibration of widely used instruments (for example standard weights or gauges).

Improvement in the economic performance of companies thanks to better use of inputs as a result of more accurate measurement (reduction in uncertainty) This would be a project for a company, a group of companies or a sector.

Cost savings due to the reduction in the duplication of tests thanks to the existence of a chain of traceability assured by the NMN. It is necessary to find major export products that until recently needed a second test abroad. Costs are calculated in the two cases and the savings determined.

2. Improvement in the performance of Chilean exports

Better competitiveness of Chilean products thanks to recognized testing based on the traceability of measurements (CIPM-MRA) and the reduction in testing abroad. It is necessary to find major export products that until recently needed a second test abroad.

Costs saved thanks to participation in the CIPM-MRA instead of signing several bilateral agreements with other governments and NMIs. Chile is the country with the most bilateral free trade agreements (FTA) in the world, it would be interesting to conduct a study on how FTA reflect the CIPM-MRA and to what extent the CIPM-MRA promotes the implementation of FTA.

Improvement in export performance due to a reduction in the uncertainty of measurement. Studies are proposed on the impact of the reduction in the uncertainty of weights on the performance of Chilean exports of copper, wood, fish and fruits.

The existence of DLs in the NMN that are internationally recognized under the CIPM-MRA has helped Chile to have access to new export markets.

Baseline to be constructed on the basis of the export statistics and reports of ProChile.

3. Reduction in the number of products rejected by foreign buyers

The best source is the Rapid Alert System of the European Commission, which is published weekly and provides an excellent compilation of all the food products rejected due to quality problems.

This is an indication of whether exporters know the requirements of the European market and take the necessary precautions. (Data source: http://ec.europa.eu/food/food/rapidalert/index_en.htm).

4. Number of exported products certified by accredited laboratories that have traceability to the DLs of the NMN (calibrations, reference materials)

For this, it is necessary to compare the data on the certified products exported with the data from laboratories accredited by the Accreditation Division of the INN.

5. Number of supervisory bodies and other public entities that refer in their relevant regulatory activities to reliable and traceable measurements

The INN has signed agreements with some government services or the function of accreditation has been incorporated into decrees or resolutions. The increase in the number of public entities that base their measurements on accredited laboratories with traceability to the DLs of the NMN is an indicator for the impact of metrology on the public sector.

Baseline: the regulatory agencies that wholly or partially depend on the accreditation granted by the Accreditation Division of the INN.

6. Number of resolved cases of consumer complaints about incorrect measurements. Reduction in losses or damages incurred by consumers

This is an interesting indicator that requires a database which Chile does not currently possess.

7. Reduction in spending on medical treatment due to better measurements in clinical laboratories

A lot of money is spent within the health system in all countries due to poor measurements (healthy people are treated as sick and vice-versa). It appears that for the time being the database is lacking. There is a good example of improvement in the measurement of cholesterol produced by the NIST.

8. The existence of reliable DLs has led to a better quality of life

This is a fairly complex indicator that brings together issues such as environmental control, more reliable clinical tests, more accurate therapeutic treatment, increased food safety, etc. It involves an improvement in the quality of life, but also means a cost reduction for industry, society and the Chilean government. It would be interesting to develop studies on certain specific aspects, but it appears that currently the data and resources required to carry them out are lacking.

F. Conclusions

In the specific case of Chile the following summary can be made:

- 1) The development of performance indicators is an extremely valid instrument for defining and measuring the outputs of NMIs, laboratories and the designated laboratories. They can be used to plan the output of services, and the monitoring and control of the results can serve as a basis for the funding provided by the State budget. The point of departure must be the actual demand of the country's economy and society, which differ in size, economic and social structure, level of development and requirements.
- 2) Impact indicators are important for determining and measuring impacts (changes) in the long term. They should not be limited to a simple economic cost/benefit comparison, because the influence of metrology relates to many other aspects of a country's development: the economy, trade, technological innovation, health, environment, standard of living, political transparency, etc. They are a valuable instrument for convincing governments, politicians, and business people of the importance of having an internationally recognized NMI and investing in metrology.
- 3) Certain difficulties are encountered in the development and implementation of indicators:
 - In the case of impact indicators in particular the problem is quite complex because a number of other factors usually come into play, whether these are associated with other services of the QI, or else external factors. There is a need to develop methodologies to prove that through investment in metrology a certain result might be obtained, which would make it possible to identify what the measurable contribution of metrology is;
 - The studies must monitor the development of the impact indicator for several years, because only in this way is it possible to obtain convincing results.
 - The indicators require the development of a baseline and the maintenance of a database that is not always easy to establish due to lack of data or access to long-term data.
 - It is not easy to establish a common language between metrologists and economists because they have different approaches. It is therefore advisable to set up a joint group of economists and metrologists to work in this topic.
- 4) Experience with ex-post impact studies is extremely helpful in developing a methodology to produce cost-benefit analysis calculations on investments to justify metrology projects.
- 5) The indicators developed for the Chilean NMN can also serve as a basis for other NMIs. But obviously they must be adapted to the specific situation of each NMI and each country.

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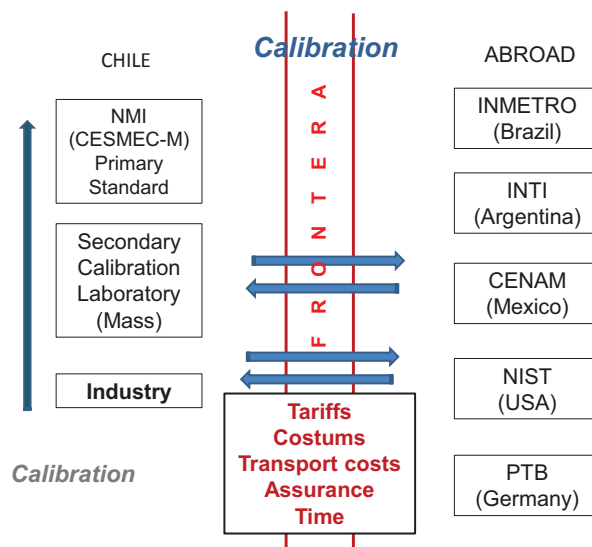
Appendix

Methodology for calculating the cost savings from calibrating standards in Chile rather than abroad.

The cost reduction could be calculated as follows (quasi-experimental method, see diagram):

- Calculate costs for a calibration in the country including transport costs
- Calculate costs for a calibration outside the country (transport, calibration fee, insurance, customs, time, second pattern or measuring instrument)
- Multiply by the number of calibrations and compare

DIAGRAM A1
COMPARISON OF A CALIBRATION WITHIN AND OUTSIDE OF CHILE



The above methodology can be useful for certain commonly used quantities:

- Mass
- Temperature
- Length
- Pressure
- Electrical quantities
- Force
- Flow
- Substance (Metrology in chemistry)

XII. The certification process for Peruvian pisco: a proposal for measuring its main effects⁹⁶

*Ricardo Fort*⁹⁷ and *Mauricio Espinoza*⁹⁸

A. Introduction

Although in the mid-nineteenth century around 150 thousand hectares of vine (the fruit of which is the grape) had been planted in Peru for the purpose of producing pisco, this level of production gradually decreased to around 11 thousand hectares of cultivated land by the late 1990s. Given the increasingly strong position of Chilean grape brandy in international markets since the early 2000s, the Peruvian government decided to introduce special measures to encourage production of and demand for this flagship product. Although there were already prior regulations on this matter dating back to the 1940s,⁹⁹ as well as a first official ruling issued in 1991 regulating the authorization of the use of the Designation of Origin (D. O.) Pisco,¹⁰⁰ it was only during this period that various complementary actions were carried out which appear to have contributed significantly to revitalizing this industry. Official estimates show that the production of Pisco in Peru has quadrupled over the last ten years, and that exports of this product have gone from a total worth of 80 thousand dollars to over one million.

One of the main initiatives carried out by the government was the revision of the technical standard of 1991, which after two years of work produced a new regulation for obtaining authorisation to use the D. O. Pisco. This process was headed by the National Institute for the Defence of Competition and the Protection of Intellectual Property (INDECOPI) and was accompanied by various changes in the rules on inspection, the creation of specialized laboratories, and the proposal of new regulations for the industry.

⁹⁶ Chapter based on the publication *Impacto de la Infraestructura de la Calidad en América Latina*, ECLAC-PTB, 2011.

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⁹⁹ For example Supreme Resolution N° 1207 of 20 December 1946, on the determination of the designations of Pisco, grape brandy, Cognac, etc.

¹⁰⁰ Supreme Decree N° 001-91-ICTI/IND of 16 January 1991.

The implementation of this regulation made it much easier for producers to obtain authorization, which is demonstrated by the large increase in the number of companies that did so from the year 2003 onwards. This coincides with the aforementioned increase in production and sales of pisco. In spite of this strong correlation, there were also several other factors that may have contributed in some way to revitalizing the pisco industry.¹⁰¹

The present study seeks to analyze the certification process for Peruvian pisco and identify the effect that it may have had on the strong growth of the industry, as well as the direct benefits generated for pisco producers.

B. History of the certification of pisco in Peru

The law creating the D. O. Pisco was enacted in 1991 and established the coastal valleys of Peru as the areas where producers can obtain the “Authorization for use” of the D. O. Pisco.

This authorization for use, granted by INDECOPI, required that producers submit samples to certification laboratories to undergo a physical-chemical analysis to determine if they fulfilled the requirements set forth in the technical standard. This standard was regarded by the State as an important requirement since the denomination of origin assured consumers that the pisco they were buying was of a certified quality.

The 1991 legislation was highly restrictive with regard to the individual levels of certain parameters measured, such as the permitted level of methanol. For this reason, many producers attempting to qualify did not pass the tests.

In light of the changes in domestic demand for pisco, a group of pisco producers got together to seek the support of the Ministry of Industry in promoting this product. As one of the first steps, the Ministry entrusted INDECOPI with the job of revising the technical standard of 1991 then in force, a task which was to take two years.

If they manage to meet all the requirements, producers receive the corresponding number for labelling from INDECOPI’s “Distinctive Signs Office” (Trademark Office). The authorization of use is granted for 10 years, and it is estimated that the process takes between two and six months, once all the legal documentation has been submitted (following the visit to the winery).

The creation of this new Technical Standard was accompanied by a proposal for institutional reform to ensure that it was complied with and which enabled a more effective organization of the actors and activities involved in the pisco sector. In 2003, the National Commission for Pisco (CONAPISCO)¹⁰² was set up, which is a public-private coordination body responsible for bringing together the various producers, unions, associations and institutions seeking to promote the development of the pisco production chain in a comprehensive manner. It provides information on production and markets for pisco.

Due to the lack of a permanent system for monitoring the productive sector’s main indicators, we sought out various sources of information with the aim of revealing the actual productive performance shown by the national pisco industry.

¹⁰¹ On the one hand, the Peruvian economy was clearly in the process of recovery after the crisis it had undergone until the early 1990s. In addition to this, it is possible that what is now referred to as the “boom” in Peruvian cuisine may also have contributed to a reappraisal of drinks from Peru based on pisco, thereby promoting increased consumption. This factor may also have been intensified due to the first international awards obtained by Peruvian pisco in important competitions abroad.

¹⁰² CONAPISCO was originally set up as a private initiative in 1997 and functioned as a consultative body.

First of all, we will analyze the sources by means of which CONAPISCO estimates production levels of pisco for the years 2000-2009 (information deemed official). The estimate produced relies on various sources to back up the initial production data for the year 2000, and then draws on information from the Ministry of Production, as well as the Tax Authority (SUNAT), to apply the annual growth rates to the data for 2000.

In addition, we analyze the role that the formal and informal markets for pisco might play, in relation to both the sector's performance and the relative importance of each of them in the production statistics. Finally, we will focus our attention on complementary indicators for the sector, such as the main destinations of Peruvian pisco, the level of domestic consumption, and the role of exports.

C. Information on the production of pisco for 2000 from Technoserve

One of the main sources of data used by CONAPISCO to determine the level of production of pisco for the year 2000 is the study carried out by Technoserve-CITEvid. This document, entitled "Study on the Competitiveness of the Wine Subsector", bases its information on statistical sources of the Ministry of Agriculture, the Ministry of Production and La Molina National Agrarian University. In addition, these data were supplemented by reconnaissance visits for validating information on the different production areas, where work meetings were held with the various actors involved.

The table below shows the estimated production of pisco that is extracted from the study, and the variables on which it is based.

TABLE 34
STATISTICS ON THE WINE SUBSECTOR ACCORDING TO TECHNOSERVE, 2001

Productive Indicators	Grape Destinations			
	Total	Table	Wine	Pisco
Hectares	11 578	7 988	2 431	1 157
Grape Production [MT]	127 804	88 185	26 839	12 780
Production (%)	100	69	21	10
Average output	11.0	11.0	11.0	11.0
Wine/Pisco Production [Lt]			16 000 000	1 500 000
Grape/ Wine-Pisco Ratio			1.68	8.52

Source: ECLAC-PTB, 2011.

1. Comparison with additional sources

In order to be able to assess the extent to which the national production of pisco estimated by CONAPISCO effectively represents the volume of domestic production, we will look at other types of supplementary sources that enable us to check the validity of this data.

Census of vine growers for the year 2000

One of the sources we will use to calculate the potential production of Peruvian pisco is the census of vine growers that was conducted by the Ministry of Agriculture in 2000 in the main producing regions: Arequipa, Ica, Lima, Moquegua and Tacna. The main information provided by the census is the number of growers per geographical area, and the number of hectares devoted to each vine variety.

TABLE 35
AREA DEDICATED TO VINE AND PISCO VINE GROWING, 2000

Department	Total vine		Quebranta vines		Proportion
	Ha	Percentage	Ha	Percentage	Percentage
Arequipa	245	3	162	2.6	66.3
Ica	4 647	57.4	2 983	48.2	64.2
Lima	2 743	33.9	2 606	42.1	95
Moquegua	114	1.4	92	1.5	80.6
Tacna	348	4.3	348	5.6	100
Total	8 097	100	6 191	100	76.5

Source: ECLAC-PTB, 2011.

Based on average yields for each region (tonnes of grapes per hectare) published by the Ministry of Agriculture, the following table estimates the total production of pisco vines resulting from the 6,191 hectares harvested (percentage of hectares destined for the production of pisco vines out of the total vines).

TABLE 36
PRODUCTION STATISTICS ON VINES IN THE PISCO VALLEYS, 2000

Department	Ha of pisco vine harvested	Average Yield x ha (2000)	Estimated production [MT] pisco grape
Arequipa	162	7.68	1 244
Ica	2 983	6.26	18 674
Lima	2 606	10.54	27 467
Moquegua	92	9.41	866
Tacna	348	11.64	4 051
Total	6 191	8.45	52 301

Source: ECLAC-PTB, 2011.

However not all the grapes produced are used for pisco production. The wholesale fruit market in Lima was the destination for around 15 thousand metric tonnes of pisco grapes that year. Much of the output also ends up in local markets, which according to the working group “Cadena Productiva Vitivinícola” (Wine Production Chain) receive approximately 33% (16 thousand tonnes) of the total.

Installed capacity of the national pisco wineries

Another approach for ascertaining the level of Peru’s pisco production is to calculate the maximum production capacity of the country’s pisco wineries, that is to say their installed capacity (litres per year), using the "Directory of Pisco Producers for 2008", which is a register containing general information on the characteristics of the pisco producers at the company/winery level.

In order to calculate the wineries’ installed capacity it is necessary to know the capacity of the tanks (alembic stills) used to contain the must, which is fermented and then distilled to obtain pisco. CONAPISCO estimates that every 4 litres of must that is fermented and then distilled produces 1 litre of pisco.

On the basis of that information, and knowing the period of production in which these wineries operate (which is usually 2 to 3 months after the harvest of their main input, grapes) it is possible to estimate the maximum possible level of production of each registered winery. The following table shows this information on an aggregate level.

TABLE 37
GENERAL STATISTICS ON COMPANIES AND WINERIES PRODUCING PISCO, 2008

Number of companies	406
Number of companies that report having a winery	247
Number of companies that do not report having wineries	159
Number of wineries reported	206
Number of wineries that reported installed capacity	157
Number of wineries that do not report installed capacity	49
Installed capacity of the wineries reported (Litres)	6 679 414

Source: ECLAC-PTB, 2011.

The above table shows a total installed capacity of over 6.5 million litres for the year 2008. However, these data have certain shortcomings. There are many producers that do not report having a winery (either rented or their own) and wineries that do not provide information on their installed capacity. This lack of information suggests that these data may be underestimated, particularly considering the large percentage of producers without declared wineries (39%) and the high percentage of wineries that do not declare their installed capacity (24%).

Even so, the figure obtained gives us an idea of the minimum level of production likely for the year 2008, and this can be compared with the information provided by the other sources mentioned for the same period.

2. Other pisco sector performance indicators

Another way to be able to evaluate the performance of the Peruvian pisco sector is by focusing on different types of indicators other than production volume. Specifically, we will look at two important indicators for the sector: Peruvian pisco exports and domestic consumption.

Export dynamism

The export data reported by CONAPISCO are based on information provided by the Customs Department. Pisco exports have increased substantially, from 18 thousand litres sold in 2002, to 230 thousand in 2009. Therefore, the cumulative growth in pisco exports is 1,161 % over the past 8 years.

TABLE 38
PERUVIAN PISCO EXPORTS, 2002-2009

Year	Litres	FOB Price \$	FOB value \$
2002	18 338	4.35	79 785
2003	56 598	5.19	293 936
2004	74 139	5.71	423 644
2005	82 735	5.46	452 039
2006	107 798	6.32	681 549
2007	172 891	6.14	1 061 385
2008	216 014	6.46	1 395 314
2009	231 190	5.93	1 371 842

Source: ECLAC-PTB, 2011.

If we look at the main destinations to which pisco is shipped, we see that for the year 2009 the United States was the main importer, while Chile was the second largest.

TABLE 39
MAIN IMPORTING COUNTRIES FOR PERUVIAN PISCO, 2009

Country	FOB value	Litres
United States	468 476	69 574
Chile	256 544	51 978
Colombia	71 108	12 917
Spain	59 932	6 390
Argentina	52 424	29 298
Ecuador	49 020	3 939
Germany	47 712	5 152
United Kingdom	36 912	2 783
Belgium	36 184	4 174
Other	293 530	44 987
Total	1 371 842	231 192

Source: ECLAC-PTB, 2011.

Formal domestic consumption

Another important point to emphasize when evaluating the performance of the Peruvian pisco sector is the level of local consumption. Although there are no official sources of information in this regard, we were able to access information from private sources on the consumption of pisco in supermarkets and convenience stores in Lima for the past four years. The following table shows number of the litres sold by these establishments for the years 2006 to 2008, as well as the total value of sales.

TABLE 40
SALES IN SELF-SERVICES LIMA, 2006-2009

Year	Litres sold	Value of sales	Average price paid (US\$)
2006	438 169	5 503 161	12.6
2007	490 028	6 790 282	13.9
2008	529 180	7 852 244	14.8
2009	570 791	8 149 433	14.3

Source: ECLAC-PTB, 2011.

As we can see, the trend is steadily increasing. As a whole, over the 4 years the amount of pisco sold at these establishments increased by 30%, while the increase in the value of sales in the same period was 48%. As it can be observed in the last column of the table, the price rose from \$12.6 to \$14.3, which represents a 14% increase in the average sales price per litre of pisco during this period. According to experts interviewed for this study, this increase in the price of the product since 2005 is due, on the one hand, to the greater demand for high quality pisco among consumers in Lima, and on the other, to the reform of the tax policy on pisco, which went from taxing the value of sales to taxing the number of litres sold irrespective of the value.

Information about pisco companies with regard to the authorization to use the Designation of Origin Pisco

Despite the fact that there is very limited information available on the pisco sector at the company level, it was possible to find out the number of companies authorized to use the D. O. Pisco in 2008. As mentioned earlier, “The directory of Pisco Producers for 2008” contains information on how many of the companies have the official authorization to use the D. O. Pisco.

TABLE 41
NUMBER OF CERTIFIED AND UNCERTIFIED COMPANIES, 2008

Authorization to use the D. O. Pisco	Yes		No		Total	
Region	Companies	Percentage	Companies	Percentage	Companies	Percentage
Total	312	76.8	94	23.2	406	100
Ica	147	78.2	41	21.8	188	100
Lima	114	85.7	19	14.3	133	100
Arequipa	26	74.3	9	25.7	35	100
Tacna	13	81.3	3	18.8	16	100
Moquegua	12	35.3	22	64.7	34	100

Source: ECLAC-PTB, 2011.

D. Possible effects of pisco certification

In this section, we will carry out a conceptual analysis of possible effects on the performance of the pisco industry that might be expected as a result of the entry into force of new technical standards and the certification of producers, before going on to discuss the possibilities and limitations on the existence of these effects in the case under analysis.

One way to systematize the main effects of pisco certification is to separate out the changes that this might generate for producers and consumers.

From the producers' point of view, the establishment of a new technical standard for pisco production, which basically led to the product being standardized and adapted to comply with the regulations in order to obtain certification from INDECOPI, allowed a quality-based distinction to be made within the market. Given that this type of regulation prevents non-certified producers from continuing to call their product “pisco” (they have to call it "grape brandy"), certification also creates a segmentation of the pisco market between "formal" and "informal" production. Lastly, the specification of the technical standard can be considered as a basic form of knowledge and technology transfer for the production of pisco, which might facilitate the entry of new producers into the sector and the reduction of research and development costs. The reduction in laboratory costs and the general costs of processing the certification may also have facilitated the entry of new producers.

From the consumers' point of view, the main effect should be the security provided by the certification of a minimum level of quality for the product, and a reduction in transaction and search costs. These effects may increase the demand for the certified product and consumers' willingness to pay for it.

The combination of these effects may encourage the creation or expansion of new markets for certified pisco, in which the increase in new brands and the growth in demand continually feed into each other.

However, the standardization of the product on the basis of the technical standard may also have some potential adverse effects. Depending on how it is implemented, it may be that the technical

specifications of the standard limit further technological innovations and therefore put a halt to improvements in the quality of the product. The main effects can be summarized in the table below.

TABLE 42
POSSIBLE EFFECTS OF THE CERTIFICATION OF PISCO

Pisco producing companies
Increase in the number of companies/wineries producing pisco
Increase in the participation of formal companies
Production
Increase in pisco production
Quality of the product
Increase in the selling price of pisco output
Increase in the quality of the pisco
Greater share of high-quality piscos in the national output
Increase in the number of varieties of pisco
Investments
Greater investment in wineries and installed capacity
Greater investment in laboratories and research
Reduction of pisco production costs
Product destinations
Increase in the volume of pisco exported
Increase in the volume of pisco sold in supermarkets and restaurants

Source: ECLAC-PTB, 2011.

E. Impact evaluation methodologies

The initial aim of this study was to design a methodology to enable an empirical analysis of the possible impacts of the Designation of Origin Pisco certification on the development of the Peruvian pisco sector. Specifically, to be able to identify whether certification standards have had any effect on the indicators we described at the end of the previous section. One way to determine this is by conducting an evaluation at the level of the producers, and finding out the effect the Designation of Origin Pisco certification has had on companies that have obtained it. This type of analysis is part of what the economic literature refers to as impact assessment.

The ideal way to find out the effect caused by a particular policy is by comparing the result obtained if the policy is implemented, with the result that would be obtained if the policy was not implemented, in relation to the same individual, or group of individuals, under analysis. The difference between these results enables us to find the net effect attributable to the policy.

What an impact assessment seeks to do is to construct the hypothetical scenario mentioned above, by comparing the set of treated observations against other untreated observations. The set of untreated observations therefore constitutes the "counterfactual" of what would have occurred to the treatment group if the treatment, or policy, had not been offered.

In this section, we will detail a possible alternative for assessing the effect that the regulation on authorization to use the Designation of Origin Pisco may have had. The regulation in question, introduced in 2002, allows those pisco producers that meet certain requirements to be granted authorization to use the D. O. Pisco. This designation certifies that the pisco produced by these companies meets certain standards of quality and comes from the authorized production areas.

Due to the fact that the authorization to use the D. O. Pisco is awarded to the companies producing the product, the effects of this certification should be observable mainly at that level. The objective of carrying out this type of evaluation is thus based on estimating the effect produced by the authorization to use the D. O. Pisco on the main production indicators of the companies under evaluation.

Identification Strategy

The first step in carrying out an impact assessment is to identify the control group that will serve as a “counterfactual”.

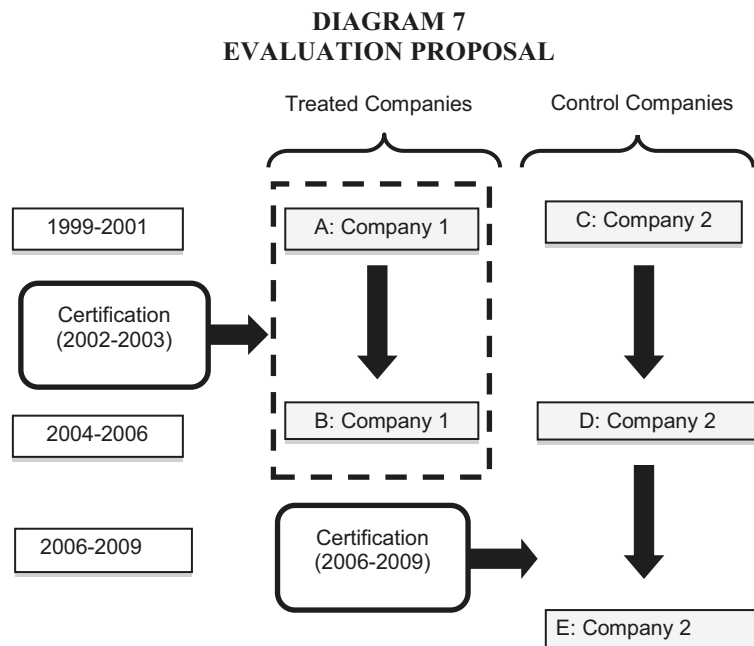
The companies that have the authorization to use the D. O. Pisco at a certain time will be considered the treatment group, while the companies that at that same time do not have this authorization shall be considered the control group. For this to be a reasonable approach, and for the comparison to be valid, it is necessary that certain requirements are fulfilled:

- The treatment and control groups must have similar features prior to the treatment group obtaining the authorization for use.
- It is necessary to check for a possible selection bias that encourages the treated companies to apply for the authorization to use the D. O. Pisco.
- It is also necessary to check for factors that might have affected the results of the intervention.

Identification Proposal

One proposal that solves the associated problems to some extent is to consider the following groups of companies as the treatment and control groups:

- Treatment Group: Companies that have obtained the authorization to use the D. O. Pisco between 2002 and 2003; and
- Control Group: Companies that have obtained the authorization to use the D. O. Pisco between 2006-2009. (Evaluation Period: 1999-2001 comparison between results and the results of 2004-2006.)



Source: ECLAC-PTB, 2011.

TABLE 43
NUMBER OF COMPANIES WITH AUTHORIZATION TO USE THE D. O. PISCO ACCORDING TO THE YEAR OF CERTIFICATION

Region	Before 2002	2002-2003	2004-2005	2006 Onwards	Without authorization	Total
Ica	23	28	53	43	41	188
Lima	11	24	20	59	19	133
Arequipa	1	7	6	12	9	35
Tacna	1	2	6	4	3	16
Moquegua	1	5	1	5	22	34
Total	37	66	86	123	94	406

Source: ECLAC-PTB, 2011.

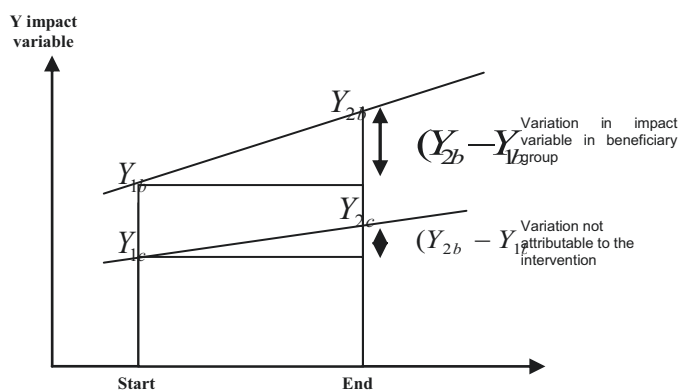
Estimation Strategy

Once the identification strategy has been developed, all that remains is to estimate the differences in the results of the two initially similar groups in order to obtain the net effect of the treatment. Using the technique of difference-in-differences, it is possible to estimate the average effect of treatment on the treated.

This method consists in comparing the differences found between treated and controls, with regard to the change in the main production indicators to be evaluated. The evaluation will consider the change in average indicators for the period 1999-2001 with respect to the period 2004-2006. Figure III.1 provides a visual representation of the main idea of the estimate.

The technique of difference-in-differences also enables the observation of changes that have occurred in another type of exogenous variables that might have influenced the outcome of the variable under evaluation. On this basis, it is possible to estimate the impact of the authorization to use the D. O. Pisco on the main productive indicators of companies in the sector.

DIAGRAM 8
CALCULATION OF THE IMPACT ATTRIBUTABLE TO THE TREATMENT



Source: ECLAC-PTB, 2011.

Since that here we are evaluating companies, we should look for indicators that address this target group. Here we shall detail which kind of indicators could be evaluated under this particular methodology and proposal:

- Quantities of pisco produced;

- Average price for a litre of pisco sold;
- Number of varieties of pisco produced;
- Share of premium pisco of the total of the sales;
- Quantities of pisco exported;
- Investments in machinery and equipment;
- Investment in technology and research;
- Average production costs for each variety produced.

These types of variables or indicators could be evaluated according to the methodology proposed if there was the necessary data at the company level for the periods 1999-2001 and 2004-2006.

Given that we cannot access this information, it could be generated through primary sources of data collection, for example, by a survey to the pisco producers in a retrospective manner. However, for the particular case that we want to analyze, this strategy would have a series of shortcomings related to the difficulty of collecting data retrospectively for such a large period of time. It is probable that biases or omissions regarding older data (like the one for the years between 1999 and 2001) are associated mainly with the loss of data that once was systematized.

Additionally, knowing the current levels of production can also be a difficult task. This is because currently the production of pisco is estimated based on the tax per liter of pisco commercialized. This type of estimations can introduce biases in the collected data, and in this case we could be underestimating the indicators of production and commercialization of the product.

F. Conclusions

This study analyzes the certification process for Peruvian pisco with the main objective of trying to understand the effect it may have had on the strong growth in the industry, as well as the direct benefits that may have been generated for the pisco producers. Unfortunately, the scant information available on the industry, and the difficulty of collecting first-hand information that would enable a rigorous impact assessment methodology to be implemented, meant that it was not possible to make a quantitative estimate of the effects of this policy.

In spite of this, the present document performs a detailed systematization of the certification process and its possible effects, as well as an analysis of all the available sources of information in order to understand the performance of the sector in recent years, which has enabled us to propose a methodological framework for analyzing this type of policies. We believe that this proposal may be useful in various fields. Firstly, because it may contribute to further discussion on the possibility of rigorously measuring the impacts of policies related to improvements in the quality infrastructure of countries, and in particular for the purpose of establishing technical standards and product certifications. Secondly, because it helps to better understand the mechanisms by which policies of this type produce effects on the producers and consumers involved, in such a way that it demonstrates the importance of opting for one or another form of design and implementation of the policy, as well as the possibility or necessity of accompanying it with complementary policies or reforms. And thirdly, because it shows that reforms of this type need to be accompanied from the outset by efforts to monitor the changes that occur in the sector.

Finally, special mention should be made of a number of issues related to the institutional design of the certification process that deserve to be part of an in-depth discussion among those involved in the sector in order to evaluate possible reforms:

It appears to be of the utmost importance to achieve agreements between all parties in order to put into operation at the earliest possible date the Regulatory Board of the D. O. Pisco. This Council should: coordinate and take charge of the dissemination of information on the D. O. to consumers and potential new businesses; provide the Bureau of Statistics of the Ministry of Production (PRODUCE) with information about the sector; and monitor the proper use of the authorization of the D. O. Pisco. The absence of directly responsible individuals in charge of these tasks may be affecting the direct effects expected from the certification.

With regard to the exclusive responsibility of INDECOPI for performing the laboratory tests on the samples of pisco submitted to obtain authorization to use the D. O., it can be said that while initially State control of this task was essential, now that the market for pisco has grown significantly, including the demand for authorizations, it may be time to consider changing this system and allowing competition from private laboratories under the regulation of INDECOPI. Some of the producers and experts interviewed mentioned their concerns about the recent delays by INDECOPI in carrying out the relevant inspections, especially for companies and wineries in areas further away from Lima, and a more decentralized system was therefore proposed.

It would appear to be essential to find a better balance of competencies between the organized private sector and the public sector to improve the performance of the pisco industry. Lastly, it is very important to improve the information and monitoring system of the pisco industry in Peru. The existing information is not only scarce but also displays significant contradictions when cross-referenced with other sources. We believe that there must be close coordination between the organized private sector and the Ministry of Production (PRODUCE) to set up the information system and continuously update it. A first task, in this sense, is to redefine the sample of companies and wineries that must be surveyed to determine the main indicators for the sector (production, sales, markets, etc.), and in this way produce accurate official statistics based on estimates.

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XIII. The infrastructural impacts of the quality infrastructure

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A. Introduction

Measuring the impacts of quality infrastructure (QI) poses challenges to researchers due to the kinds and multitude of roles that this institutional complex has within societies. The difficulty of identifying and measuring the impacts of QI reduces the capacity to demonstrate the importance of the activities of QI to policy makers and society, and also to improve the policy design to achieve development or innovation goals, to which QI can be key.

There is often a discussion about the difference between direct and indirect impacts of QI which makes the task of assessing and justifying its impacts more difficult. In order to address this issue, QI impacts should be distinguished according to direct and infrastructural impacts. As the direct impacts have been widely theorized and are also easier to understand, this section will focus on the infrastructural impacts of QI

The characteristics of the impacts of QI are similar to those of roads or electrical-grids. Their primary role is to facilitate economic and social activities by firms, citizens or policy makers, often referred to as third parties. This means that in order to understand and capture their main impacts, one must consider the direct consequence of the activities that third parties are able to carry out due to their access to QI services.

Within this methodological reflection, infrastructural impacts must be conceptualized and the possible categorizations of these kinds of impacts must be indicated. Acknowledging that this theory has to be further discussed and developed, this shall be a contribution both for the design of impact studies as well as of policies that shall open a new perspective on how to understand and demonstrate the importance of QI.

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B. Infrastructural impact

An infrastructural impact can be defined as the consequence of an intervention, such as an infrastructural one, which allows certain activities by third parties to take place. The impact is the result of an activity by this third party, which could either not be carried out without the existence of the infrastructural intervention or whose efficacy would be significantly reduced without it. The contribution of the infrastructural intervention does not vary as a proportion of the direct impact. Instead, it is always equal to the amount of the direct impact that the third parties carried out. For example, a road, the typical facility considered as an infrastructure, may serve, in year 1, for 10 thousand trips by trucks to carry goods. In year 2, 20 thousand and in year 3 they may be 5 thousand. The amount of trips per year varies due to changes in socio-economic factors that lay beyond on whether the road had intrinsically changed. For the infrastructural impacts, it only matters that in the three years periods there were the total of trips of 35 thousand allowing the exchange of goods worth of a certain estimated value, being these the infrastructural impact of the road. Could have been more or less in each year, and in the future it can also vary, but the infrastructure is not accountable for those changes.

An infrastructure, however, is not always positive simply because it compensates the costs. On the contrary, in cases where financial, human and physical resources are scarce, the most successful infrastructure is the one that facilitates the highest direct impacts by third parties (i.e. infrastructural impacts), and the best policy design is the one that allows the most infrastructural impacts with the same resources reflecting its accurate interpretation of the needs of a society. Thus, to understand the roles of an infrastructure, one has to look to the extent of the use that the infrastructure provides to its users.

We shall see now how this understanding that normally applies to more traditional infrastructures can also be applied to QI.

C. The infrastructural impacts of quality infrastructure

As the name indicates, QI's most important role is to serve as an infrastructure. In terms of its infrastructural impacts, based on the research conducted so far, they can be divided in three different categories:

- International trade
- Implementation of regulations
- Innovation

We shall look into each of these in further detail and illustrate the impacts that arose from case studies that we have followed during the last three years. The case studies to be covered are as follows:

- INTI (scales): Verification and calibration of large scales for grain exports
- INTI (petrol pumps): Verification and calibration of petrol pumps.
- CENAMEP: Implementation of resolution and associated metrological services on electrical meters.
- Inmetro: Metrological services supporting the implementation of Lei Seca in Brazil.
- INDECOPI: Accreditation of laboratories for hydrobiological products
- LATU (milk sector): Quality infrastructure services in the milk sector.

- LATU (wine sector): Quality infrastructure services in the wine sector.
- Inmetro - PTB: Cooperation Inmetro – PTB.

1. International trade

One of the most relevant infrastructural impacts of QI, and one of the main reasons for policy makers to invest in the development of such a system is that it enhances local firms' access to global markets. International trade is highly subject to technical standards, so participating in trade, especially in North American and EU markets, implicitly requires compliance to their respective standards and technical regulations.

Regarding the standards, the family of ISO 9000 standards, especially ISO 9001, is one of the most required in the World. These are voluntary, meaning that they are demanded by the buyers, so they are not imposed by any law. In order for a company to demonstrate that it complies with these standards, it must be certified by an accredited certification body. Additionally, one of the conditions to comply with such standards is to prove traceability of measurements, which is demonstrated by the exclusive use of laboratories that are accredited following ISO 17025. The National Metrology Institute (NMI) plays a very important role in this by guaranteeing the lowest uncertainty in the national measurement sector (or within international demands), and by demonstrating, (through the participation in international laboratorial comparisons, for example the respective Calibration and Measurement Capabilities (CMCs), meaning that the calibration services provided by the NMI give traceability to the international measurement standards.

Technical regulations, which are compulsory, require a similar reasoning. The only difference is that products or services affected by technical regulations imply that, independently from the buyers' will, those selling must demonstrate compliance to them, otherwise they cannot enter the market. The process of demonstrating compliance can be similar, requiring certification and accreditation bodies, and an internationally recognized NMI, depending on the requirements that the regulatory agencies impose.

Therefore, the establishment of QI opens the following opportunities to the local producers regarding the participation in international trade:

- *Higher value-added goods*: Being capable of demonstrating that a good has a certain quality level implies that producers will obtain higher returns on their products and also access for demanding markets like those of EU and North America, whose consumers can pay higher prices.
 - LATU (milk sector). The prices obtained by milk exporters increased from US\$ 1,54 in 1996 to US\$ 6 in 2007 (current prices).
- *Diversification of markets*. Obtaining international recognition for the national QI and providing the metrological support to local companies for conforming to such standards are ways of improving access to new markets, thus reducing their dependency from a smaller number of foreign economies.
 - LATU (milk sector). Since 1997, Uruguay received missions from 17 countries plus the European Union, all of which approved its QI for the milk sector, thus opening up the possibility of trade agreements with these countries concerning milk and milk-derived products. As a consequence, there was a gradual diversification of destinies, namely a reduction of the weight that Brazil had in the 1990s because of its early obtainment of mutual recognition agreement of milk certificates. Other countries established such agreements later and, as a consequence, exports to Brazil were reduced as a share of the total exports (from 90% of total exports in 1998 down to 20% in 2010).

- *Equity in access to markets.* Large or multinational firms are less affected by the absence of a QI publicly available in the country because either they have their own laboratories or, particularly in the case of multinationals, they can acquire their services in other countries where they operate. In order to improve the share in exports of national firms, namely to small and medium enterprises, a cost-effective QI is vital to promoting access of these companies to international markets.
 - INDECOPI. In Peru, the number of exporting companies in the field of hydrobiological products increased from 194 to 303 from 2000 till 2011. This represents a significant opening up of this market to new companies, for a kind of product that is highly affected by technical regulations and standards given the health issues that are at stake.
- *Avoid Export Bans.* Controlling the quality of exporting goods is a way of reducing non-conformities in the target market, which may impose export bans to certain countries for all the producers.
 - INDECOPI. An example from Peru, concerning the exports of Palabritas (a type of marine mollusk), which received a notification in 2008, that led to an import ban of this product by the EU. As a consequence, it is estimated that Peru exporters have lost US\$ 86 million, in the period between 2009 - 2011.
 - LATU (wine sector). Creating a compulsory certification for exporters can be a way of controlling that all exporters of one country are not affected because one or a group of exporters do not comply with the requirements of the target markets. What LATU did for wine is a way of avoiding that goods that do not meet the technical regulations in foreign countries are exported. If they were, there would be a risk of a ban on Uruguayan producers from a certain country or group of countries.
- *Measurement equipment trade balance.* As a country passes through a process of industrialization and its companies try to comply with increasingly restrictive regulations, their demands for measurement equipment with the required traceability, implies that if the local industry is not be able to provide these goods at all or in the quantity demanded, then local companies will have to import them.
 - Inmetro - PTB. The development of the force laboratory in Inmetro, helped in the development of the manometers industry. The evolution for this item was very positive, from a trade balance deficit of US\$ 3,8 million in average between 1997 and 1999, to a superavit of US\$ 3,4 million, in average, from 2004 until 2011.

2. Implementation of regulations

Creating and implementing a technical regulation on issues such as consumers' protection, public health, and environmental protection poses several challenges. If the measurement capabilities required to sanction the cases where this is violated are not available, it will not be possible to enforce the regulation. Secondly, if measurement instruments are not accurate enough, a citizen or an enterprise that is complying with a technical regulation risks being sanctioned unfairly due to wrong measurements. Furthermore, if government cannot guarantee traceability of measurements, citizens can appeal and the effective implementation of the regulation is impossible.

At last, creating a regulation in a new field or one that is more restrictive than the existing one, for example, in terms of the maximum errors allowed for the measurement instruments, requires that measurement instruments in use comply with the new requirements. Therefore, unless the NMI is capable of providing the required calibration services and other supporting services cost-effectively to the local producers, these regulations may force smaller enterprises out of the markets, because they cannot afford the investments to guarantee the traceability of their measurements or a reduction of the uncertainty. As a consequence, only large companies would be able to respond to the new regulation

or these instruments would have to be imported in the event that the local industry is not prepared to produce them.

In this sense, the development of legal metrology needs to be accompanied by the development of services provided by scientific metrology to the measurement instruments industry or to the calibration of the measurement instruments used by the inspectors. Without this, inequities in the access to the markets are created or may impede the regulation from being enforced.

- *Enforcing regulation.* There is an infrastructural impact of QI, when a regulation cannot be enforced without QI services.
 - INMETRO. The implementation of Lei seca in Brazil created very strict rules on drinking and driving and had significant impacts in terms of accident reduction. The implementation of this law is considered to be responsible for the reduction by 32% of deaths resulting from driving accidents between March 2009 and December 2011 and Inmetro was central to the calibration of the breath analyzers used to enforce the law, providing trust to the analyzes and protecting them from being taken to court by consumers attempting to avoid sanctions.
- *Fair trade.* Reducing the maximum error allowed in measurement instruments and effectively implementing such regulations promotes fairness in trade, meaning that consumers and producers get closer to paying/earning what they actually are selling.
 - CENAMEP. In Panama, a law which reduced the maximum error allowed in electricity meters was put into place, which obliged CENAMEP to equip itself to calibrate samples of the meters and verify if the requirement of the technical regulation were being met, and also provide consultancies to firms so that they could improve their measurement procedures. The impact of the implementation of the technical regulation in terms of the reduction of unfairness is estimated to be US\$ 1,2 million per year. This could not be achieved if the measurement capabilities of CENAMEP were not good enough to verify if the technical regulation was being implemented.
 - INTI (petrol pumps). The implementation of the technical regulation reducing the maximum error allowed a reduction in losses for consumers by wrong measurements by \$43.121.831 between 2006 and 2008.
 - INTI (scales in Argentina). The reduction of maximum error allowed in scales from 0,67% to 0,01%, led to a reduction in trade unfairness of US\$ 967.928.696 from 2003 until 2008. Furthermore, this implied an improvement in the receipts of the Argentinean State with taxes on imports by US\$ 27.093.717 per year.

3. Innovation

There are two types of innovation to be considered here: those which are new to the World and those which are new to the country. For an economy that is passing through an initial process of industrialization in a given sector, as far as QI is concerned, it may be more relevant to analyze the innovations which are new to the country, especially in the measurement capacities of the national industry to appropriate an already existing foreign technology. This is considered a form of innovation from the country's perspective. For innovations which are new to the world, QI is relevant considering the new challenge faced by entrepreneurs or society in the need to develop measurement systems in new fields and reduce uncertainty.

It is important to understand the infrastructural roles of QI in supporting the participation of local firms in global innovation systems. Engaging in international innovation systems, and participating in cooperative R&D initiatives with companies worldwide requires that companies can demonstrate their ability to provide the goods that consumers or other stakeholders require, and that

their measurements are traceable to international standards. In terms of the infrastructural impacts, one has to consider the innovations that QI services allowed firms to undertake.

- *New to the World.* Through research, metrology can provide new metrological knowledge, new calibration services that enable companies to develop new products or services, or standards which define new characteristics of products or processes enabling more companies in different countries to participate in R&D processes.
 - Inmetro (PTB-Inmetro cooperation). In the field of temperature, Inmetro and PTB engaged in a research project to develop new temperature sensors (thermocouples of platinum and palladium, and of metal-carbon eutectic fixed point cells) for the range of temperatures between 900 and 1500°C. The direct impact of this research constitutes a metrological innovation. As an infrastructural impact, producers that work at high temperatures (for example, in siderurgy) can produce or improve their production processes as a consequence of the development of a more reliable scale for this temperature range.
- *New to the country.* Technological appropriation is a process that fosters the industrialization process, consisting of using already existing knowledge and reproducing it in the country. In order for local companies to appropriate technologies, they often require the same measurement systems where those technologies are utilized. By creating a new primary or secondary calibration service, the NMI is providing traceability or reducing uncertainties to the measurements made by local companies, which shall allow them to reproduce certain technologies.
 - INMETRO-PTB. The implementation of the primary method for the pH allowed Inmetro to produce a primary Certified Reference Material (CRM) with a lower cost for the local industry (one third of the cost in comparison from importing from the US). As a consequence, two laboratories started producing secondary CRM, which were useful for the most common applications (Ph 4, 7 and 12) of US\$137 thousand in 2011. Without the implementation of the primary method, Brazilian laboratories would only be able to produce non-certified reference material, and companies looking for certified reference materials would have to import.

D. Methodological aspects of infrastructural impacts: the design of the counterfactual

One of the most significant methodological specificity concerning the measurement of infrastructural impacts has to do with the design of the counterfactual. In the case of direct impacts, the normal methodologies of constructing a counterfactual (both experimental and non-experimental) are the most adequate. However, in order to look for infrastructural impacts, we have to reason in another way. In this case, constructing the counterfactual follows the question, “would a given impact resulting from a third party activity be possible without QI service(s)?”. If after researching the answer to this question one can affirm that it could not take place at all, then the impacts of the third-party activities are infrastructural impacts of the defined QI service(s).

If it would be possible but only at a very high cost or to a much smaller extent, one has to analyze whether these activities would still take place and how, considering the difference between the value of the indicators in both situations (the actual with the infrastructural intervention and the hypothetical without it) and the infrastructural impact of the intervention.

E. Policy implications

Understanding the infrastructural roles of QI and the capacity of measuring them is central for an effective policy design, and therefore to optimize the innovation or development impacts for society which can be reached through the appropriate use of QI.

As it is an infrastructure, a policy maker must understand who the users will be and what use(s) they can give the infrastructure in order to accomplish their own goals. An infrastructure that supports the “highest use”, according to the various goals, is the one to be considered optimal.

The scenario comparison requires identifying the possible services created within the QI and which uses the users are expected to give and to what extent. This has to be compared to the availability of resources, both physical (such as laboratories or equipment) and human. In the field of QI, this is quite relevant as activities may be very specific and demand physical and human resources that are highly specialized and scarce.

The difficulty of mobilizing the required resources is more apparent in smaller countries. Whenever there are neighboring countries, they must consider sharing the tasks involved in an infrastructure. Contrary to physical infrastructures like roads or electrical grids, QI infrastructure can easily be shared and benefitted from by actors in both countries. Even the performance of QI activities can be optimized if there is a larger scale of action. For a certification or accreditation body, if they are only working with companies in a small country, they may not have enough activity to either be profitable enough to justify developing such activities or specialize to the degree that the production and social systems require. Similarly, metrological activities can further develop in case there are specialists focusing on the specific topics, which may imply very high investments, and only compensate if there are a high number of customers using and benefiting from the outputs arising from the research. Lastly, also in terms of standardization, the more countries that share common standards, the higher the interoperability between production systems, and the easier their producers will be able to develop cooperative activities among them, which enlarges the innovation system in which they are participating.

F. Conclusion

If impact studies ignore the infrastructural impacts of QI services, they risk underestimating the impacts or have difficulties justifying its contributions, which is also related to designing an appropriate counterfactual.

The wide range of services and purposes of QI, illustrates the complexity of attempting to understand, let alone demonstrate its importance. There remains a significant amount of work to be done both in conducting more impact studies, improving methodologies, and simplifying the language through which it is explained to policy makers or society in general. Reinforcing the infrastructural nature of QI promotes the idea that it is meant to serve its users and that it can be strategic for the accomplishment of their own goals, and that, therefore, it is of their interest to know how to use it and demand new uses or directions for it.

There may be diverging interests from different players regarding the design of QI services. Its organizational structure must include the identification and assessments of the benefits and losses by various types of users, as well as the identification of conflicts of interest that may be present throughout the course of its use.

QI can also play a very important role for issues regarding sustainability of economic and ecological systems and in promoting regional development. For example, for the development of renewable energy technologies, or to help rationalizing the consumption of energy of households; for the creation of incentives for producers to follow certain practices through certification schemes that help differentiating processes that create virtuous economic cycles from those with neutral or negative

impacts; by regulating activities that misuse the natural resources, which may create long-run problems that will affect the living standards of the populations. QI is, in this sense, a powerful tool for the challenges faced by today's society, but its impacts and their measurement must gain visibility.

XIV. Lessons and policy recommendations for the quality infrastructure¹⁰⁴

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The various chapters that make up this publication have, in one way or another, enabled progress to be made in measuring the impacts of quality infrastructure in different dimensions and areas of countries' development. During the course of the various case studies presented, a number of limitations and recommendations for improving the management of the quality infrastructure (QI) have also been identified. Although a number of recommendations of a general nature are given, it must be emphasized that it is essential to take into account the fact that the economic and social conditions that characterize each case study differ across countries and are related to the effects and results obtained.

The studies presented clearly show that the services provided by the quality infrastructure can generate significant positive impacts, in both the economic and social spheres. By providing reliable, transparent and comparable information, regarding quantity or the characteristics of goods or services, the QI allows for a more in-depth insight into their features and technical specifications. Being able to quantify and verify the characteristics of the products or services that a country does or can offer is important in this regard, since in general it makes it possible to define more effective and efficient policies, and also to work on the definition and implementation of various policies and instruments for promoting specific productive sectors, such as export policies, consumer protection policies, environmental protection policies and policies on science, technology and innovation, among many others.

¹⁰⁴ This section is based on the publication “Impacto de la Infraestructura de la Calidad en América Latina, CEPAL-PTB, 2011”, and incorporates several of the lessons that emerge from a series of new studies carried out recently, which are part of this document.

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A. Recommendations for developing the quality infrastructure

The impact studies show that quality services and their application can generate significant positive impacts in both the economic and social spheres. These impacts may be at the macroeconomic, sectoral, or corporate level, or at the level of the State budget, for fostering technological innovations, for promoting consumer protection or for improving the situation of small and medium-sized enterprises (SMEs) and producers.

At the same time, the studies demonstrate that neglecting quality-related aspects leads to a lack of knowledge of important production and economic parameters, often resulting in losses for the company, the State and/or consumers (a fact that is clearly illustrated by the case studies from Argentina and Panama).

By analyzing the chain of impact of the services provided by the quality infrastructure components, it can be seen that the direct utility of the QI relates to the definition of the technical specifications for a product or service and the verification of compliance or conformity assessment.

Given the importance of the QI, and based on the findings from the case studies presented, a number of public policy recommendations are proposed below.

B. Public policy recommendations

1. Recognize the value of the QI as a transversal infrastructure that is related to and impacts on many economic sectors and on society

The studies have shown the positive impact that the services of the QI have on an economic sector; however, the services provided by the QI not only serve to support businesses in a specific sector but are also beneficial for companies from different economic sectors.

This can be observed in several of the case studies presented. The study from Brazil focuses on the generation of knowledge and technical competence in the development of a service related to the creation of a certified reference material for ethanol in water. This service enabled the implementation of a federal law, which laid the foundations and sped up the process for developing technical solutions in other areas, such as the establishment of the criteria for the composition of biodiesel and the analytical capabilities to determine that composition. The decisive technical support for the implementation of a federal law in Brazil has resulted in a significant impetus being given to the consolidation of scientific research and innovation capabilities at the country's National Metrology Institute (INMETRO).

In addition, the study on high capacity scales in Argentina demonstrates that it was not only necessary to improve the calibration capabilities of these scales in the country but that this process also entailed improving the quality of the companies that carried out repairs and maintenance of these scales. This study also describes the process of innovation in the management of weighing scale repair companies, which enabled them to improve their services and guarantee their future. In addition, the changes in metrological controls introduced in Argentina and the reduction of uncertainty in the measurement of grains have curbed tampering and fraud in the sale and purchase of cereals, especially for storers and producers, and even for the State coffers.

The studies also show the social impact of the QI. For example, the quality payment system introduced many years ago in Uruguay has helped small, medium and large producers to be rewarded for the improvement in the quality and efficiency of their milk production. Not only did this make it possible to increase the sector's level of competitiveness but, given the way the process was carried out, it prevented micro and small producers from being threatened, thereby enhancing their productive capabilities and prospects of survival.

Furthermore, the case of Panama shows that periodic metrological control helps to rein in energy suppliers. Over time a decreasing number of meters outside the limits permitted in the market were detected, which means that fewer and fewer consumers have malfunctioning meters. As a result, there has been a clear reduction in the existing asymmetry of information as well as a rebalancing of commercial power.

2. Promote the QI using a systemic approach

First of all, it is necessary to emphasize a systemic approach to quality. It seems clear that a product's competitiveness depends, among other factors, on the quality of the end product, along with the price, service and image. However, quality should not only be a criterion for the final product; it should also apply to the raw material, which is to say that it must be taken into account from the beginning of the value chain until the product reaches the end consumer. Moreover, the consumer must have the information needed to assess the quality of the product obtained, so the quality of the raw material has a great impact on the quality of the end product.

In the case of the Uruguayan dairy sector, it can be seen that the quality of the products was improved through an incentive mechanism involving "payment for quality" of the raw material. This mechanism is implemented by the competent health authority. This enables the first raw material transaction in the value chain (raw milk) to be carried out with quality criteria: transparent, measurable and reliable; which also ensures that the investments made by the primary producers and the industrial sector are conducted with a clear objective and measurable achievements. In this way it is possible to achieve development in primary production, which is crucial for the competitiveness of the end product, thus demonstrating the importance of long-term systemic development to ensure the success of policies.

In the case of the Uruguayan wine sector, it was possible to establish an effective certification system thanks to the support of technically competent services, combined with a system of solid training for the sector. The calibration and testing services developed by LATU for the sector have demonstrated their technical competence, which is internationally recognized. These measures are also accompanied by knowledge transfer initiatives, which have achieved an improvement in the production reported by the wineries.

The study carried out in Argentina shows that the misuse of scales in the transactions within a value chain can mean huge losses for companies in the sector, which can have serious consequences: at the level of the agricultural producers it results in a reduction in the competitiveness of their products, caused by the funnelling off of resources needed for investment, while at the State level, it causes a reduction in the revenue collected from duties.

In the case of Panama, the misuse of the electrical energy meters resulted in unfair trade between the energy companies and residential customers, which was detrimental to households throughout the country. This situation was able to be reversed through the improvement of the measurements performed by the electrical energy meters.

Secondly, it may be necessary to develop the range of services offered by the QI in conjunction with the demand. To promote the introduction of "quality criteria" into a productive sector, it should be borne in mind that the corresponding services (standards, testing, calibration and certification) do not always exist or else do not have the necessary competence and recognition. For this reason, the sectoral development strategy must include instruments to promote the creation or strengthening of the quality services offered as well as recognition of them.

In the event that quality services are not yet well developed, it is advisable to gradually introduce "quality criteria" into the various productive sectors, so that the development of the QI is in step with national needs. In addition, in order to be as inclusive as possible and to allow smaller companies to adapt their production systems to the new requirements, it is also necessary that the policies take into account the gradual integration of smaller companies. In the case of the Uruguayan

dairy sector, the requirements for the "quality criteria" were gradually increased in the quality payment system while maintaining a high number of participating companies. The policies to promote improvement in the quality of raw milk thus led to an increase in the income of small and medium-sized dairy producers, without jeopardizing or threatening their continued presence in the market.

Due to the impact of the QI on the different sectors and the interdependencies involved in the development of the supply of services required by the sectors, it is recommended that the QI should be taken into account from the conception of the sectoral promotion instruments and policies. For example, the case study from Peru shows that it may be beneficial for a regulatory agency to be supported by previously established services rather than creating its own structures. The competent authority for issuing health certificates for the export of marine products uses accreditation as a tool to determine the competence of laboratories seeking authorization to provide services during the official certification process.

3. Promoting the introduction of quality management systems into companies is an essential element for each policy that encourages the international competitiveness of its economy

The introduction of management systems adapted to the reality of companies is essential in order for them to introduce quality concepts into their production systems and become active promoters of quality in value chains. It is also necessary that companies demand quality of their trading partners and are aware of their rights. A positive example is the development of the dairy sector in Uruguay. The study from Argentina also describes the development achieved by weighing scale repair companies, with some managing to obtain ISO 9000 certification, thus ensuring a service management oriented towards correct weighing by the scales for trucks. In addition, the increase in the testing laboratories' capabilities for determining the alcohol content of wine helped the wine sector in Uruguay to decrease the number of non-conformities in the labelling of the end product. Similarly, the study from Panama presents positive impacts resulting from the implementation of regulations with the support of CENAMEP in the country's electricity sector, which not only affects the residential sector but can also seriously affect one of the main costs incurred by certain companies or sectors in the country.

4. Ensuring the development of the QI, through the provision of adequate resources by the State as well as through the creation of an institutional framework that promotes cooperation between the public and private sector, is another of the strategies to consider

Developing and maintaining technical competence, as well as achieving international recognition of the services provided, requires a great deal of human and financial resources. This means that investments by the State are essential, especially for the aspects where the QI acts as a public good. The State will not be able to fully recover this investment through income for services, but it does have a macroeconomic and social benefit, which more than justifies the commitment to ensuring universal access.

On the other hand, there are certain QI services that are offered on a moneymaking basis, given their corporate profitability. That is why it is necessary to create a framework in which both the public and private sector can develop their respective competencies. There are various examples of this, including that of Argentina, where to ensure the measurement quality of scales an association was formed between INTI (public sector) as the National Metrology Institute, and the scale repair companies (private sector). The success achieved in promoting the dairy industry in Uruguay is also based on concerted action between the public sector through the creation of conditions at the macro level (for example with the provision of a monitoring infrastructure) and the private sector, at the enterprise level, with the implementation of programs to promote quality management. In this particular case, the coordination of the public and private actors in the sector culminated in the

founding of the National Institute for Milk (INALE) in 2007. Similarly, in the case of Peru, an association was set up between INDECOPI and private laboratories to carry out the certification of seafood products for export.

5. Achieving international recognition of the services of the QI as a necessary element for each export policy

The international recognition of the QI has an effect on its image and, very often, is a legal requirement for exports to be accepted in the country of destination. In many countries of destination there are technical regulations that include conformity assessment.

The study on the dairy sector in Uruguay shows the number of times a sector is evaluated by its business partners to achieve mutual recognition agreements on conformity assessment systems. The competence and recognition of LATU, the health authority (MGAP) and the other institutions involved provides important support for achieving agreements and thereby accessing the various target markets.

The case of the certification system for Uruguayan wine shows that conformity assessment supported by internationally recognized services such as calibrations and testing is a key element in maintaining markets accessible for products and has the potential to open up new markets. In a similar vein, the qualitative assessment of exports from Peru confirms that an internationally recognized accreditation service is an element that helps companies to get a foothold in export markets.

C. Recommendations for the institutions of the quality infrastructure

1. Analyze existing impact studies as a basis for strategic planning, and eventually starting own studies on crucial topics

Although they have been carried out only recently, the existing impact studies can help to analyze and demonstrate the benefit that the QI represents for companies, for the productive sector and for the economy, as well as for consumers and society. From the studies carried out, it can be observed that the question "what is the impact of..." alone has already generated an impact on institutions (this impact was not achieved intentionally and has not been measured). Very often this question is not given sufficient importance, at least not explicitly. The question should be an explicit criterion during strategic planning, always taking into account, on the one hand, the social benefit of the investment and, on the other, that it will not always be possible to perform impact studies for all investments.

To carry out their own impact studies it is advisable for the institutions of the QI to have the necessary skills to start or to conduct internal studies. Depending on the size of the institution, it is important to set up a unit dedicated to carrying out such studies, or to coordinate the assignment of the studies to third parties.

In addition, the institution responsible for the QI should document the situation that exists before an intervention, to ensure that it is then easier or possible to compare the ex-ante and ex-post situation, i.e. the impact of the intervention.

2. Use impact studies to strengthen the relationship and mutual understanding with users (regulators, laboratories, companies, consumers)

As mentioned above, the case study from Peru shows that it is beneficial for a regulatory body to be supported by accredited services that are already established rather than creating its own structures

and laboratory capabilities. The authority responsible for issuing export health certificates for marine products now uses accreditation as a tool to determine the competence of laboratories seeking authorization to provide services during the official certification process.

This impact study demonstrates the value of accreditation and can also be used by the accreditation body to improve its supply of services before the regulators.

In the process of designing, analyzing and interpreting the results of economic and social impact studies, it is important that the actors of the QI develop a better understanding of the needs of users. This would be highly beneficial to the institutions of the QI and to their users, since it facilitates the link with the beneficiaries of the system and at the same time means that the services are increasingly geared towards the demand (both explicit and implicitly).

D. Recommendations for researchers and those involved in impact studies

1. Continue to develop studies as well as the concepts and methodologies for designing, analyzing and interpreting impact studies

During the development of the impact studies there were various situations in which the technical experts and economists were seen to "speak different languages". This hampered the implementation of some of the studies and overcoming this hurdle is certainly a constant challenge for the institutions of the QI. The need to create the scientific capacity to perform impact studies (ex ante and ex post) was also identified. In the case of the larger countries in the region, this capability can be created within the institutions of the QI (as for example in Inmetro of Brazil), but in most cases the easiest way is to develop a pool of experts linked to the institutions who understand what the QI is, and can support the development of such studies.

It is imperative, therefore, to deepen the analysis and interpretation methodologies. For example, it would be very useful to collect information to establish the baseline after having defined the methodology at the beginning of an intervention, so that it can be used effectively to analyze the impact of the intervention in the future. The methodology must also be able to be adapted in the event that the information is not available.

2. Promote the documentation of the baseline and the development of indicators in QI interventions (for example new services) that show a high potential for an impact study in the future

One of the major challenges of impact studies is the definition of the starting point, i.e. the lack of information to describe the situation before the intervention. It is therefore advisable to document the initial situation well, especially in those cases where a high impact is expected.

In addition, the data is often difficult to access. This is due to the fact that companies often do not want to share their information, and in the case of the public sector and of the institutions of the QI they may not have documented information. The chapter on the methodological aspects of impact studies presents some ideas on how to design performance indicators aimed at measuring the effects of the QI. The aforementioned chapter notes that while for performance indicators there are some simple solutions to adequately determine the impact of a policy, it is often necessary to carry out studies that require the assistance of experts. In the case of Peruvian pisco, the main objective was to analyze the certification process for pisco and try to understand the effect that it may have had on the strong industry growth. In this regard, what is proposed is an impact assessment methodology that makes it possible to ascertain the net effect on the pisco producers of obtaining authorization to use the D. O.

However, this impact assessment methodology was hindered by the lack of available and documented information on pisco production.

3. Create a platform or active network to exchange experiences, problems and solutions for developing impact studies

It is clear, however, that not all the quality infrastructure institutions will be able to carry out studies to provide a better basis for assessing the impact of their services. A network could be created and used to transmit the results of a study carried out by one entity to another. Another possibility would be to deal with these issues within the regional and international organizations (see, for example, the web page of the BIPM, which provides a list of sources for impact studies: http://www.bipm.org/en/practical_info/useful_links/impact.html).

International technical cooperation and the exchange of experiences constitute a very useful tool for strengthening the QI and must be promoted, as shown by the development of this publication, to facilitate opportunities for exchange of experiences as well as access to external technical competencies.

4. Carry out impact studies for all the elements of the QI individually or systemically

One of the challenges for the future is to be able to increase the number of impact studies in all areas of the QI (metrology, accreditation, standardization, testing). These studies must deepen the analysis of the impacts that the QI has, not only in the economic sphere but also socially and environmentally speaking. It is important, in addition, to carry out studies that show the impact of the QI as an integrated system rather than that of each component separately. The joint effect of the different components of the QI is often much greater than the simple sum of the individual effects.

References

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Epilogue: A guide to designing impact assessment studies on quality infrastructure

A. Introduction

An impact study is a research that tries to identify and measure the positive and negative impacts in a society and/or environment resulting from a certain intervention or phenomenon. Concerning quality infrastructure services, impact studies are about interventions in the fields of metrology, standardization, conformity assessment, and accreditation, for example, can be on the creation of a certified reference material, the development of a new metrological instrument, the establishment of a new calibration service, the certification of organic farms, the accreditation of laboratories, etc.

Due to strong complementarities between quality infrastructure services, sometimes it is more accurate to analyze the impacts of a group of interventions, instead of an intervention alone. For example, when the creation of a standard was followed by a certification scheme, or if the development of a new metrological instrument was followed by the accreditation of laboratories that perform the tests, etc., it is more accurate to assess the impacts of both interventions than of only one, as it will be difficult to isolate the impacts of each intervention. Therefore, before starting the impact study on a quality infrastructure service, it is necessary to precisely define the intervention or group of interventions that is to be analyzed and the chronology of the various interventions.

Then, impact studies have three distinct stages. Firstly, one has to delineate an impact theory, which shall identify all the possible positive and negative social, economical and environmental impacts of an intervention and all the stakeholders (i.e. the people/institutions affected by an intervention). Secondly, it is necessary to test these hypothetical impacts. The last phase concerns to the interpretation of the results, where one has to define those impacts that could be proven as consequences of the quality infrastructure service and those that could not, and make policy recommendations.

In terms of the staff required for an impact study, it is necessary at least one person that has a profound understanding about the quality infrastructure service or services to be analyzed so that is capable to develop a comprehensive impact theory, and someone with knowledge on statistics to coordinate the data collection and processing according to the established impact theory. In case the institution has no one with the required statistical knowledge, a person from a university or research institute can be temporarily hired specifically for this purpose.

The time required to perform an impact study depends mainly on whether the service has been already or not yet implemented. In the case it was not yet implemented, it will be easier to make a comprehensive study in terms of the variety of impacts and more capable to demonstrate them. However, this normally requires more time than to develop an impact study on a service that is already being provided, because it will be necessary first to implement the service and then to wait a period of time until it produces effects (the length of this period depends on the kind of the hypothesized impacts). If the service was already implemented, the performance of the impact study can be faster (yet not less than 3 months), but it may face more technical difficulties concerning the availability of data required to demonstrate the hypothesized impacts. For these reasons, selecting the appropriate impact study is very important, namely concerning the correspondence between the time, costs and feasibility associated with the various possible case studies and the initial expectations of the institution.

At last, the interest of stakeholders on the impact study on quality infrastructure services can be very important in order to have access to data (for instance, related with the quantities produced over the years, exports, prices, investment on R&D, etc.) vital to demonstrate the impacts and which can be inaccessible otherwise. Therefore, a good communication strategy can be crucial for the realization of an impact study. This means that, from the one side, one has to be able to explain the benefits of conducting the impact study (namely concerning the need of developing more quality infrastructure services) and, from the other side, it is necessary to guarantee that data of individual firms will remain confidential, especially that it does not fall in the hands of their competitors, that only the aggregate indicators are going to be used.

B. Step by Step Guide

1. Selection of the study

The difficulties related with finding and/or generating data that can confirm the impacts of QI services (according to the limitations of time, costs, etc.) shall help us selecting the correct impact study to conduct in a group of possible of studies:

- a) Select 3 or 4 possible impact studies that could be performed;
- b) Fill the selection matrix (Annex II) for each study;
- c) Compare the different studies according to the following:
 - The difficulty associated with each study concerning their expected capacity, that is, if it will be possible to demonstrate the impact hypothesis in an effective and scientific manner, given the costs, time, and technical capacities required to realize it.
 - The visibility that each study would obtain, that is, the potential importance of each study for the stakeholders (i.e. economic agents, policy makers, citizens, etc.)
- d) Select the study according to the relation benefits (visibility and quality) against limitations of resources (staff, costs and time required).

1st stage: Creating an impact theory
<ol style="list-style-type: none"> 1) Brainstorm: Within the institution discuss and make a list of possible impacts. 2) Stakeholders: Identify the stakeholders (companies, households, specific communities, general population etc.) 3) Participatory mapping: Interview a small number of stakeholders (short questionnaire inquiring about the impacts they felt since they the intervention has taken place, and ranking them in terms of importance. <ol style="list-style-type: none"> a) if the stakeholders are companies the interviews can be made through email; b) if the stakeholders are households / local communities, small group discussions can be made with the help of local NGOs to identify possible impacts – 1 or 2 group discussions, each with 8 to 12 community members

<p>(preferably with different positions in the community)</p> <p>4) Indirect Impacts: Identify other possible impacts that may not be felt directly by stakeholders (e. g. related with environment), or about spillovers that stakeholders may not acknowledge (e. g. third-parties benefiting from the intervention), or any other types of indirect effects.</p> <p>5) Create the Impact Theory:</p> <ol style="list-style-type: none"> a) Impacts of the intervention (define the intervention or group of interventions). b) Impacts on what (specific issues at an economic, social and environmental level)? c) Impacts on who (match different stakeholders with specific impacts)? d) Impact how (try to define the causal mechanisms)?
<p>2nd Stage: Testing the impact</p>
<p>1) Matching impacts with indicators: corresponding to the possible impacts that were defined in the 1st stage, indicators are to be found that would sanction them (e. g. lower prevalence of diarrhea – number of children in hospitals with diarrhea per month)</p> <p>2) Data collection:</p> <ol style="list-style-type: none"> a) If there is available data that can sanction the impacts hypothesized use it (e. g. employment rates, diarrhea, co2 emissions, GDP growth). b) If data is not available, design a questionnaire, define the quantity and variety of stakeholders to be surveyed – if possible, work with local organizations that are already implemented on the field. <p>3) Measuring Impacts:</p> <ol style="list-style-type: none"> a) Control group approach: Create 2 groups. <ul style="list-style-type: none"> - The treatment group: receives the intervention - The control group: does not receive intervention. <p>The control group should share a socio-economic situation similar to the treatment group and be as much as possible immune to the effects of the intervention.</p> <p>In order to measure the impacts, one has to compare the indicators that were selected between the control group and the intervened group – the differences about the evolution of such indicators since the intervention should sanction the impacts</p> <p>Select 2 periods:</p> <ul style="list-style-type: none"> - Before the intervention - After the intervention b) Non-experimental approach <ol style="list-style-type: none"> i) Use the contingency evaluation method ii) Use the hypothetic-deductive approach, e.g. compare the evolution of the indicators since the intervention should sanction the impacts
<p>Select 2 periods:</p> <ul style="list-style-type: none"> - Before the intervention - After the intervention <ol style="list-style-type: none"> b) Non-experimental approach <ol style="list-style-type: none"> i) Use the contingency evaluation method

<ul style="list-style-type: none">ii) Use the hypothetic-deductive approach, e.g. compare the evolution of the indicators (through a time-series regression) that you selected between the period before intervention and the period after the intervention (e.g. by using a dummy variable).4) Control for other factors: third variables / events may cause two variables (i.e. the intervention and a specific indicator) to correlate without existing any causality, e. g. if in the period after an intervention prices in the international markets behave differently than before intervention, the exports revenue may increase or decrease regardless the intervention; if an intervention intends to increase exports, and when estimating the impacts of the intervention one does not include a variable for the floatation of the prices, they will be biased (i.e. overestimated or underestimated according on the evolution of prices).
3rd stage: Interpreting the results
<ul style="list-style-type: none">1) Limitations of the study: Identify the limitations of the study – which other factors may be influencing the results but that were not related with the intervention, if people are overestimating the impacts, if the control group and the treatment group have different characteristics, etc.2) Triangulation: Compare the information gathered – the results from the survey or analysis of indicators (the 2nd stage) with the information that was collected during the interviews, group discussions, and reviewing the literature (the 1st stage).3) Understand unexpected impacts (or lack of them): Compare your expectations (the theory that you created) with the results that you got (when verifying the theory) and debate why they differed. Use this opportunity to learn how the intervention can be improved and produce policy recommendations.4) Conclude: Establish impacts that can be considered as clear outcomes of the interventions. Establish some that could not be confirmed by the data / indicators but that in interviews or with other methods were found to be relevant to stakeholders. Establish the hypothesized impacts that you could not find any significance at all.

Annex 1 Glossary

- External factors: factors that influence the behavior of an indicator but that are not related with the intervention.
- Indicator: A variable that is used to measure an impact, that is, a change in a phenomenon or process.
- Intervention: A service or services of quality infrastructure to be analyzed in the impact study.
- Magnitude of the impact: the dimension of the impact.
- Significant result: The changes that have occurred with the indicator can be attributed to the intervention.

Annex 2 Selection matrix

Describe the intervention, i.e. which is (are) the intervention(s) that is (are) going to be analyzed?

Describe the context of the intervention and its main initial motivations (political, economical, environmental, and social):

Chronology of the relevant interventions (including those performed by other quality infrastructure institutions):

Name all the institutions involved:

Region/City/Neighborhoods affected by the intervention (if it was nationwide, please mention):

Name the expected direct impacts of the intervention:

Positive:

Negative

Name the expected indirect impacts:

Positive -

Negative -

Main beneficiaries of the intervention

Main undermined stakeholders:

Indicators required

Description	Do they exist already? (if yes, write for which time period it is available?, and go to 12.)	Source:	Does not exist data yet? (make an X and go to 11.)

11. Notes about how to generate the necessary data that does not exist yet:

1. If it to be done a survey:

- a) Localization and dimension of the treatment group (that receives the intervention):
- b) Localization and dimension of the control group (the one that does not receive the intervention):
 - Period of time for the realization of the survey:
 - Date of the first survey (before the intervention):
- c) Date for the second survey (after the intervention):
- d) Costs

2. If it will be generated through laboratory tests:

- a) Time period required:
- b) Costs:

12. Final remarks:

- 1) Additional difficulties to generate data (e.g. political, lack by interest of stakeholders, etc.):
- 2) Deadline of the study:
- 3) Staff that is lacking right now (e.g. to collect data, to process the data, to write the final report, etc.):
- 4) How to disseminate the impact study (how to reach the different interest parties?):
- 5) Other remarks:

Annex 3 Summary matrix

1. Describe the intervention(s):			
2. Institutions involved:			
3. Region / cities / communities affected:			
4. Which stakeholders are likely to be directly affected:	List Impacts: (Rank by importance for stakeholders, from higher to lower)	Indicators:	Source: (if the indicator exists, indicate for which period it is available, if not, write “to be generated”)
a)	1		
	2		
	3		
	4		
	5		
b)	1		
	2		
	3		
	4		
	5		
c)	1		
	2		
	3		
	4		
	5		
5. Indirect effects:	Stakeholders affected:	Indicators:	Source:
a)			
b)			
c)			
d)			
6. External factors that may have changed the impacts of intervention (political, economical, institutional, exogenous, other) and rank by the expected magnitude:			
Positive influence:			
a)			
b)			
c)			
Negative influence:			
a)			
b)			
c)			

Abbreviations

AB	Accreditation Body
AFIP	Federal Administration of Public Revenues, Argentina
Aliceweb	System of data analysis of the foreign trade of the department of foreign trade of the Ministry of Development, Industry and Foreign Trade, Brazil
ASEP	National Authority of Public Services, Panama
BIPM	International Bureau of Weights and Measures
BMZ	Federal Ministry for Economic Cooperation and Development, Germany
CBT	Brazilian Traffic Code
CENAMEP	Panama National Metrology Center
CIPM	International Committee for Weights and Measures
CMC	Calibration and Measurement Capability
CGCRE	Accreditation body of INMETRO, Brazil
CND	National Development Corporation, Uruguay
CONAPISCO	National Commission for Pisco, Peru
CONAPROLE	Cooperativa Nacional de Productores de Leche, Uruguay
CRM	Certified Reference Materials
DIGESA	General Directorate of Environmental Health, Peru
DIMCI	Directorate for legal metrology of INMETRO, Brazil
DL	Designated Laboratories
DNV	National Directorate of Roads, Argentina
D. O.	Designation of Origin
DPCT	Scientific and Technological Policy Department, UNICAMP, Brazil
EA	European Co-operation for Accreditation
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
FAO	Food and Agriculture Organization, United Nations
FTA	Free Trade Agreement
GEOPI	Study Group on the Organization of Research and Innovation of UNICAMP, Brazil
IAC	Agronomy Institute of Campinas, Brazil
IAF	International Accreditation Forum
ILAC	International Laboratory Accreditation Cooperation
IMEKO	International Measurement Confederation
INALE	National Institute for Milk, Uruguay
INDECOPI	Peruvian National Institute for the Defence of Competition and the Protection of Intellectual Property
INMETRO	Brazilian National Institute of Metrology, Standardization and Industrial Quality
INN	National Institute of Normalization, Chile
INNOQ	National Institute of Standards and Quality, Mozambique
INPM	Brazilian National Institute of Weights and Measures
INRIM	Istituto Nazionale di Ricerca Metrologica, Italy
INT	National Institute of Technology, Brazil
INTI	National Institute of Industrial Technology of Argentina
IPEMS	Institutes for weights and measurements of INMETRO, Brazil
ISO/IEC	International Organization for Standardization/International Electro Technical Commission
ITINTEC	Institute for Technological and Industrial Research and Technical Standards, Peru
ITP	Institute of Fisheries Technology, Peru
KCDB	Key Comparison Database of BIPM
LATU	Technological Laboratory of Uruguay
MDIC	Ministry of Development, Industry and Foreign Trade, Brazil
MGAP	Ministry of Livestock, Agriculture and Fisheries, Uruguay
MINECON	Ministry of Economy, Development and Tourism, Chile
MRA	Mutual Recognition Agreement
MSMEs	Micro, Small, and Medium Enterprises

NCSLI	National Conference of Standards Labs International
NGO	Non-governmental Organization
NIST	National Institute of Standards and Technology, U.S.
NMI	National Metrology Institute
NMN	National Metrology Network, Chile
OASIS	Operational and Administrative System for Import Support, U.S.
OIML	Organisation International de Métrologie Legal
OUA	Uruguayan Accreditation Body
PAC	Pacific Accreditation Cooperation
PADTC	Plano de Desenvolvimento Científico e Tecnológico, Brazil
PTB	Physikalisch-Technische Bundesanstalt
QI	Quality Infrastructure
R&D	Research and Development
RM	Reference Material
SANIPES	National Service for Fishery Health, Peru
SCI	Secretariat of Internal Trade
SCU	Supervision and Coordination Unit, Chile
SENACYT	National Secretariat for Science, Technology and Innovation
SI	International System of Measurement Units
SI	Standardization Institute
SIM	Sistema Interamericano de Metrología
SNA – INDECOPI	Accreditation body of INDECOPI, Peru
SUNAT	Superintendencia Nacional de Administración Tributaria, Peru
UNICAMP	State University of Campinas, Brazil
UNIDO	United Nations Industrial Development Organization
WTO	World Trade Organization



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