Title:

The Effect of Mutual Recognition Arrangement on Agricultural Exports of the Philippines: The Role of Laboratory Accreditation

By

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This study is submitted in fulfillment of the requirements of the degree of Master of Arts in International Development at the International University of Japan in 2023.

ABSTRACT

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This study analyzes how mutual recognition arrangement (MRA) affects trade facilitation through the accreditation of laboratory facilities serving agricultural exporters in the Philippines. A modified gravity model employing panel-data estimations is used to assess the influence of the factors of laboratory accreditation on bilateral trade flow among other countries. The results show that MRA recognition has a trade-increasing effect on the export performance of agricultural products through accreditation of laboratory services. Thus, the MRA and the addition of accredited laboratories that secures the safety and quality of products and establish globally accepted standards are significant to international trade. While the current global agricultural trade policies focus on multiple facets of sustainable development, the key aspect of this issue is understanding what provisions countries can adopt to maximize trade with other countries. As such, this study is important to further understand the patterns of trade behavior through deep analysis of imperative trade-related constrictions.

Keywords: laboratory accreditation, MRA, trade, gravity model, agriculture

ACKNOWLEDGEMENT

To all those who played a part in this journey, I would like to express my sincerest gratitude and appreciation in making this work possible. Your support and belief in the importance of this study truly made a difference. Your encouragement in my abilities was a driving force behind the successful completion of this thesis. Thank you for playing a role on my academic endeavor.

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CHAPTER 1

INTRODUCTION

The improvement of the agricultural industry in the global landscape is a dormant market we are yet to overcome. Multiple studies backed up by real numbers have degenerated the breaking factors in trade facilitation, specifically in making sure to step out of possible concerns on imports and exports. Remarkable developments have been recorded on trade limitations in quality processes, yet multiple factors and components influencing such are still unknown. Hence, this study will put a more profound understanding of the current condition of trade in agricultural products. Particularly, this study will try to clarify matters related to the role of mutual recognition arrangement (MRA) through accreditations of laboratories handling agricultural produce from the Philippines.[1]

The reduction of trade barriers has been a notable trend in global trade growth due to the commitment to the World Trade Organization (WTO). However, the international trade mechanisms have reported various issues with the use of nontariff measures (NTM). These issues encompass the reductions of technical barriers to trade (TBT) and sanitary and phytosanitary (SPS) efforts, particularly in the agriculture and food sector. Notwithstanding on the apprising of TBT and SPS measures to be controlled in the existing global standards and empirical evidence, the widespread dissemination of such measures to the WTO members has raised issues on the new

[1] MRA means that two or more parties mutually accept each other's conformity assessment procedure as equivalent to ensure compliance with the prevailing technical regulations (Correia de Brito, 2016). This means that regulatory measures are considered not to be different to allow trade restrictions.

wave of protectionism. This protection covered under the influence of trade regulation and product standards and safety (Ferraz et al., 2018). Ronen (2017) noticed that NTM is highly observed by the government for multiple valid reasons creating friction and serving protectionist motives. This public policy covers alignment of the market issues, including incoherent information or mediums, public health and safety, protection of buyers, ensuring better national security infrastructure, and other related purposes.

The NTM to international trade of today's supply chain concerning the reduction of technical barriers has emerged as a challenge for developing countries. Exports from developing countries are likely to be negatively affected by the NTM compared to exports from developed countries based on several empirical studies predominantly in the agriculture and food sector (Ronen, 2017). Disdier et al. (2008) found an overall adverse effect of notified TBT and SPS measures on export from developing countries to OECD countries, largely in agriculture and food trade. Fontagne et al. (2005) distinguished that NTM has restricted trade impacts on agriculture and food trade compared to other products. Also, Ghodsi et al. (2017) showed that developed countries are minorly affected by NTM compared to developing countries as standards and restrictions are imposed. Thus, the complex requirements for importing and exporting goods and services have impeded achieving international market access. These requirements include laboratory testing as part of conformity assessment procedures to comply with different technical regulations. Testing procedures for agricultural producers reduced the export share, causing a negative effect on international trade, as found in the study conducted by Chen et al. (2006). In the Philippines, the testing for TBT and SPS measures is one of the highly

encountered obstacles in the agriculture sector as trade requirements, based on the 2014-2015 NTM survey conducted by the International Trade Centre (2016). One of the most common procedural difficulties in exporting agricultural products includes the availability of accredited testing laboratories. Thus, exporters have limited access to the international market which significantly impacts the total export revenue derived from agricultural commodities. Additionally, this limitation affects the contribution of the agriculture sector to the economy's output.

In the last three decades, the agriculture sector in the Philippines has experienced a relatively small and declining share in the economy's output compared to the industry and services sector. In 2020, only 10 percent accounts for its contribution to the overall gross domestic product having a total export revenue of about 9.5 percent in agricultural crops based on the report of the Philippine Statistic Authority (2021). The agricultural markets for high-value products have become more complex, making it difficult for domestic producers to participate and advance in the global supply chain. The most identified challenge in the coordination along the worldwide supply chain is the need for the trade exporter to signal quality through standard and conformity assessments. Such constraint affects agricultural trade performance, particularly in developing countries, as Moïsé et al. (2013) reported. Compliance to meet the standards for regulatory purposes includes the requirement of testing laboratories accredited based on international standards to facilitate market access from one country to another. Moreover, the lack of accredited laboratories or insufficient capabilities within the scope is an additional cost factor both incurred by producers and consumers. This cost arises from the need to invest in establishing new

processes and quality infrastructure to ensure compliance with the export requirements. Developing countries, like the Philippines, often encounter limitations in this regard.

In view of the initial economic conditions, a solution was established and implemented to address the adverse trade effects of NTM. This solution involves recognizing one conformity assessment to standard through MRA as encouraged by the WTO stated in Article 2.4 of the TBT Agreement (www.wto.org). Hence, this gives incentives to legislators to mutually agree in coordinating the dynamics in external relationships generated by the increased profiling of standards. Also, this can be a valuable structure in the trade agreement that does not put underlying purposes for regulations, simply making sure that it will not have additional costs suffered by producers and consumers. Furthermore, the MRAs play a crucial role in resolving coordination issues related to NTM. They achieve this by reducing information asymmetries and promoting transparency. As a result, harmonization and mutual recognition have a positive effect on the extensive margin of trade through export, facilitating export diversification (Ronen, 2017). Also, Baller (2007) supports the positive influence of MRA on firms' decision to export as recommending standards and related testing procedures are fixed rather than a variable cost for OECD firms. Although harmonization and MRA can address an extensive range of regulatory trade barriers, most national policies are not well implemented, are inconsistent, and create a vague business environment. Also, the net trade effect depends on various determinants, which include the specific market covered, particular standards involved, sectors affected, and other considerations (Ronen, 2017).

Generally, empirical researchers face challenges in the evaluation of the influence of NTM on international trade, particularly in the agricultural sector. This difficulty hinders in providing conclusions related to the actual effect on international trade. To date, there are limited literature and studies published in the Philippines, particularly on the profile and nature of this work. Thus, this study provides empirical evidence supporting the pragmatic theoretical concept of the economic effect of NTM to trade. In particular, this study determines the effect of MRA through the accreditation of laboratory services focusing on agriculture export in the Philippines. This study hypothesized that the Philippines as a signatory to International Laboratory Accreditation Cooperation (ILAC) - MRA, has a positive trade effect on international trade facilitation. This contribution is achieved through the increase in the push-effect of ISO/IEC 17025 accredited laboratories with the scope of testing agricultural commodities.[2] Moreover, the result of this study aims to provide a national framework and make policy by supporting evidence to the Philippine government specifically to improve the trade facilitation in the agriculture sector.

Philippine agriculture is certainly challenged both in the domestic and international landscape. But it is worth noting that development in the agriculture sector is a huge factor in food security, given international trade is beneficial in the growth of this sector. Significantly, political and social settings in the last decades have changed, as well as the number of accredited laboratories affecting the international

[2] ILAC is a formal cooperation with an authority to establish a network of MRA among accreditation bodies of respective economies supporting the trade facilitation through removal of trade barriers (www.ilac.org); ISO/IEC 17025 (General requirements for the competence of testing and calibration laboratories) helps facilitates the cooperation between laboratories and other related bodies by generating a wider acceptance of results between countries (www.iso.org).

trade mechanism of the Philippines. Subsequently, the quality of infrastructure conditions has evolved too, influencing the government agencies and businesses to comply with international affairs in achieving sustainable growth and metrics. Thus, the significance of this study is pertinent to update and deep dive into the dynamics of trade through analysis of imperative trade-related constrictions. Its objective aims to establish the performance of the Philippine agricultural export to trade facilitation and its economic contribution.

The rest of the paper is organized as follows. Following the introduction, the next chapter provides a brief empirical literature review on accreditation and its role in agricultural trade. Chapter 3 describes the data set used for the estimation. Chapter 4 provides the econometric model and discusses the methodological approach. Chapter 5 presents the results of the empirical analysis. Chapter 6 concludes and makes some policy recommendations.

CHAPTER 2

ACCREDITATION AND ITS ROLE IN AGRICULTURAL TRADE

The importance of accreditation and its related services to the economic framework has been demonstrated through several empirical studies. These works have provided extensive and substantial information in establishing the effect of standard compliances as viewed in the international scenes of accreditation. These works include the benefits to international trade relations. Notably, there are many prevailing concepts of the role and significance of laboratory accreditation in explaining the bilateral trade pattern in the agriculture sector.

Trade globalization has taken the quality of a particular consumption into public interest (Auriol and Schilizzi, 2015). Internationally, governments legislate the food and agricultural safety requirements to achieve this quality, considering that standards are being met through laboratory testing. Nowadays, consumers and authorities are highly conscious of these quality attributes, wanting the commodities to be certified and meet particular requirements. These provisions have the propensity to increase exports from developing countries through quality improvement and reduction of information asymmetries (Maertens and Swinnen, 2009; Curzi et al., 2020). Therefore, compliance must be achieved before particular commodities are imported or exported, particularly on agricultural products. The accuracy and reliability of measurement that determines the quality of products depend on the competitiveness of the industries involved. Countries with internationally accredited laboratories have a significant advantage due to the qualification of processes and

products beneficial in removing technical barriers to trade. The influence of international accreditation through measurement and testing systems and conformity assessment represents a crucial capability of countries' quality infrastructure. It directly affects the economies of scale, hence contributing to the competitive advantage of domestic producers (Blind, 2001). However, these mechanisms play a crucial role for developing countries seeking integration into supply chains in developed countries. Yet, the compliance in standards incurs additional costs, leading to the imposition of technical barriers and inhibiting trade, particularly in the agriculture sector (Shepherd and Wilson, 2013). Still, several studies on trade influences accreditation highlight the certification as a medium of raising awareness of quality among consumers (Clougherty and Grajek, 2014; Blind et al., 2018).

Imports from outside the country's regions started to adapt to the changing global standards in large supply chains. Progressively, through economic pressures and competition, more local businesses outside the global supply chains applied for International Organization for Standardization (ISO) accreditations (Sampaio et al., 2009).[3] Studies on ISO certifications proved multiple extrinsic and intrinsic reasons why companies push to be accredited. For instance, the company enhances the possibility of undertaking exports by improving the quality of products to increase the number of markets (Chen et al., 2008). Some are used as a tool to signal investment and quality upgrading to improve performance and have higher productivity (Potoski and Prakash, 2009). Subsequently, consumers become aware of these international

[3] ISO is an independent and non-governmental international organization with different technical standards across different countries, responsible in developing consensus-based, voluntary and market relevant standards that support innovation and provide solutions to global change(www.iso.org).

market developments demanding quality products with a positive impact on health and safety. This demand extends to the requirements of complying with specific standards. In the context of agricultural trade, these become regulatory requirements controlled by the government, causing either trade promotion or constraints (Shepherd and Wilson, 2013).

Research conducted across countries provided information on the accreditation and exportation scene. For example, Martincus et al. (2010) research in Argentina from 1998-2006 showed that ISO accreditation significantly increases exportation volumes and receiving countries. While according to the study of Ferro (2011), the World Bank's Enterprise survey showed that developing countries are most likely to export products when they are ISO accredited. Through the same data source, Hudson and Orviska (2013) established that firms serving local markets are the last to adopt international standards where higher exportations are seen. In a similar study by Goedhuys and Sleuwaegen (2013), they established a positive relationship between ISO accreditation and sales and productivity, using data from 59 countries. From a different perspective, accreditation through product certification of agricultural and food products can impede international trade development as developing countries meet difficulties in standards requirements (Chen et al., 2006). The same findings by Disdier et al. (2008) that compliance to specific measures tends to reduce the exportation from developing countries, and Shepherd (2007) emphasized that voluntary standards in food and agriculture can constrain the trade effect from developed countries. However, the impact of safety and quality requirements can either reduce or enhance trade in agricultural and food products, as noted in the study

conducted by Henson and Jaffee (2008). Also, this varies over a period given a particular condition between countries involved, reflecting the behavior towards the global standards, level of risk, and other correlated factors. Furthermore, internationally harmonized standards can be a barrier or a catalyst of trade depending on sector specificities (Shepherd and Wilson, 2013). The multiple effects of compliance with standards have made it challenging to recognize the specific medium that influences trade. Therefore, empirical studies have resulted in diverse net outcomes (Clougherty and Grajek, 2014).

While for the Philippines alone, international commitments related to agricultural trade facilitation are significant. The Philippines is covered by multiple parties and agreements with the WTO. Based on the technical information on technical barriers to trade of WTO (www.wto.org), the goods exported in the international markets may require multiple testing to demonstrate compliance with different technical regulations. The reason is because of the difference in compliance with testing protocols, a policy imposed by bureaucracy, or a manipulation from protectionist groups resulting in an additional cost for exporters to access multiple markets. Thus, a mutual recognition arrangement (MRA) through the accreditation of laboratory services will reduce this incurred valuation if the products are only tested once and the results are accepted in all markets. The recognition is usually based on confidence established through international standards and conformity assessment practices implemented by the national accreditation body.[4] The accreditation issued

[4] The Philippine Accreditation Bureau (PAB) was recognized as the national accreditation body of the Philippines, tasked to accredit conformity assessment services such as inspection, testing, certifying bodies, and other related bodies needed by the country through Executive Order 802 issued in 2009.

for a conformity assessment based on a specific standard of the exporting country member has the same equivalence of evaluation performed by the importing country member, such as ISO/IEC17025 (General requirements for competence and testing and calibration laboratories). Technically under MRA, test results issued by an ISO/IEC 17025 accredited laboratory in compliance with the technical regulations of an exporting country can be accepted by an importing country under the same agreement. However, Pasadilla and Liao (2007) observed that one of the significant challenges in the Philippines was the lack of technical infrastructure, which relates that some laboratories being inefficiently used. Also, not all government laboratories meet the ISO requirements or have accreditation by trading partners to ensure compliance with nontariff measures (NTM) in the agriculture sector. Thus, MRA negotiations are worthless if there is still a lack of technical competence, such as the limited number of accredited laboratories and inadequate capabilities to meet the standard export requirements.

The Philippines, together with other members of the Association of Southeast Asian Nation (ASEAN), is committed to promoting the intra-regional trade of agricultural and food products by reducing NTM to improve food safety and sector competitiveness. Most of the technical dealings of NTM are also apparent in the ASEAN region, wherein the Philippines take mostly the form of testing and inspection requirements (Pasadilla, 2013). Medalla and Mantaring (2017) reported that the Philippines has the second highest number of NTM notifications related to technical

The certificates issued by PAB accredited laboratories are reliable and processed following international practices through its full membership and signatory status to International Laboratory Accreditation Cooperation – Mutual Recognition Arrangement (ILAC-MRA).

barriers to trade (TBT) and sanitary and phytosanitary (SPS) measures among ASEAN. The majority is in export cases caused by certification, testing, and some environmental-specific requirements. Thus, the ASEAN developed a framework agreement on mutual recognition (i.e., the ASEAN Consultative Committee on Standards and Quality) to provide a common basis for the harmonization process and implementation of MRA of conformity assessment measures of the respective national accreditation body. Such includes the recognition of test reports of accredited laboratories. Still, there remains a need for effective implementation of the established agreement at the regional and national level among ASEAN to deal with the uncertainties among buyers, support the domestic producers, and foster appropriate levels of protection between trade partners in the agriculture sector (Keatts, 2017). Also, Pasadilla (2013) emphasized that diminishing NTM depends on the country's political will with necessary regulatory policies aligned with the interests of the concerned parties.

Moreover, Philippine agriculture is exposed to possible roadblocks from international challenges. Pasadilla and Liao (2007) discussed the market limitations of Philippine agricultural commodities in the European Union market. The reason is because of the country's weak infrastructural framework. Tiongco and Fransisco (2011) conferred the constrictions due to the protections imposed by developed countries, particularly in the agriculture sector. These measures, such as NTM, limits the access of the Philippine export to the international market. Also, Quimba and Calizo (2018) emphasized that Philippine agricultural products are disproportionately affected by NTM. This primarily because of a higher incidence of SPS resulting from

increased production costs by the local producers and decreased export growth. Thus, accredited laboratories ensuring the quality of products and meeting the standard requirements seem to matter more in trade facilitation.

CHAPTER 3

METHODOLOGICAL APPROACH

This study used a modified gravity model to estimate the export push-effect of MRA through the accreditation of laboratory quality standards covering agricultural commodities. Various studies in international trade flow analysis have used the gravity model. In practice, the gravity model relates to the logarithm of the trade monetary value proportional to the gross domestic product (GDP), negative on the distance, and contains variables measuring other dynamics that influence the bilateral trade agreement between countries. Consequently, the estimated results of the gravity model can be combined with experiments on trade policy to analyze the implied welfare changes (Head and Mayer, 2014). The approach of this study is based on the empirical work on an extended gravity model used by Eaton and Kortum (2001), Anderson and Van Wincoop (2003), Santos Silva and Teneyro (2006;2011), Clougherty and Grajek (2014) and Blind et al. (2018).

The modified gravity model is expressed as follows:

$$\begin{aligned} lnExport_{ijt} = {} & \beta_0 + \beta_1 ISO/IEC17025_{it} + \beta_2 ISO/IEC17025_{it} ILACMRA_{jt} + \beta_3 lnGDP_{it} + \\ & \beta_4 lnGDP_{jt} + \beta_5 lnPopulation_{it} + \beta_6 lnPopulation_{jt} + \beta_7 Infrastructure_{it} + \\ & \beta_8 Infrastructure_{jt} + \beta_9 FTA_{ijt} + \beta_{10} lnDistance_{ij} + \beta_{11} Language_{ij} + \\ & \beta_{12} Landlocked_j + \beta_{13} Colony_{ij} + \delta_t + \varepsilon_{ijt} \end{aligned} \quad (1)$$

where $Export_{ijt}$ is the export value of agricultural commodities from the Philippines to importing country in year *t*; $ISO/IEC17025_{it}$ is the number of ISO/IEC 17025 accredited laboratories in the Philippines with the scope covering agricultural products; $ILACMRA_{jt}$ is a dummy variable whether the importing country is a member of ILAC-MRA in year *t*; GDP_{it} and GDP_{jt} are the GDP value added in the agriculture sector of the Philippines and the importing country in *t*; $Population_{it}$ represents the number of population of the Philippines and $Population_{jt}$ represents the importing country in time *t*; FTA_{ijt} is a dummy variable indicating whether the Philippines and the importing country are in the same Free Trade Agreement; $Infrastructure_{it}$ and $Infrastructure_{jt}$ are the Infrastructure Index of the Philippines and the importing country, respectively, in year *t*; $Distance_{ij}$ is the geographical distance between the Philippines and the importing country; $Language_{ij}$ is a dummy variable if the Philippines and the importing country have a common language; $Landlocked_j$ dummy variable whether the importing country is landlocked; $Colony_{ij}$ is a dummy variable if the importing country has colonized the Philippines; δ_t are the year-time dummies; and ε_{ijt} is the error term.

Endogeneity problems are usually encountered in gravity models that use policy variables as reverse causality exists between trade flow performance and trade-related policy decisions (Blind et al., 2018). The reverse causality in the context of this study is pertinent as openness to trade may lead to a higher export level that can induce the adoption of international standards, while standardization may also determine the level of trade (Blind, 2002). To deal with this issue, this study used instrumental

variables (IV) that are highly correlated with the endogenous variable but uncorrelated with the error term (Wooldridge, 2020). The number of ISO/IEC 17025 accredited laboratories is instrumented with the number of accredited ISO 15189 and certified ISO 13485 laboratories.[5] The same approach is made with the interaction of ISO/IEC 17025 to ILAC-MRA as instrumented with the interaction of ISO 15189 and ISO 13485 to ILAC-MRA and IAF-MLA, respectively.[6] ISO 15189 and ISO 13485 are voluntary standards used in medical laboratories with the same framework as ISO/IEC 17025. These are highly correlated to the explanatory variables as they have common elements in the quality management system and some technical features, especially on equipment calibration requirements. Hence, accreditation of ISO/IEC 17025 can be penetrated by the number of accreditation and certification of ISO 15189 and ISO13485, respectively. Additionally, as both IVs deal with human diagnostics, it is unlikely they correlate with the error term with the trade equation. Thus, export trade levels of agricultural products were not affected directly, making ISO 15189 and ISO 13485 appropriate IVs. The relevance and validity of the IVs are checked using the tests for under-identification and weak instruments. Results are shown in Table 2 for the respective models.

[5] ISO 15189 specify the requirements for quality and competence in medical laboratories as used by customers, regulating authorities and accreditation bodies (www.iso.org); ISO 13485 specify the requirements to demonstrate the ability of an organization to provide medical devices and related services that meets the customer and applicable regulatory requirements. Also, this can be used by external service parties proving product and related services to such organizations (www.iso.org).

[6] IAF-MLA (International Accreditation Forum – Multilateral Recognition Arrangement) is an agreement of mutual recognition of accredited certification of management systems, products, services, processes, persons and validation and verification(www.iaf.nu).

Clougherty and Grajek (2014) explained that multilateral resistance terms should augment the gravity equation to capture the equilibrium effect of trade flows between countries resulting from bilateral trade costs. The importance of proper control for multilateral resistance terms was emphasized by Baldwin and Taglioni (2006) as the traditional gravity equation omitted these terms, which are correlated with trade costs resulting in biased estimations.

Several studies used modified approaches from Anderson and Van Wincoop (2003) by estimating the multilateral resistance terms by remoteness indexes as a function of bilateral distance and GDPs. Baier and Bergstrand (2009) solve a reduced-form gravity equation establishing bilateral trade flows and trade costs. They used the first-order log-linear Taylor series expansion, a method previously employed by Claugherty and Grajek (2014) and Blind et al. (2018) in establishing the relationship between international standards and trade. Also, this approach of nonlinear systems of price equation gives premise to the theoretical estimation of multilateral resistance terms, as noted by Head and Mayer (2014). Thus, relative to the approach of Baier and Bergstrand (2009), the multilateral resistance terms for distance and free trade agreements are constructed using the following equation (2) and (3), respectively:

$$MRDistance_{ij} = \left[\left(\sum_{k=1}^{N} \theta_k lnDistance_{ik} \right) + \left(\sum_{m=1}^{N} \theta_m lnDistance_{im} \right) - \left(\sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m lnDistance_{mk} \right) \right] \quad (2)$$

$$MRFTA_{ijt} = \left[\left(\sum_{k=1}^{N} \theta_k FTA_{ikt} \right) + \left(\sum_{m=1}^{N} \theta_m FTA_{imt} \right) - \left(\sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m FTA_{mkt} \right) \right] \quad (3)$$

where $\theta_{it} = \frac{GDP_{it}}{\sum_{n=1}^{N} GDP_{nt}}$ is the ratio of country $i's$ GDP in the world GDP and where m, k and n are for convenient expression. The calculated multilateral terms are added in the gravity equation (1), and the model specification is shown in Tables 2 and 3.

The estimation techniques used in this study employ both log-linear and nonlinear models in testing the hypothesis. The initial strategy is a full estimation of the model using identified specifications, followed by sectioning into sub-models where the importer is a developed or less developed country as estimated using the most-fitted regression model.

The baseline gravity regression follows the approach of Clougherty and Grajek (2014) by applying the pooled ordinary least square (OLS) estimation. The equation controls the impact of any time-specific effects in the data series with year dummies (δ_t). Also, it considers any possible heteroscedasticity and autocorrelated error terms (ε_{ijt}) by using cluster-robust standard error. However, trade data is inherent to heteroscedasticity and zero observations; thus, the log-linear estimation technique using OLS may lead to inconsistent coefficient estimates (Santos Silva and Teneyro, 2006).

The panel data technique of fixed effect estimation accounts for the sources of unobserved heterogeneity that are constant for a given exporter across all importers. This approach takes the advantage of mitigating the bias and satisfying the criteria for multilateral resistance terms. Meanwhile, Feenstra (2004) suggested using exporter

and importer fixed effects to counter difficulties in programming from Anderson and Wincoop (2003) while ensuring to account for multilateral resistance terms. More than considering unobservable multilateral resistance terms, the exporter-time and importer-time fixed effects receive the size variables from other structural gravity models. These models include both the observable and unobservable variables specific to countries, with various dimensions that include national policies, government structures, and currency trade (Yotov et al., 2017).

Eaton and Kortum (2001) proposed another approach for the gravity model as easier to implement and interpret (the EK-Tobit estimator). Martin (2020) used this method in dealing with the limited-dependent variable bias results from limiting extreme values of the distribution of a latent variable at a threshold value providing unbiased parameter estimates. Modern theory directs us to allowable values wherein the current values in the market are not relevant due to varying productivity levels among institutions and nations (Chaney, 2018). With respect to this, the EK-Tobit estimator provided a threshold alternate from the minute imports among countries instead of the constraint observations. Also, the advantage of the EK-Tobit estimator is that it does not require exclusion restriction and is the preferred estimator under the log-normal error (the normality assumption) (Head and Mayer, 2014).

However, data sets in bilateral trade between countries with around half common for larger shares of total and sectoral trade contain zero trade values (Martin, 2020). Melitz (2003) highlighted the presence and behavior of heterogeneous firms in the international market as not all exporting firms export to all countries resulting in

zero trade flows in the matrix. Zero trade flows in gravity models were rarely highlighted because their occurrences are infrequently given attention and the convenience of the log-linear estimator (Martin and Pham, 2020). Zero trade flows are simply dropped out of the estimation when the trade value is transformed to logarithmic form (i.e., the log of zero is not defined), and omitting these zero values will lead to sample selection bias. Gravity model estimation will have inconsistent results and may cause a loss of useful information if zero trade in the data is really zero and reflects systematic rounding errors with minimal trade flows (WTO, 2012).

Santos Silva and Teneyro (2006) suggested a simple and suitable approach to deal with this issue using the gravity model in the multiplicative form in applying the Poisson Pseudo Maximum Likelihood (PPML) estimator, providing consistent estimates of the non-linear model. Santos Silva and Teneyro (2011) further examined the performance of the PPML estimator in the presence of a high proportion of zeros in the dependent variable and when the data is given by a constant elasticity model. Similar to their results in 2006, the estimations were consistent even with the predominance of a large proportion of zeros in the data. Also, it is more robust to depart from overdispersion in the dependent variable (heteroskedasticity assumption). The PPML estimation method is consistent in heteroscedasticity and accounted naturally for zero trade flows as seen to be fit for estimating the gravity equation. Furthermore, Shepherd (2016) emphasized three desirable properties of the PPML estimator for applied policy researchers using the gravity model: (i) it is consistent with fixed-effects, (ii) it naturally includes zero trade values from the observations, and (iii) interpretation of the estimated coefficients are straightforward.

The PPML does not suffer from the incidental parameter problem with two sets of fixed effects in panel data as long as the sizes grow at the same rate and the regressor are exogenous or predetermined (Fernández-Val and Weidner, 2016). Under general conditions, gravity equations with exporter and importer fixed effects are not affected by such problems (Santos Silva and Teneyro, 2006). In fact, multilateral resistance indexes can be recovered from the estimated fixed effects using the PPML estimators (Fally, 2015). Also, Weidner and Zylkin (2021) have shown that only PPML, among its family members of pseudo maximum likelihood estimators, has the consistent property even though the models have three sets of fixed effects. Although, PPML cannot be used to estimate gravity models that include fixed effects with IVs as it suffers from the incidental parameter problem (Santos Silva and Teneyro, 2022).

Furthermore, the adequacy and misspecification of all the estimators used are checked using Ramsey Regression Equation Specification Error Test (RESET) (Ramsey, 1969). It is a general specification test of the model's functional form and whether the conditional expectations are correctly specified.

CHAPTER 4

DATA DESCRIPTION AND SUMMARY STATISTICS

The panel data set is limited to years from 2015-2019, covering the sum of exported agricultural products in the Philippines based on the 2-Harmonized System (HS) Commodity Classification.[7] The range of agricultural commodities includes Chapters 01 to 24 and 50 to 53. The reference data of the dependent variable is from the United Nation Statistical Division's COMTRADE Database (www.comtrade.un.org/db/). This database has a panel and matrix structure yearly defined by the type of HS commodities traded by the Philippines to its export destination countries.

This study hypothesized that ILAC-MRA positively facilitated international trade, particularly in exporting agricultural products in the Philippines through ISO/IEC 17025 laboratory accreditation services. A dummy variable is applied to whether the importing country is a signatory member to ILAC-MRA for ISO/IEC 17025 (testing) to determine the effect. Information on the signatories to ILAC-MRA is available on the ILAC website (www.ilac.org). The number of ISO/IEC 17025 accredited testing laboratories covering the scope of interest is taken from the PAB database (www.dti.gov.ph/pab). The dataset for IV, which includes the number of ISO15189 accredited medical laboratories, and the number of ISO13458 certified

[7] HS is regulated by the World Custom Organization (WCO) that serves as the classification system for export and import traded products used by many countries worldwide (https://www.wcoomd.org/en.aspx).

quality management systems on medical devices, are taken from the PAB database and ISO Survey (www.iso.org/the-iso-survey.html), respectively. Also, information on the signatory status of ILAC-MRA based on ISO 15189 is available on the ILAC website, while the IAF-MLA signatory status based on ISO 13485 is available on the IAF website (www.iaf.nu).

The data on the gross domestic product (GDP), population, and logistic performance index (LPI) is taken from the World Bank's World Development Indicator (World Bank). The information for the dummy variable indicating whether the Philippines and the importing country are in the same Free Trade Agreement is accessed through Asian Development Bank's (ADB) Asia Regional Integration Center Free Trade Agreement database (www.aric.adb.org/fta-country). The geographical distance and other dummy variables like common language, landlocked countries, and cultural features as colonial history is taken from the Centre d'Etudes Prospectives et d'Information Internationales (CEPII) database (Conte et al., 2022).

Since ISO 9001 has influenced ISO/IEC17025, this study follows the same arguments by Clougherty and Grajek (2014) and Blind et al. (2018). These arguments consider the positive correlation of the physical infrastructure to the standard as a form of soft infrastructure. However, this correlation may cause an overestimation of the effects of ISO/IEC17025 and the ILAC-MRA.[8] The infrastructure index mirrors the infrastructure development of the Philippines and its exporting countries, thus taking

[8] ISO 9001 is the standard's criteria for quality management system with principle based on customer focus, motivation and implication of top management, process approach and continual improvement of an organization (www.iso.org).

into account the factors of ISO/IEC17025. The infrastructure index used in this framework is the simple average of three indicators used in the study of Blind et al. (2018), which includes the (i) number of departing passengers from the nation's airport, (ii) number of telephone line subscriptions, and (iii) data on the goods transported (in million tons-km) via railways. Data are taken from the World Bank's World Development Indicator (World Bank).

Table 1

Variable description and summary statistics of model variables.

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
$Export_{ijt}$	Agricultural trade export value from PHL to country *j* in billions (USD)	925	0.0311	0.1320	0.000	1.4700
$ISO/IEC17025_{it}$	ISO/IEC17025 accredited laboratories in PHL	925	104.20	8.4521	96	119
$ILAC\ MRA_{ISO/IEC17025}$	Dummy variable if country *j* is a signatory member of ILAC-MRA in ISO/IEC17025	925	0.4454	0.4973	0	1
GDP_{it}	GDP value added in agriculture of PHL in billions (USD)	925	33.300	0.4060	32.500	33.700
GDP_{jt}	GDP value added in agriculture of country *j* in billions (USD)	866	18.300	80.500	0.0002	102.00
$Population_{it}$	Population of PHL in millions	925	105.00	2.1218	102.00	108.00
$Population_{jt}$	Population of country *j* in millions	925	38.600	146.00	0.0104	1410.0
$Infrastructure_{it}$	Infrastructure index of PHL	925	2111479	183637.6	1774823	2288189
$Infrastructure_{jt}$	Infrastructure index of country *j*	893	2237232	7644850	98	98000000
FTA_{ijt}	Existence of free trade agreement between PHL and county *j*	925	0.0886	0.2844	0	1
$Distance_{ij}$	Distance between PHL and country *j* (mile)	925	6296.692	2783.48	751.00	12008
$Landlocked_{j}$	Dummy variable if country *j* is landlocked	925	0.1351	0.3421	0	1
$Language_{ij}$	Dummy variable if PHL and country *j* have a common language	925	0.4541	0.4982	0	1
$Colony_{ij}$	Dummy variable if PHL and country *j* has a colonial relationship	925	0.0378	0.1909	0	1
$ISO15189_{it}$	ISO15189 accredited laboratories in PHL	925	23.4	0.4902	23	24
$ISO13485_{it}$	ISO13485 certified medical laboratories in PHL	925	18.4	5.5021	8	23
$ILAC\ MRA_{ISO15189}$	Dummy variable if country *j* is a signatory member of ILAC-MRA in ISO 15189	925	0.2984	0.4578	0	1
$ILAF\ MLA_{ISO13485}$	Dummy variable if country *j* is a signatory member of IAF-MLA in ISO 13485	925	0.0638	0.2445	0	1

CHAPTER 5

RESULTS AND DISCUSSION

The estimation results of the aforementioned econometric models are shown in Table 2 with seven different specifications, allowing whether the main findings are generally robust. Regression specification (1) reported the result of the baseline gravity equation using ordinary least squares estimation. To deal with potential endogeneity and heterogeneity issues, specifications (2) and (3) used fixed-effect estimation while employing the instrument variables with an importer cluster-robust covariance matrix and standard error. Regression specifications (4) and (5) used the EK-Tobit estimation to deal with the limited-dependent variable bias, whereas specifications (6) and (7) used PPML to account for zero trade flows from the observations. Each model specification is estimated with and without multilateral resistance terms as a further robustness check (except for the simple pooled regression model).

The main variables of this study are ISO/IEC17025 and its interaction terms with ILAC-MRA dummies of the importing countries. As a result, this study found a positive trade-increasing effect of ISO/IEC 17025, including its interaction term with ILAC-MRA, which is consistent with existing empirical trade literature (Swann et al., 1996; Blind, 2004; Blind and Jungmittag, 2005; Potoski and Prakash, 2009; Clougherty and Grajek, 2014; Blind et al., 2018). The coefficient value indicated minimal effects on agricultural export. An increase in ISO/IEC 17025 accredited laboratories will increase the export value by 6% (significant at p-value<0.05), as shown in the specification (4). The value will increase further by 0.0014 in billion

USD (highly significant at p-value<0.001) as recognized by the importing countries with ILAC-MRA signatory status, as shown both in the specification (6) and (7). However, most of the results of the interested variables are not significant. The reason may be because voluntary standards as a differentiation strategy appeared to be significant only during the early adoption stage, wherein the voluntary sustainability standards certified products increased as differentiation advantage decreased, particularly in the agricultural settings in the Philippines (International Labour Organization, 2022). Also, voluntary standards and international harmonization in developing countries affect the extensive margin of trade that is correlated with the fixed cost of adoption (Shepherd, 2007).

The signs and magnitude of the results of mass variables such as GDP, population size, and infrastructure index also conform to the expectations except for the free trade agreement. The GDP of the Philippines and the importing countries have positive values showing significant effects on international trade (except the fixed-effect specifications for having a negative sign but of no relevance since it is insignificant). The positive impact of economic growth can lead to greater capacity utilization affecting the development of the export sector (Tyler, 1981; Vohra, 2001). As predicted, the population of both the Philippines and the importing countries have negative values since the growing population may account for growing consumption which may inhibit agricultural output, thus affecting international trade (Boserap, 1975). Though, the effect of population in the Philippines is not significant. Also, the negative effect of the importing country's population may due to lower GDP per capita as GDP is already controlled for. The infrastructure index of the Philippines has

positive and significant values, while the estimation results of the importing countries are somewhat ambiguous. The quality and availability of infrastructure matters to enhance trade by encouraging export quantity (Rehman et al., 2020). Different from the expectations when the Philippines and the importing countries are in the same free trade agreements, the results are negative. They are highly significant (p-value<0.001) as shown in the specification (6) and (7), which is probably because of trade diversion and efficiency losses associated with higher-cost from trade preferences, thus lowering the output (Sun and Reed, 2010). Based on the study conducted by the International Labour Organization (2022), there were issues identified with a free trade agreement that included time-consuming, tedious processes and additional costs incurred due to certification requirements which may affect the coefficients' values. Other control variables such as common language, distance, colony, and landlocked have the expected results and are consistent, as shown in the specifications (1), (4) and (5). Yet, these variables are omitted using fixed-effect and PPML regression.

To determine the presence of endogeneity, the differences in the coefficient estimates of specifications (1) and (2) were compared using the Hausman specification test (Hausman, 1978). The results failed to reject the null hypothesis of being non-systematic; hence, it cannot support the existence of the causality issue. However, various empirical studies have established the simultaneity between standards and international trade. Trade performance and the level of adoption of standards as a policy variable are interdependent, failing to be strictly exogenous (Barett and Yang, 2001; Blind, 2002; Potoski and Prakash, 2009; Clougherty and Grajek, 2014). Next, the relevance and correlation of the instrument variables are evaluated by the LM

version of the Kleibergen-Paap rank statistic (Kleibergen and Paap, 2006). They are verified using Sanderson-Windmeijer conditional F-statistic as the model has multiple regressors (Sanderson and Windmeijer, 2016). The results failed to reject the null hypothesis suggesting that the instrument variables may be inadequate to identify the equation. Thus, using fixed-effect regression may not be sufficient. It is necessary to have valid and strong instrumental variables to allow deeper inferences in obtaining the parameter of interest.

Moreover, the adequacy of all the estimated models to check the functional form was evaluated using the heteroscedasticity-robust RESET test. The null hypothesis indicates the power of the fitted values has no relationship with the response variable, meaning the model is not suffering from omitted variable problems (Ramsey, 1969). The results in Table 2 showed that OLS and EK-Tobit estimations did not pass among the models as their test statistics are significantly different from zero (p-value<0.05 and <0.001, respectively). The fixed-effect and PPML fail to reject the null hypothesis signifying that the estimators passed the functional form test. However, the fixed-effect estimation used in this study fails to satisfy the requirements using the instrumental variable approach, and that could not be relied on. Thus, using a nonlinear gravity model such as PPML is the most suitable estimation to establish the results of this study. Conforming to Santos Silva and Teneyro (2006; 2011), the PPML is deemed fit to be the workforce for estimating gravity equation and the appropriate estimator to be contingent on the process generating the error term under constant variance to mean ratio (Head and Mayer, 2014).

Table 2

Regression results.

Dependent variable for (1) to (5) is $lnExport_{ijt}$ and for (6) to (7) is $Export_{ijt}$							
Independent variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	FE w/IV	FE w/IV	EK-Tobit	EK-Tobit	PPML w/ FE	PPML w/ FE
$ISO/IEC17025_{it}$	0.0526 (0.0415)	0.0403 (0.0809)	0.0339 (0.0723)	0.0581* (0.0352)	0.0335 (0.0362)	0.0107 (0.0115)	0.0117 (0.0103)
$ISO/IEC17025_{it}$ x $ILACMRA$	0.0003 (0.0013)	0.0044 (0.0250)	0.0058 (0.0237)	0.0004 (0.0012)	0.0005 (0.0013)	0.0014*** (0.0005)	0.0014*** (0.0005)
$lnGDP_{it}$	13.0040** (6.4495)	12.0304 (7.6903)	11.7322 (7.4083)	11.303** (5.5361)	10.0036* (5.6580)	6.5220*** (1.6178)	8.4066*** (1.5564)
$lnGDP_{jt}$	0.0044 (0.5468)	-0.0422 (0.5839)	-0.1054 (0.5558)	0.5741* (0.3314)	0.0953 (0.3558)	0.6488 (0.4619)	0.1550 (0.4676)
$lnPopulation_{it}$	-38.5924 (32.2768)	-30.5740 (53.7514	-26.5475 (48.1727)	-43.2344 (26.7607)	-27.3782 (27.5498)	-7.8246 (10.0849)	-10.0873 (8.6388)
$lnPopulation_{jt}$	-8.0034** (3.9529)	-8.5787* (5.1115)	-8.7214* (4.8790)	-9.7650*** (2.3302)	-7.8769** (2.3919)	-7.8769 (2.6863)	-2.9681 (3.6729)
$lnInfrastructure_{it}$	6.637 (4.0596)	5.6490 (6.4675)	5.1969 (5.9021)	7.0605** (3.2407)	5.4190* (3.3237)	2.4334** (0.9466)	2.8749*** (0.9248)
$lnInfrastructure_{jt}$	-0.2082** (0.0837)	-0.2089*** (0.0740)	-0.2102*** (0.0760)	-.20900*** (0.1093)	-0.14032 (0.1118)	0.4306* (0.2292)	0.3162 (0.2188)
FTA_{ijt}	-0.0479 (0.3299)	-0.0785 (0.2685)	-0.1656 (1.2257)	-0.0187 (0.4724)	01106 (0.9012)	-0.3396*** (0.0807)	-0.5098*** (0.1591)
$lnDistance_{ij}$	-22.180*** (6.3635)	-----	-----	-24.181*** (3.8936)	-22.322*** (3.9976)	-----	-----
$Language_{ij}$	17.7058*** (4.8028)	-----	-----	20.054*** (3.4998)	18.254*** (3.6120)	-----	-----
$Landlocked_j$	-22.432*** (5.5407)	-----	-----	-24.792*** (3.8990)	-22.994*** (4.0225)	-----	-----
$Colony_{ij}$	61.8926*** (19.2237)	-----	-----	67.569*** (11.4659)	49.2805** (22.5204)	-----	-----
Constant	637.4434 (424.5949)			792.079** (343.7403)	522.9413 (0.0253)		
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multilateral Resistance Term	No	No	Yes	No	Yes	No	Yes
Observations	706	686	686	707	707	840	840
R-Squared	0.9293	0.0218	0.0091				
Kleibergen-Paap rk LM statistic		2.901	4.034				
Hansen J statistic		0.014	0.026				
Ramsey test	3.72*	0.34	0.01	29.57***	24.87***	2.46	0.73

Notes: Robust standard errors in parenthesis

***p<0.001, **p<0.01, *p<0.05

Consequently, the results validate the study's hypothesis that ILAC-MRA recognition positively affects agricultural products' export trade performance through ISO/IEC 17025 accreditation of laboratory services. The results strongly support the

findings of Blind et al. (2018) on the increase of the export-enhancing push effect of ISO standards if both exporting and importing countries are signatories to MRA. Also, sub-sample models between developed and less developed importing countries were estimated using PPML to supplement the rationale of the study. More detailed differentiation is done to analyze the effect of the main variables on international trade. The results are shown in Table 3.

Table 3

Regression results between developed and less developed importing countries.

Dependent variable is $Export_{ijt}$		
Independent variables:	(1) PHL → DC	(2) PHL → LDC
$ISO/IEC17025_{it}$	0.0202	0.0539***
	(0.0153)	(0.0102)
$ISO/IEC17025_{it}$ x $ILACMRA$	0.0010	-0.0000
	(0.0007)	(0.0004)
$lnGDP_{it}$	5.5523***	10.1807***
	(1.1888)	(2.0616)
$lnGDP_{jt}$	1.0352**	-0.6475**
	(0.4091)	(0.3166)
$lnPopulation_{it}$	-18.9585*	-40.5124***
	(9.7551)	(10.0981)
$lnPopulation_{jt}$	-6.6492*	3.1648
	(3.4608)	(2.8458)
$lnInfrastructure_{it}$	3.5930***	6.5153***
	(0.8331)	(1.2266)
$lnInfrastructure_{jt}$	0.3753	-0.0468
	(0.2936)	(0.1140)
FTA_{ijt}	0.3925**	-----
	(0.1933)	
Year dummies	Yes	Yes
Multilateral Resistance Term	Yes	Yes
Observations	203	637
Ramsey test	0.05	0.06

Notes: Robust standard errors in parenthesis
***p<0.001, **p<0.01, *p<0.05

Regression specifications (1) and (2) show the trade effects between developed and less developed countries. The results confirm the heterogeneity assumption in the

findings of Blind et al. (2018) that is caused by the heterogeneity in the development of countries in the data set.

The export-push effect of ISO/IEC 17025 is highly significant in less developed countries (i.e., an increase of 0.0539 billion USD in export value, significant at p-value<0.001) as shown in the specification (2) but find no evidence when exporting to developed countries as shown in the specification (1). The push effect of ISO standards in developing countries is consistent with the findings of Clougherty and Grajek (2014) and Blind et al. (2018). The compatibility and quality of international standards benefit intra-industry trade and positively affect foreign trade by promoting export (Blind and Jungmittag, 2005). Whereas import restrictions constrain the expansion of exports to developed countries through agricultural policies wherein domestic production from developing countries encounters barriers. Such includes adaptive costs to domestic and international standards, which incurred the setup cost in compliance, thus, compelling abandoned exportation (Fisher and Serra, 2000). Moreover, less developed countries cannot meet import requirements from developed countries due to a lack of financial and technological resources, which are factored into difficult to comply with (Ferro et al., 2015). For the interaction terms with ILAC-MRA, both results of the country classifications are insignificant as the outcome may be in high-functional institutional intermediaries (Clougherty and Grajek, 2014). That trade sector involves other means and resources to ensure the quality of ISO certificates (Blind et al., 2018) that is missing in the bilateral trade of the Philippines among importing countries. Also, accreditation bodies from other economies with ILAC-MRA signatories can perform cross-frontier accreditation

wherein they can import or export services such as ISO/IEC 17025. Subsequently, this competes with domestic service providers, thus, leading to inefficient duplication and adverse effects on transparency in the global accreditation system (Harmes-Liedtke and Matta, 2021).

Control variables such as the exporting country's GDP, population, and infrastructure index are consistent with the results in Table 2. GDP of the importing developed and developing countries have opposing signs as developed countries benefit more than less developed countries. Most developing countries have agricultural-based economies that profoundly trust export proceeds; thus, increasing import tends to exhibit poor economic performance. Also, less developed countries tend to have higher agricultural value added. The results in the population of developing countries and the infrastructure index of both importing countries are insignificant. In contrast with the results in Table 2, the coefficient for the free trade agreement is positive and significant, particularly with developed countries, as the Philippines have the most with and highest volume of agricultural foreign trade export (Philippine Statistic Authority).[9] The largest export destination countries during the covered period include Japan, the United States, Australia, and European Union members.

The results of the RESET test for the adequacy of the sub-sample model between developed and less developed countries passed the functional form test, thus

[9] The Philippine Statistic Authority releases annually the highlights of the foreign trade statistics for agricultural commodities (www.psa.gov.ph).

making no doubt on the appropriateness of the PPML estimation. The results are shown in Table 3.

In summary, the results have shown the positive relationship of ISO/IEC 17025 standards to the agricultural trade in the Philippines as the adoption of standards enhances the export trade push-effect and can be further increased through ILAC-MRA. Likewise, this indicates that increasing the trust-effect of accreditation bodies signatory to a mutual recognition arrangement can be beneficial in reducing trade barriers, improving productivity and product quality, and providing access to larger markets, as noted in other related empirical studies (Baller, 2007; Chen and Mattoo, 2008; Clougherty and Grajek, 2014, Blind et al. 2018).

CHAPTER 6

CONCLUSION AND RECOMMENDATION

Accreditation of laboratory services using an international standard such as ISO/IEC17025 supports the exporter's participation in international trade by reducing information asymmetries and transactional costs, thus providing access to a larger potential market. By providing accreditation evidence, countries send readiness signals in quality trading. Moreover, the authorized bodies that offer accreditation services with ILAC-MRA signatory status help to improve and support the exportation among participating countries by reducing associated cost-increasing effects that disconnect buyers and sellers. Thus, ILAC-MRA signatory countries can assist in determining opportunities for exporters from developing countries such as the Philippines. Moreso, participation in the ILAC-MRA network contributes to decreasing market risks, resolves trade barriers by ensuring a freely flowing trade landscape, and improves the presence of the companies on the international scene by increasing the level of trade and trust.

The empirical results of the preceding analysis have shown that an increase in the number of ISO/IEC 17025 accredited laboratories increases the market potential for international trade, particularly in the agriculture sector. The results are consistent with other studies on standardization and international trade (Potoski and Prakash, 2009; Clougherty and Grajek, 2014; Blind et al., 2018). However, the export push-effect is more evident in developing than developed countries. The effect of ISO/IEC17025 accreditation through ILAC-MRA recognition with large importing

countries has a positive and significant impact; however, this cannot be distinguished between the country classification. Generally, the empirical results appeared to have a minimal effect on recognizing accreditation to international trade for the scope of agriculture. It seems that efforts to maintain the accreditation services appeared to diminish over time upon the realization that premium benefits are unreciprocated in terms of additional effort required. Also, the effect may depend on the quality of infrastructure development that succeeded in the country.

Furthermore, the results of this study have shown the positive relationship between ISO/IEC 17025 accreditation of laboratory services to international trade and increased exportation through recognition of ILAC-MRA membership. Thus, it is an effective policy tool in addressing the technical barriers to trade and supports domestic producers in improving access to the international scene. This study's empirical analysis indicates that accreditation bridges the gap in addressing the technical requirements imposed by importing countries for nontariff measures. Locally, the Philippine agricultural products will not be tested further, given that producing market players are accredited. Agricultural products in the Philippines will be marketed with a high reputation and lower production costs as the importing countries will recognize it. Such mechanisms will further help local producers penetrate the global market as the countries will signal competence and trust in trading. Equipping the importing countries with the necessary gateway for information exchange on standards will increase the export potential of local market players.

Therefore, there are several essential concerns that are highly recommended for better policy formulation and decision-making in the context of laboratory accreditation and mutual recognition arrangement.

First, policymakers should focus on strengthening the accreditation processes by streamlining procedures, harmonizing related activities including the alignment of processes with the global best practices and ensuring transparency. This will facilitate smoother international trade mechanisms and improve market access for domestic producers. Also, strong support to strengthen the national quality infrastructure is necessary to improve investment opportunities and boost productivity and innovation as a key to greater integration of the Philippine partnerships with other countries in the local and international trading system. However, increased and stricter monitoring should be implied with the policy changes among the businesses involved as this level of bureaucracy is prone to corruption and red tape violations.

Promoting awareness and capacity building should be prioritized among businesses about the benefits of accreditation and MRAs. Targeted training programs, workshops, and several information campaigns can be organized to improve understanding and encourage active participation and compliance with standards, thereby enhancing trade facilitation. Then, continuous monitoring and evaluation should be established to assess the effectiveness of programs that will enable evidence -based decision making.

Moreover, government should support research initiatives to provide a stronger evidence base for policy formulation and decision-making processes. Hence, this will deepen the understanding of the trade behavior patterns and specific implications of accreditation across sectors.

Nonetheless, this study comes with limited scopes on providing proof to emphasize the influenced behavior of data. It is important to consider some factors that can be used in determining the effect of accreditation and evidence of commitment to mutual recognition arrangement to international trade.

To address these considerations, future research should take into account the complexity of technology and products, as accreditation alone is heterogenous (Blind et al., 2018). It is important to consider the information such as the relative and fixed costs associated with seeking and maintaining the accreditation, the effectiveness of the country's national quality infrastructure, and the cost-benefit analysis of businesses involved (Clougherty and Grajek, 2014). By incorporating these factors, researchers can gain a better understanding of the heterogeneity issue and provide more robust findings. Also, this study should account for the market structure dynamics, including industry shake-out and evolving supply chains, considering that accreditation is a relatively new development to understand better the implications of accreditation on trade behavior and market conditions.

By considering these recommendations and conducting thorough analysis, future research can contribute to a more comprehensive understanding of the

relationship between accreditation, trade behavior patterns, and policy formulation. These understandings are vital for policymakers and stakeholders in making informed decisions and stimulate sustainable economic growth.

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