Institutions and Economies
Vol. 14, No. 3, July 2022, pp. 53-86 https://doi.org/10.22452/IJIE.vol14no3.3

Non-Tariff Measures in the Food Processing Sector in Malaysia: An Assessment of Welfare Impacts

Vickie Yew Siew Hoon[a], Abul Quasem Al-Amin[b] and Evelyn S. Devadason[c]

Abstract: *Given the ambiguity of the overall welfare effects of non-tariff measures (NTMs), this paper furthers our understanding of the well-being of consumers by focusing on a single sector analysis. It examines the welfare effects associated with the highly regulated food processing sector in Malaysia. A comparative static computable general equilibrium model is employed to quantify the welfare impacts of a partial removal of NTMs, or a reduction in trade restrictiveness of NTMs. The simulation results indicate welfare gains, albeit minimal (not more than 2%), from a partial reduction in NTMs, both in the short run and long run. A plausible reason for the somewhat small gains in welfare in the food sector is the dominance of standard-like measures relative to price or quantity-based regulations. The positive and small welfare effects from a partial removal of NTMs suggest that some regulations in the food processing sector may be pervasive in that they may embed some protectionist elements and/or they do not address genuine market failures. Therefore, this paper concludes that there is still scope for regulatory reform in the food processing sector in Malaysia.*

Keywords: Non-tariff measures; Food processing; Welfare; Computable general equilibrium model; Malaysia.
JEL Classification: F10, F14, D58

[a] Corresponding author. HELP Academy, Department of University of London International Programmes, Wisma HELP, Jalan Dungun, Damansara Heights, 50490 Kuala Lumpur Malaysia. *Email: vickie.yew@help.edu.my*

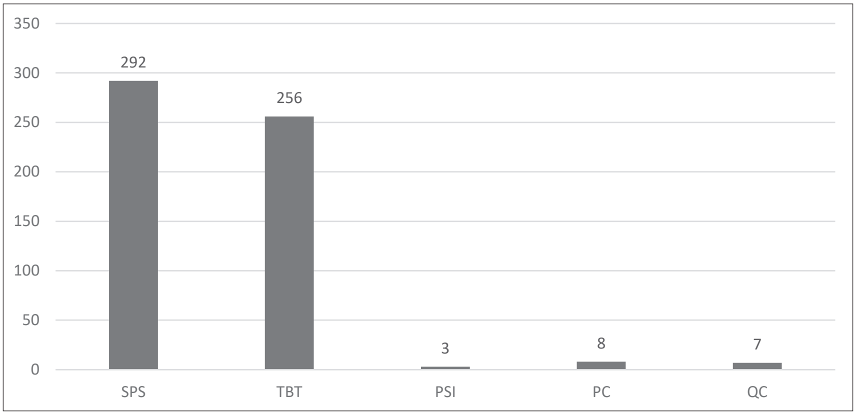
[b] Department of Geography & Environmental Management, rm. EV1-330, Faculty of Environment, University of Waterloo, Canada; and Department of Development Studies, Daffodil International University, Bangladesh. *Email: aqalamin@uwaterloo.ca*, Orcid ID: 0000-0002-6097-1197.

[c] Department of Economics and Applied Statistics, Faculty of Business and Economics, University of Malaya, Lembah Pantai, 50603 Kuala Lumpur, Malaysia. *Email: evelyns@um.edu.my*, Orcid ID: 0000-0003-0697-0190.

Introduction

Global trade in food is highly regulated using non-tariff measures (NTMs). Malaysia is also increasingly reliant on NTMs in food imports because of the pervasive issue of food safety. Approximately 63% of import-related NTMs in Malaysia are found in the food sector (ERIA-UNCTAD, 2017). Technical measures or standard-like measures,[1] which include sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBTs), dominate this sector. SPS and TBTs constitute 52% (292 measures) and 45% (252 measures) of total import measures in food processing, respectively (see Figure 1).

Figure 1: Incidence of NTMs in Food Processing



Notes: SPS – sanitary and phytosanitary; TBT – technical barrier to trade; PSI pre-shipment inspection; PC – price control; QC – quantity control. Refer to Appendix C for the 11 sub-sectors of food processing.
Source: NTMs are calculated from ERIA-UNCTAD database (2017).

The high incidence of standard-like measures in the Malaysian food processing sector is not surprising for the following two reasons: First, SPS, by definition, applies to food. Second, SPS and TBTs measures in the food sector are applied to the whole supply chain from the production process to trade and to the handling of food. Within both categories of SPS and TBTs, there is also a high concentration of specific regulations or requirements for importing food. For example, most of the SPS measures are for controlling the use of some ingredients in foods and feed and their contact materials, and for labelling requirements. Similarly, most of the TBTs found in food processing are for quality of product or performance requirements, followed by requirements of labelling and packaging.

Though NTMs are generally used for legitimate reasons such as health, safety and quality, there could be some NTMs that serve as "hidden" barriers to trade, more so in the case of the food sector in Malaysia, which is highly import intensive (particularly for sub-sectors such as meat, grain mills, dairy products, vegetables and fruits, and animal feeds), dominated by small and medium-sized enterprises (SMEs) (MIDA, 2018), and where standard-like measures abound. It can therefore be argued that this sector may plausibly be over-regulated, or alternatively, the measures may be poorly designed and administered, thereby rendering them trade restrictive. In that case, a reduction of NTMs may be needed to facilitate trade.

That said, the argument for reducing NTMs in highly regulated sectors, such as food processing, is not compelling if the welfare effects are not considered, since trade effects of NTMs *per se* fail to provide a complete understanding of the well-being of consumers. Some NTMs may restrict trade but in fact improve welfare if they address market failures in that sector (Beghin et al., 2012). As such, the trade and welfare effects of NTMs do not necessarily carry the same sign. Hence, insights from the welfare analysis are critical inputs for the regulatory reform process.

Given the ambiguity (protectionist versus pro-competitive) of the overall welfare effects of NTMs, a single-sector case analysis is justified since NTMs relate to the design and the implementation of the regulation, which is not just country- but sector specific. Moreover, NTMs, particularly SPS and TBT measures that dominate the food processing sector, are often presented as a package (with conformity assessments and specific procedures of compliance) and not as single stand-alone measures. It has already been sufficiently acknowledged in the Association of Southeast Asian Nations (ASEAN) that obstacles lie in the compliance procedures of NTMs (see UNCTAD, 2009; ITC 2014; 2016a; 2016b; 2017), which include regulation related administrative burdens, lack of transparency of information, discriminating behaviour of officials, delays and informal or unusually high payment for getting approvals, lack of sector-specific facilities (for example testing and storage) and lack of recognition/accreditation, among others.

This paper, therefore, assesses the welfare impacts of a reduction of NTMs in the highly regulated food processing sector in Malaysia. The study focuses on the welfare of households, a topic that is under-researched in the national context despite the growing prominence of NTMs[2] (Ha and Rosenow, 2019). Specifically, the paper extends the methodology used in previous research on the labour market (employment and wage) effects of NTMs in food processing in Malaysia (Yew et al., 2020a) to focus on the welfare objective, which is considered broader and more important, as it embraces far more than purely economic issues. Hence, this paper contributes to the empirical literature on the welfare impacts of import-related NTMs in two ways: First, it takes Malaysia, a country in the ASEAN region where many NTMs are considered to function as protection of domestic producers from competition from imports (Vanzetti et al., 2018). Second, it adopts a sectoral focus on food processing, which is import intensive and evidenced to be the most highly regulated sector in Malaysia (Devadason et al., 2019).

The paper proceeds as follows. Section 2 presents the theoretical underpinnings of the welfare effects of NTMs based on previous findings. This is followed by a description of the static computable general equilibrium (CGE) modelling approach and the data assembled for the analysis, in Section 3. Section 4 reports and discusses the results. Section 5 concludes.

Theoretical Considerations

According to economic theory, the effect of NTMs on welfare is ambiguous. In the presence of informational asymmetries or negative externalities, some NTMs can improve welfare (Disdier and Marette, 2010; WTO, 2012; Doan and Zhang, 2022). Alternatively, some NTMs may cause welfare losses (Ganslandt and Markusen, 2001; Treichel et al., 2012). A positive or negative welfare effect will depend on how NTMs address or correct market failure, the types of NTMs employed (Santeramo and Lamonaca, 2019; Disdier and Fugazza, 2020), and other market-specific conditions (Li and Beghin, 2012; Hoekman and Nichita, 2011).

NTMs that are mainly designed to protect domestic producers (discriminatory NTMs) instead of addressing market failures can bring a negative impact on trade and welfare in the importing country. Swinnen

(2017) relates welfare losses to food standards that create rent redistribution between consumers and producers. Likewise, Beghin et al. (2012) and Pienaar (2005) confirm that welfare tends to increase when NTMs are reduced, though the latter qualifies that the effects on trade could still be somewhat ambiguous. On the other hand, Fugazza and Maur (2008) and Xiong and Beghin (2014) argue that NTMs can have a positive impact on welfare if they address market imperfections or correct market failures (see also Beghin et al., 2012) caused by information asymmetry and negative externalities. NTMs in that context can resolve uncertainties or the lack of transparency about the quality or safety of imported products, which then enhances consumer confidence (or trust) and boosts demand. For example, Pienaar's (2005) study shows that NTMs in the form of labelling requirements on imported goods improved the welfare of the importing country as they provided the necessary product information to consumers and reduced transaction costs (see also Maertens and Swinnen, 2009a; 2009b).

The empirical literature on NTMs provides contrasting and heterogeneous evidence, with some studies supporting the welfare loss view, and others favouring the welfare gains explanation. The impact of NTMs on welfare, as per theory, is assumed to be distributed through several channels. First, since NTMs contribute to an increase in price (Treichel et al., 2012), the removal of some NTMs will result in a reduction in prices, particularly for food products that are considered as necessities and important to consumer spending. Cheaper imports contribute to an increase in imports and influence domestic production, especially for those sub-sectors of food that are dependent on imported inputs. Competition in the domestic market increases because of rising imports, which further depresses prices. Consumption increases because of cheaper domestic and foreign goods as NTMs in the food sector do not discriminate between foreign and domestic producers. Thus, the purchasing power and real incomes of consumers increase, leading to overall welfare gains. Second, lower compliance costs from a reduction in NTMs contribute to an increase in domestic production and exports. Then follows increases in labour demand, factor prices (including wages) that will induce the reallocation of factors of production across sectors. Higher wages and lower product prices improve welfare. The gains contributed by improvements in allocative efficiency reduce economic distortions (Fujii and Ando, 2002; Andriamananjara et al., 2004; Beghin et al., 2012). Andriamananjara et al. (2004) stress that welfare gains imply that the allocative efficiency impact of a reduction of NTMs offsets any unfavorable terms of trade impact.

The price channel through which NTMs influence welfare is verified in several studies. The price effects of NTMs are found to be generally very large – up to 190% for the wearing apparel sector in Japan, and the bovine meat sector in China – in the study by Andriamanajara et al. (2004), based on an applied general equilibrium (AGE) model. The price effects of wearing apparel in the European Union (EU) were evidently less, but still substantial at 60%. Global welfare gains from the removal of NTMs were estimated at US$90 billion. Vanzetti et al. (2018) suggest that the net welfare in ASEAN countries would increase by the order of US$3 billion if harmonizing of technical NTMs and the elimination of non-technical NTMs were fully applied to intra-ASEAN trade only. Such gains were estimated to increase to US$12 billion if technical measures on non-ASEAN imports were further reformed. About US$18 billion of gains would be achieved if ASEAN technical measures could be matched to international levels, allowing ASEAN exporters access to the European, American, and Japanese markets.

Other studies examining the price impacts of NTMs focused on a single country. For example, estimates from the study by Chemingui and Dessus (2008) indicate that NTMs increased the domestic price of imported goods in Syria by an average of 17% based on a comparison of world and domestic prices using a CGE model. Their results also show that a complete removal of NTMs would result in the reallocation of gains. Cadot and Gourdon (2014) find NTMs raised trade unit values by 8% for half of the products analysed at the 6-digit level of the harmonised system (HS) in Africa – 3% for SPS measures and 5% for TBTs. But there is an offsetting factor in the form of deep integration clauses – a product of the mutual recognition of conformity assessment procedures. As a result, the price-raising effect of NTMs is offset by around one quarter.

Fugazza and Maur (2008) instead provide a useful summary of the various means by which costs created by NTMs, for example fixed costs (see Itakura, 2019), are modelled. They note that Hertel et al. (2001) first introduced an efficiency-shock variable, which simulated the impact of a lowering of non-tariff trade costs in the Japan-Singapore free trade agreement (FTA). A US$9 billion annual welfare gain was produced, largely derived through the trade facilitation component. Fox et al. (2003) and

Walkenhorst and Yasui (2005) model the direct and indirect transaction costs from a lack of trade facilitation. The modelling assumed direct transaction cost as an import tax, which produces a transfer of rent between importers and domestic agents, while indirect transaction cost represents efficiency losses. The results by Walkenhorst and Yasui (2005) reveal substantial welfare gains of around US$40 billion (80% of which is derived from the efficiency gain effects). Francois et al. (2013) simulate the impact of improvements in trade logistics using a trade efficiency cost approach. Their result indicates that income effects related to trade facilitation reform could account for 0.2% of gross domestic product (GDP) and two-fifths of the overall impact on reform.

Despite the differences in the modelling techniques (cost-benefit analysis; gravity model and partial equilibrium model and CGE; see Disdier and Fugazza, 2020) of the price and cost effects of NTMs, some studies conclude that the net effect of NTMs on welfare will ultimately depend on the size of the gain in utility (increase in consumer trust or confidence) compared to the size of the reduction in consumption expenditures (higher equilibrium price) (Crivelli and Gröschl, 2016; Swinnen, 2016).

Though the literature suggests that the welfare effects of NTMs are contextual, in that they depend on whether the NTMs address externalities and if they are properly designed, most of these studies are cross-country or country based. There is a shortage of studies on the *sectoral* welfare impacts of NTMs to address the concerns of welfare reducing NTMs and provide targeted policy recommendations. In the case of Malaysia, one such study for the transport sector is by Lau (2020), but the focus was on the welfare impacts of non-tariff barriers (NTBs), and not NTMs. With a special focus on NTMs in food processing, a sector with the highest incidence of NTMs in Malaysia, this study contributes to the contemporary debate on the welfare-reducing effects of NTMs and recommendations for regulatory reform.

3. Methodology

The study applies the I-O, SAM and CGE model for assessing the welfare impact of NTMs, and the details of the approach are elaborated in the following sub-sections.

3.1 Construction of social accounting matrix

The SAM is constructed based on multiple sources (national income statistics, household income and expenditure statistics; see Section 3.3), including the I-O table. The SAM, which is broader than the I-O table, is developed for Malaysia using 2010 prices as the base. The SAM 2010 is chosen to calibrate the CGE model instead of the SAM 2014 as the latter does not disaggregate the food processing sector into the 11 sub-sectors, as listed in Appendix C.

The I-O table for 2010 comprises 124 production sectors, of which 12 sectors are classified as agriculture, 76 sectors as manufacturing, four sectors belong to mining and quarrying, and the remaining 32 sectors are classified as services. To stay relevant to the focus of the study, which is on the processed food sub-sectors, the 124 sectors are reclassified into 15 sectors (11 food processing sub-sectors; agriculture; mining and quarrying; and services; and other manufacturing) as described in Appendix B.

The final model therefore constitutes 15 sectors (11 subsectors of processed food - meat and meat production, seafood, vegetables and fruits, dairy products, oils and fats, grain mills, bakery products, confectionary, other processed food, animal feeds, and beverages), three institutional agents, two primary factors of production (labour and capital), and the rest of the world (ROW).

3.2 CGE model

The study adopts a comparative static CGE model (see also Yew et al., 2020a) to quantify the welfare impact of NTMs. The model, which follows the general structure and specification of Löfgren et al. (2001) and Robinson (1989), has four blocks of equations: price system, production, institution, and system constraints (see Appendix A for the detailed description of the model). We begin with reviewing the basic characteristics of the CGE model, explaining how to incorporate NTMs into the CGE model, the welfare measurement, and a description of the data.

The functioning of a market economy, combining the behaviour of microeconomic agents with closure rules of macroeconomic aggregates, are simulated in the model. At equilibrium prices, the agents, which are the profit-maximising producers and utility-maximising households, come together at factor and product markets respectively. Producers, more specifically, are assumed to be operating under the constant elasticity of substitution (CES) functions. The production technology allows for the substitution between production factors and is governed by relative factor prices, while the intermediate input use is determined by fixed I-O coefficients in the Leontief (1936) functions. The flexibility in choosing different elasticities of factor substitution is allowed once this CES production function is employed (Partridge and Rickman, 1998) (see production block in Appendix A).

Trade with the ROW is based on relative prices of exports and imports. The CES and constant elasticity of transformation (CET) functions are used to model trade flows as per the Armington assumption. The substitution between imports and domestic commodities is determined by a CES Armington function. Producers, in turn, take the decision to export based on a CET function. Given that Malaysia is a small-sized country, it is assumed to be a price taker in the world economy. Thus, the model treats import price as an exogenous variable.

To incorporate the NTMs into the CGE model, a new parameter m_c is added into equation (1) as an ad-valorem equivalent (AVE),[3] derived from the estimation by Kee et al. (2009).

$$PM_c = (1 + tm_c + m_c).\ EXR\ .pwm_c \tag{1}$$

Equation (1) expresses the import price (PM_c) as the domestic price of imports paid by domestic consumers for imported goods (exclusive of sales tax). The domestic price of imports is taken to depend on the world price of import (pwm_c), import tariffs (tm_c), AVE of tariffs (m_c)[4] and exchange rates (*EXR*). The model uses one equation for each imported good. The distinction between variables and parameters is made by the notational principles. In equation (1), the exchange rates and domestic prices are flexible, while the world price of imports and tariffs are taken as fixed (small country assumption). Since the share of Malaysia in world trade is small, it faces an infinitely elastic supply schedule at the world price. NTMs generate a difference between the domestic and world prices as the imposition of NTMs directly affects the domestic price of the imported goods. Therefore, the most appropriate way to model NTMs is as a tariff equivalent[5] (Andriamananjara et al. 2003).

This study compares the impact of NTMs reduction on welfare using the initial price vector. Thus, the Hicksian equivalent variation (EV) is chosen to measure the household welfare impact of a partial removal of NTMs in the food processing sector. The EV estimates the amount of income that would have to be taken away from (or given to) the economy to leave it as well off as before the policy change. In other words, it determines how much of the income (*I*) must compensate a consumer to forgo the policy change. Following Xie (1995), the utility function (*U*) is also added to investigate the welfare level of households (h) in the model. The utility function, which measures the welfare of consumers as a function of consumption, is expressed in equation (2).

$$U_h = \sum_i hhcles_{i,h} . \log(THCON_h) \tag{2}$$

where

U_h	= utility function for households
$THCON_h$	= total household consumption
$Hhcless_{i,h}$	= household consumption shares

In the model, the prices of all commodities are fixed at unity. Therefore, the Hicksian EV measures a welfare change because of a change in the total utility, as shown below:

$$EV_h = \frac{U_h^1 - U_h^0}{U_h^0} . I_h \tag{3}$$

This study assumes that the supplies of labour and capital are fixed. In other words, the endogenous total supply of the factor simply records the level of total employment. There are two factor market closures to reflect the case in the short run and long run. Factor market closure assumes that capital is fixed, and labour can freely move between sectors in the short run. Unemployment does not occur. In the long run, factors of production (capital and labour) are fully mobile (both in overall value and between sectors).

The model and equations above are set out in the general algebraic modelling system (GAMS) language – used to solve linear, nonlinear, and mixed-integer types of equations – and CONOPT, is the solver that is adopted for this study. Based on this modelling system, this study simulates the short-run and long-run welfare impact of a proposed NTM (or tariff equivalent) cut on the import side. Since NTMs in the Malaysian food processing sector do not discriminate between foreign and local producers, their reduction is expected to affect not just import prices but also domestic prices.

Considering the potential positive impact of NTMs (expressed as tariff equivalents) that serve public policy objectives, such as the protection of human health, this study is confined only to a partial (and not complete) removal of NTMs. A partial removal of NTMs therefore more aptly reflects a reduction in trade restrictiveness of NTMs rather than a reduction in the number of NTMs *per se*. Accordingly, we assume that AVEs of NTMs are cut by 10% or 50% in all food processing sub-sectors. The assumption is also in line with the Malaysian government's efforts to reduce compliance costs (Malaysia Productivity Corporation [MPC], 2018) and ASEAN's targeted 10% reduction in trade transaction costs (Damodaran, 2017). Three scenarios are introduced in this study to analyse the impact of a partial reduction in NTMs: Baseline scenario (BS) – considers no policy changes; the economy will continue following the existing trends; Modest scenario (MS) – assumes a 10% reduction of NTMs in the food processing sector. Ambitious scenario (AS) – assumes a 50% reduction of NTMs in the food processing sector. The results are presented as a cumulative percentage change between the baseline and the counterfactual simulations (MS or AS).

3.3 Data

To ensure a consistent and comprehensive data set for the development of the SAM, an earlier 2010 I-O table, published by the Department of Statistics (DOS, 2015), Malaysia, is used instead of the later 2015 version. The model equations in the preceding section are therefore calibrated to the values of a 2010 SAM. In constructing the SAM for 2010, the study also employs additional national-level data sourced from the DOS and the Ministry of Finance (MOF). The data include the national account statistics and balance of payments, government expenditure and revenue statistics, and (unpublished) disaggregated data on employment and wages by occupation from the *Industrial Survey* and the *Labor Force Survey* (DOS, 2010).

Next, the HS6-digit codes are identified for the 11 processed food sub-sectors that are included in the SAM (see Appendix C). For that purpose, a table of concordance was established between the Malaysia Standard Industrial Classification (2008) (or MSIC 2008) and the HS trade classification. The study then uses the estimated AVEs of NTMs by Kee et al. (2008, 2009[6]) to compute the AVEs for the benchmark dataset of the CGE model. The AVEs for the 423 HS6-digit product codes listed in Appendix C, compiled from Kee's dataset, are averaged over the 11 sub-sectors of processed food. It is worth noting here that the AVEs of NTMs (not reported here) show substantial variation across the 11 sub-sectors, implying a complex protection structure for food processing. The AVEs in the sub-sectors with the highest incidence of SPS and TBTs (other processed food, beverages, and vegetables and fruits) are found to be much smaller than that for sub-sectors with a relatively lower incidence of regulations.

It can therefore be inferred that the incidence of NTMs is not a reflection of trade restrictiveness. More importantly, the varying restrictive or protective effects of NTMs by sub-sectors of food processing justify the empirical analysis of the overall welfare effects of this sector.

3.4 Limitations of study

The are several limitations of the study that are worth recognizing. The first limitation relates to the use of AVEs to quantity NTMs, in this case as a tariff equivalent. For this study, we have employed the country and product specific AVEs of Kee et al. (2009). AVEs provide an estimate of the overall effect of NTMs which cannot be decomposed by measure. Notwithstanding that, since 97% of the NTMs in food processing is that of SPS and TBTs, some inferences can still be drawn on the welfare effects of a partial removal of standard-like measures. The lack of a decomposition of NTM types however does not detract us from the main objective of the paper, which is to examine the *sectoral* welfare effects of NTMs in food processing.

Second, the CGE model is heavily based on assumptions. Nevertheless, it is useful for simulations purposes like that of this study, which is to simulate the impacts on welfare when there are policy changes (reduction in trade restrictiveness of NTMs). The simulation results should not be viewed as a prediction, but as an estimate of the strength and direction of the change (welfare gain or loss) in the situation, *ceteris paribus*.

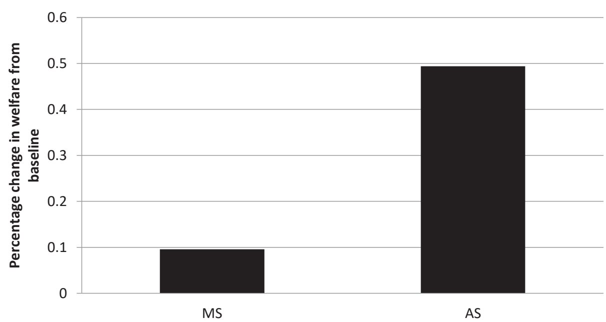
4. Results of Simulation

4.1 Impact on welfare

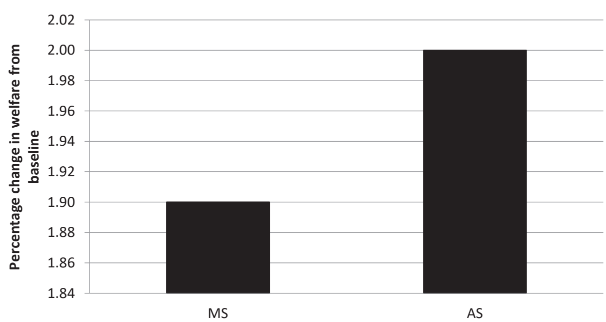
The changes in welfare in the short run and the long run under both the MS and AS scenarios are presented in Figure 2. The simulation results confirm that a partial removal of NTMs in the food processing sector leads to positive changes in welfare in both the short run and the long run under the MS and AS scenarios. The welfare impacts in the long run (about 2%) are, however, only marginally greater than that of the short run (less than 1%). Interestingly, the results indicate almost similar welfare gains under both the MS and AS scenarios.

Figure 2: Impact of Reduction of NTMs on Welfare

(a) Short run



(b) Long run



Notes: MS – modest scenario that assumes a 10% reduction of NTMs in the food processing sector. AS - ambitious scenario that assumes a 50% reduction of NTMs in the food processing sector.
Source: Simulation analysis.

A plausible reason for the gains (albeit small) in welfare in the food sector is the dominance of SPS and TBTs measures relative to price (subsidy) or quantity (quota) based[7] regulations (see Figure 1). Technical measures, though they often have non-trade policy objectives to correct market failures, can be somewhat restrictive if these regulations are associated with burdensome procedural requirements. Vanzetti et al. (2018) therefore confirm that welfare gains are highly likely from reducing technical measures (like SPS and TBTs) that come with price-raising effects. It is worth noting here that the results on higher welfare for Malaysia from cuts in NTMs are also confirmed in a recent study by Itakura (2019) based on his calibrated CGE model with heterogeneous firms. His model assumes the trade-restricting effects of NTMs' are indirectly captured by fixed costs, which ultimately deter market entry. Though this study did not consider the types of NTMs, our findings are still comparable with the arguments of Vanzetti et al. (2018) since the incidence of SPS and TBTs is highest in the Malaysian food sector (see Figure 1).

The welfare-enhancing effects of a reduction in NTMs in the food processing sector for a small and highly open economy like Malaysia, is not surprising, and is somewhat consistent with the arguments of Ganslandt and Markusen (2001), in that the *implementation* of NTMs rather than the NTMs *per se*, specifically, affects small countries, where both producers and consumers may lose. Following which, indiscriminate NTM elimination may not be the solution as the small gains in welfare may come at a high cost, especially when the NTMs address a public policy objective. Instead, regulatory reform may be key to addressing any trade restrictiveness of NTMs in the food processing sector.

Overall, the positive impact on the welfare of consumers corroborates previous evidence for Malaysia on gains from a reduction in NTMs in the food sector through other channels, namely employment, wages, production, and trade (exports and imports) (see Yew et al., 2020a; 2020b). It can therefore be concluded that in the food processing sector, positive gains are derived both in terms of trade and welfare with a partial removal of NTMs. That said, the welfare analysis of NTMs in this study is considered more comprehensive than that offered by the trade effects channel alone.

4.2 Sensitivity analysis

A sensitivity analysis has been performed to determine the robustness of the model results. The study simulates a 30% reduction and 30% increment from the elasticity parameters (Armington CES and CET functions) in the model. The results of the sensitivity analysis (Table 1) again show that the reduction of NTMs in the food processing sector increases overall welfare in both the short run and long run. The magnitude of the changes is slightly lower and higher following the simulation applied to the elasticity values. It can therefore be concluded that the model employed in this study provides stable estimates of changes in welfare.

Table 1: Sensitivity Analysis for the Impact on Welfare (% change from baseline)

Scenario	Short run			Long run		
	Original Assumption	CES and CET reduced by 30%	CES and CET increased by 30%	Original Assumption	CES and CET reduced by 30%	CES and CET increased by 30%
MS	0.09	0.08	0.10	1.90	1.88	1.91
AS	0.49	0.46	0.52	2.0	1.98	2.01

5. Conclusion and Policy Implications

This paper employs the EV to measure the change in welfare resulting from a partial removal of NTMs in the food processing sector. The results support welfare gains (albeit minimal) from a reduction in NTMs in both the short run and long run. Notwithstanding that, the overall welfare gains from cuts in NTMs (or rather the reduction in trade restrictiveness) in the food sector suggest that some measures may still be pervasive in that they may embed some protectionist elements and/or they do not address genuine market failures. Specifically, standard-like measures that are poorly designed or badly implemented can still increase uncertainty and trade restrictiveness and deter market entry. This could end up reducing trade and the potential welfare gains the NTMs were intended to achieve in the first place.

The positive welfare gains of a partial removal of NTMs from the import side suggest that there is scope to enhance welfare through the review of these measures. Namely, the conformity assessment procedures associated with NTM measures (SPS measures and TBTs) in Malaysia should be given due attention. Given that the ‘harm’ of the NTMs may not be visible when it is not directly related to the measure or requirement itself but originates from its application and the administration (involving implementation and enforcement), the government should move forward with reforming standard-like measures to get rid of the unnecessary burdens in the procedures of compliance. This can be done in two phases. Phase 1 should involve the mapping of the procedures of compliance for each food measure that comes under the purview of the related Ministries and government agencies. Phase 2 should follow-up with an engagement with the industry (related businesses or traders in the food processing sector) to identify the procedural obstacles associated with the regulation and compliance procedures. The information obtained from both stakeholders (government and industry) should then be used to validate the costs of compliance and the needed reforms in the NTMs. Some corrective action can be taken to simplify complex procedures associated with specific measures.

Acknowledgement

The work was supported by the Tun Ismail Ali Chair Research Grant (Grant No: GA010-2021).

Notes

[1] The term ‘standard-like’ is used to describe SPS and TBTs as they often take the form of standards to be met by imports as well as their domestic counterparts. SPS measures correspond to standards and procedures to protect human, animal and plant health from diseases, pests, toxins, and other contaminants. TBT features technical regulations, product standards, environmental regulations, labelling and other related measures that have bearings on human health and animal welfare.

[2] The total number of NTMs in Malaysia in 2018 was 920, the country with the fourth highest incidence of NTMs in the ASEAN region, after Thailand, the Philippines and Indonesia (Devadason et al., 2019)

[3] The AVE of an NTM is the uniform tariff that results in the same trade impacts on the import product due to the presence of the NTM.

[4] The WTO (2012) stresses that an NTM would have the same trade restricting effect as a traditional ad-valorem tariff.

[5] Since NTMs are expressed as a tariff equivalent in this study, the impacts of NTMs on trade are considered the same as trade restrictiveness. Importing countries must bear higher import prices when governments implement NTMs. When a liberalising country removes NTMs, the demand for imported goods will increase causing pre-tariff prices of imported goods to increase.

[6] Kee et al. (2009) interact NTM variables with country variables, making it possible to simulate country-specific AVEs based on country characteristics. They first estimate the quantity-impact of NTMs on imports and then turn to the transformation of quantity-impacts into price effects, using the import demand elasticities.

[7] Price and quantity controls in Malaysia are limited to dairy products, confectionery, and bakery products.

References

Andriamananjara, S., Ferrantino, M., & Tsingas, M. (2003). Alternative approaches in estimating the economic effects of non-tariff measures: Results from newly quantified measures. U.S International Trade Commission, Office of Economics Working Paper No.2003-12.C. Retrieved from: https://www.usitc.gov/publications/332/ec200312c.pdf

Andriamananjara, S., Dean, J., Feinberg, R., Ferrantino, M., Ludema, R., & Tsingas, M. (2004). The effects of non-tariff measures on prices, trade and welfare: CGE implementation of policy-based price comparisons. U.S International Trade Commission, Economics Working Paper No. 2044-04-A. Retrieved from: https://www.usitc.gov/publications/332/ec200404a.pdf

Beghin, J.C., Disdier, A.C., Marette, S., & Van Tongeren, F. (2012). Welfare costs and benefits of non-tariff measures in trade: a conceptual framework and application. *World Trade Review*, *11*(3), 356-375. doi.org/10.1017/S1474745612000201

Cadot, O., & Gourdon, J. (2014). Assessing the price-raising effect of non-tariff measures in Africa. *Journal of African Economies*, *23*(4), 425–463. doi.org/10.1093/jae/eju007

Chemingui, M.A., & Dessus, S. (2008). Assessing non-tariff barriers in Syria. *Journal of Policy Modeling*, *30*(5), 917–928. doi.org/10.1016/j.jpolmod.2007.03.003

Crivelli, P., & Gröschl, J. (2016). The impact of sanitary and phytosanitary measures on market entry and trade flows. *World Economy*, *39*(3), 444-473. doi.org/10.1111/twec.12283

Damodaran, R. (2017). M'sia continues to play active role in ASEAN non-tariff barriers issues. *New Straits Times*, 12 September. Retrieved from: https://www.nst.com.my/business/2017/09/279014/msia-continues-play-active-role-asean-non-tariff-barriers-issues (accessed 15 March 2019).

Department of Statistics (DOS) (2008). *Malaysia Standard Industrial Classification 2008*. Jabatan Perangkaan Malaysia: Kuala Lumpur, Malaysia.

DOS (2015). *Input-Output Tables*, 2010. Jabatan Perangkaan Malaysia: Kuala Lumpur, Malaysia.

DOS (2010). *Labour Force Survey Report*, 2010. Jabatan Perangkaan Malaysia: Kuala Lumpur, Malaysia.

Devadason, E.S., Govindaraju, VGR C., & Kam, A.J.Y. (2019). Non-tariff measures in Malaysia. In Ha, T.T.D., and Rosenow, S. (Eds.), *Non-Tariff Measures in ASEAN – An Update* (pp. 98-119), Economic Research Institute for ASEAN and East Asia (ERIA): Jakarta.

Disdier, A-C., & Marette, S. (2010). The combination of gravity and welfare approaches for evaluating non-tariff measures. *American Journal of Agricultural Economics*, *92*(3), 713-726. doi.org/10.1093/ajae/aaq026

Disdier, A-C., & Fugazza, M. (2020). *A Practical Guide to the Economic Analysis of Non-Tariff Measures*. UNCTAD: Geneva. doi.org/10.18356/b9cc8a8d-en

Doan, T.T.H., & Zhang, H. (2022). Technical barriers to trade, product quality and trade margins: Firm-level evidence. ERIA Discussion Paper No. 421. Retrieved from: https://www.eria.org/uploads/media/discussion-papers/FY21/Technical-Barriers-to-Trade%2C-Product-Quality%2C-and-Trade-Margins_Firm-level-Evidence.pdf

Economic Research Institute for ASEAN – United Nations Conference on Trade and Development (ERIA-UNCTAD) (2017). TRAINS: Non-Tariff

Measures (NTMs) based on official regulations. Retrieved from: http://asean.i-tip.org/?platform=hootsuite

Fox, A., Francois, J., & Londono-Kent, P. (2003). Measuring border costs and their impact. On trade flows: The United States–Mexican trucking case. Mimeo, Erasmus University, Netherlands. Retrieved from: https://pdfs.semanticscholar.org/a6ce/5a56e5633fea664ceb6045a9d2a419f10c9e.pdf

Francois, J., Berden, K., Tamminen, S., Thelleand, M., & Wymenga, P. (2013). Non-tariff measures in EU-US trade and investment: an economic analysis. IIDE Discussion Paper No. 20090806. Institute for International and Development Economics, Rotterdam. Retrieved from: https://www.gtap.agecon.purdue.edu/resources/download/5177.pdf

Fugazza, M., & Maur, J.C. (2008). Non-tariff barriers in CGE models: how useful for policy? *Journal of Policy Modeling*, *30*(3), 475–490. doi.org/10.1016/j.jpolmod.2007.10.001

Fujii, T., & Ando, M. (2002). Quantifying the economic impact of removing non-tariff measures: tariff equivalent approach. Paper presented at the 5th Conference on Global Economic Analysis: Sustainable Development and the General Equilibrium Approach, 5-7 June 2002, Taipei. Retrieved from: https://www.gtap.agecon.purdue.edu/resources/download/1054.pdf

Ganslandt, M., & Markusen, J.R. (2001). Standards and related regulations in international trade: a modelling approach. In Maskus, K.E. and Wilson, J.S. (Eds.), *Quantifying the Impact of Technical Barriers to Trade: Can it be Done?* (pp. 95-136). University of Michigan Press: Ann Harbor.

Ha, T.T.D., & Rosenow, S. (2019). *Non-Tariff Measures in ASEAN – An Update*. Economic Research Institute for ASEAN and East Asia (ERIA): Jakarta.

Hertel, T.W., Walmsley, T., & Itakura, K. (2001). Dynamic effects of the 'new age' free trade agreement between Japan and Singapore. *Journal of Economic Integration*, *16*(4), 446- 484. doi.org/10.11130/jei.2001.16.4.446

Hoekman, B., & Nicita, A. (2011). Trade policy, trade costs, and developing country trade. *World Development*, *39*(12), 2069-2079. doi.org/10.1016/j.worlddev.2011.05.013

Itakura, K. (2019). Impacts of NTMs on trade and welfare: A case study on ASEAN. In Ing, L.Y., Peters, R. and Cadot, O. (Eds.), *Regional*

Integration and Non-Tariff Measures in ASEAN (pp. 27-39), Economic Research Institute for ASEAN and East Asia (ERIA): Jakarta.

ITC (2014). *Cambodia: Company Perspectives – An ITC Series on Non-Tariff Measures*. International Trade Centre: Geneva.

ITC (2016a). *Indonesia: Company Perspectives – An ITC Series on Non-Tariff Measures*. International Trade Centre: Geneva.

ITC (2016b). *Thailand: Company Perspectives – An ITC Series on Non-Tariff Measures*. International Trade Centre: Geneva.

ITC (2017). *Nepal: Company Perspectives – An ITC Series on Non-Tariff Measures*. International Trade Centre: Geneva.

Kee, H.L., Nicita, A., & Olarreaga, M. (2008). Import demand elasticities and trade distortions. *Review of Economics and Statistics*, *90*(4), 666-682. doi.org/10.1162/rest.90.4.666

Kee, H.L., Nicita, A., & Olarreaga, M. (2009). Estimating trade restrictiveness indices. *Economic Journal*, *119*(534), 172-199. doi.org/10.1111/j.1468-0297.2008.02209.x

Lau, W.K.C. (2020). Welfare effects of trade barriers on Malaysian car industry: An alternative approach. Unpub. PhD thesis, Swinburne University of Technology, Australia. Retrieved from: https://researchbank.swinburne.edu.au/file/3ee17e7c-ee6a-4d3d-b54b-bb7a036a86c2/1/wai_kun_callie_lau_thesis.pdf

Leontief, W.W. (1936). Quantitative input and output relations in the economic systems of the United States. *Review of Economics and Statistics*, *18*, 105-125. doi.org/10.2307/1927837

Li, Y., & Beghin, J.C. (2012). A meta-analysis of estimates of the impact of technical barriers to trade. *Journal of Policy Modeling*, *34*(3), 497-511. doi.org/10.1016/j.jpolmod.2011.11.001

Löfgren, H., Harris, R. L., & Robinson, S. (2001), *A Standard Computable General Equilibrium (CGE) Model in GAMS*. International Food Policy Research Institute (IFPRI): Washington DC.

Maertens, M., & Swinnen, J. (2009a). Trade, standards and poverty: evidence from Senegal. *World Development*, *37*(1), 161-178. doi.org/10.1016/j.jpolmod.2007.10.001

Maertens, M., & Swinnen, J. (2009b). Food standards, trade and development. *Review of Business and Economics*, *54*(3), 313–326. doi.org/10.1142/9789813226470 0003

Malaysia Productivity Corporation (MPC) (2018). *Annual Report 2018*. MPC, Petaling Jaya. Retrieved from: http://www.mpc.gov.my/wp-content/uploads/2019/12/MPC-ANNUAL-REPORT-2018.pdf

Malaysian Investment Development Authority (MIDA) (2018). Food industry in Malaysia, Retrieved from: http://www.mida.gov.my/home/administrator/system_files/modules/photo/uploads/20180903103354_Food%20Industry%202018_V4.pdf

Partridge, M.D., & Rickman, D.S. (1998). Regional computable general equilibrium modeling: A survey and critical appraisal. *International Regional Science Review*, *21*(3), 205-248. doi.org/10.1177/016001769802100301

Pienaar, N. (2005). Economic applications of product quality regulation in WTO trade Agreements. Unpub. PhD thesis, Stockholm University, Stockholm, Sweden.

Robinson, S. (1989). Multisectoral models. In H. Chenery and T. N. Srinivasan (Eds.), *Handbook of Development Economics* (pp. 885-947), Vol. 2, Elsevier: United Kingdom.

Santeramo, F.G., & Lamonaca, E. (2019). The effects of non-tariff measures on agri-food trade: A review and meta-analysis of empirical evidence. *Journal of Agricultural Economics*, *70*(3), 595-617. doi.org/10.1111/1477-9552.12316

Swinnen, J. (2016). Economics and politics of food standards, trade, and development. *Agricultural Economics*, *47*(1), 7-19. doi.org/10.1111/agec.12316

Swinnen, J. (2017). Some dynamic aspects of food standards. *American Journal of Agricultural Economics*, *99*(2), 321-338. doi.org/10.1093/ajae/aax02

Treichel, V., Hoppe, M., Cadot, O., & Gourdon, J. (2012). Import bans in Nigeria increase Poverty. *Africa Trade Policy Note*, *28*, World Bank: Washington, DC.

UNCTAD (2009). N*on-tariff Measures: Evidence from Selected Developing Countries and Future Research Agenda*, United Nations Conference on Trade and Development: Geneva.

Vanzetti, D., Knebel, C., & Peters, R. (2018). Non-tariff measures and regional integration in ASEAN. Paper presented at the Twenty First Annual Conference on Global Economic Analysis, 13–15 June, Cartagena, Colombia Retrieved from: https://www.gtap.agecon.purdue.edu/resources/download/8863.pdf

Walkenhorst, P., & Yasui, T. (2005). Benefits of trade facilitation: A quantitative assessment. In Dee, P.S. and Ferrantino, M. (Eds.), *Quantitative Measures for Assessing the Effects of Non- Tariff Measures and Trade Facilitation* (pp. 161-192), World Scientific Publishing Inc.: River Edge, NJ. doi.org/10.1142/9789812701350_0009

World Trade Organisation (WTO) (2012). *Trade and Public Policies: A Closer Look at Non-Tariff Measures in the 21st Century*. WTO: Geneva.

Xie, J. (1995). Environmental policy analysis: an environmental computable general equilibrium model for China. Unpub. PhD thesis, Cornell University, Ithaca, New York.

Xiong, B., & Beghin, J. (2014). Disentangling demand-enhancing and trade-cost effects of maximum residue regulations. *Economic Inquiry*, *52*(3), 1190-1203. doi.org/10.1111/ecin.12082

Yew, V.S.H., Al-Amin, A.Q., & Devadason, E.S. (2020a). Labour market effects of non-tariff measures: A computable general equilibrium for the food processing sector in Malaysia. *Indian Journal of Labour Economics*, *63*(3), 629-656. doi.org/10.1007/s41027-020-00239-0

Yew, S.H., Al-Amin, A.Q., & Devadason, E.S. (2020b). Modelling economic effects of reducing non-tariff measures in the food processing sector of Malaysia using computable general equilibrium. *Malaysian Journal of Economic Studies*, *57*(2), 167-199. doi.org/10.22452/MJES.VOL57NO2.1

Appendix A: Description of the Model

(i) Price Block

Import price:

$$PM_c = (1 + tm_c + m_c).\ EXR\ .pwm_c \tag{A.1}$$

$$\begin{bmatrix} import\ price \\ (DCU) \end{bmatrix} = \begin{bmatrix} tariff\ and \\ AVEs\ of\ NTMs \\ adjustment \end{bmatrix} . \begin{bmatrix} exchange\ rate \\ (DCU\ per\ FCU \end{bmatrix} . \begin{bmatrix} import\ price \\ (foreign\ currency \end{bmatrix}$$

Equation A.1 shows that the domestic price of imports paid by domestic consumers for imported goods (exclusive of sales tax). It depends on the world price of import, import tariffs and AVE of tariffs and exchange rates.

Export price:

$$PE_{c=}(1 - te_c).\ EXR.pwe_c \tag{A.2}$$

$$\begin{bmatrix} export\ price \\ (DCU \end{bmatrix} = \begin{bmatrix} tariff \\ adjustment \end{bmatrix} . \begin{bmatrix} exchange\ rate \\ (DCU\ per\ FCU \end{bmatrix} . \begin{bmatrix} export\ price \\ (foreign\ currency \end{bmatrix}$$

Equation A.2 denotes the domestic price of export received by domestic producers. The domestic price of exports is determined by the export tax rate, exchange rate and the world price of exports.

Absorption price:

$$PQ_c\ .QQ_c = \ [(PD_c.QD_c) + (PM_c.QM_c)_{c \in CM}]\ .(1 + tq_c) \tag{A.3}$$

$$[absorption] = \begin{bmatrix} domestic\ sales\ price \\ times \\ domestic\ sales \\ quantity \end{bmatrix} + \begin{bmatrix} import\ price \\ times \\ import\ quantity \end{bmatrix} . \begin{bmatrix} sales\ tax \\ adjustment \end{bmatrix} c \in CE$$

Equation A.3 is an absorption price. It is expressed as the total spending on domestic output and imported goods at the domestic and import prices respectively, inclusive of the sale tax. The domestic and import prices exclude the commodity sales tax but include the cost of inputs traded. The absorption equation applies to all domestic and imported commodities, while those commodities that are completely exported are not included in the absorption equation.

Domestic output value:

$$PX_c\,.\;QX_c = PD_c.QD_c + \;(PE_c.QE_c) \tag{A.4}$$

$$\begin{bmatrix} \textit{producer price} \\ \textit{times} \\ \textit{domestic output quantity} \end{bmatrix} = \begin{bmatrix} \textit{domestic sales price} \\ \textit{times} \\ \textit{domestic sales qunatity} \end{bmatrix} + \begin{bmatrix} \textit{export price} \\ \textit{times} \\ \textit{export quantity} \end{bmatrix}$$

Equation A.4 is the domestic output value at producer prices. This equation states the total values of domestic sales and exports at producer prices. It includes domestically produced commodities, while excluding the value of the output consumed at home.

Activity price:

$$PA_a \;=\; \textstyle\sum_{c\in C} PX_c\,.\,\theta_{ac} \tag{A.5}$$

$$\begin{bmatrix} \textit{activity} \\ \textit{price} \end{bmatrix} = \begin{bmatrix} \textit{producer price} \\ \textit{times} \\ \textit{yields} \end{bmatrix}$$

The activity price is shown in equation A.5. The activity price is the gross revenue per activity unit. It can be defined as the yield per unit of activity multiplied by price of activity-specific commodity, which is further summed across all commodities

Value-added price:

$$PVA_a = \;PA_a - \textstyle\sum_{c\in C} PQ_c\,.\,ica_c \tag{A.6}$$

$$\begin{bmatrix} \textit{value} - \textit{added} \\ \textit{price} \end{bmatrix} = \begin{bmatrix} \textit{intermediate input cost} \\ \textit{per unit of aggregate} \\ \textit{intermediate input} \end{bmatrix} - \begin{bmatrix} \textit{input cost} \\ \textit{per activity unit} \end{bmatrix}$$

Equation A.6 indicates that the price of value added is the difference between an activity's revenue or cost and the price of intermediate goods.

Consumer price index:

$$\overline{CPI} = \quad \textstyle\sum_{c \in C} PQ_c \, . \, cwts_c \tag{A.7}$$

$$\begin{bmatrix} consumer \\ price\ index \end{bmatrix} = \begin{bmatrix} price\ times \\ weighs \end{bmatrix}$$

Equation A.7 is the consumer price index. It acts as *numẽraire* in domestically marketed output. Thus, it is treated as an exogenous variable.

(ii) Production Block

Activity production function:

$$QA_a = \sigma_a \textstyle\prod_f F_a . QF_f^{\alpha_f} \tag{A.8}$$

$$\begin{bmatrix} activity \\ level \end{bmatrix} = f \begin{bmatrix} factor \\ inputs \end{bmatrix}$$

Equation A.8 shows the production function used in the model to quantify the activity level. The model employed the CES production function to show the linkage between activity levels. Each activity uses the combination of value added and intermediate inputs to produce output.

Factor demand:

$$WF_f * WFDIST_{fa} = \propto_{fa} * PVA_a \left(\frac{QA_a}{QF_{fa}}\right) \tag{A.9}$$

$$\begin{bmatrix} marginal\ cost \\ of\ factor\ f \\ in\ activity\ a \end{bmatrix} = \begin{bmatrix} marginal\ revenue \\ product\ of\ factor \\ f\ in\ activity\ a \end{bmatrix}$$

Equation A.9 gives the factor demand. The demand for factors is determined at the level where the marginal revenue equals marginal cost per factor.

Intermediate demand:

$$QINT_{ca} = ica_{ca} * QA_a \tag{A.10}$$

$$\begin{bmatrix} intermediate \\ demand \end{bmatrix} = f \begin{bmatrix} activity \\ level \end{bmatrix}$$

Equation A.10 gives the framework of the intermediate input calculation. Intermediate demand for each activity is determined via a standard Leontief formulation.

Output function:

$$QX_c = \sum_a \theta_{ac} * QA_a \tag{A.11}$$

$$\begin{bmatrix} domestic \\ output \end{bmatrix} = f \begin{bmatrix} activity \\ level \end{bmatrix}$$

Equation A.11 represents production of commodities with a certain level of activity. The right side of this equation shows the sum of production quantities, while the variable on the left represents output produced domestically.

Composite supply (Armington) function:

$$QQ_c = \propto_c^q . \left(\delta_c^q . QM_c^{-\rho_c^q} + \left(1 - \delta_c^q\right) . QD_c^{-\rho_c^q}\right)^{\frac{1}{-\rho_c^q}} \tag{A.12}$$

$$\begin{bmatrix} composite \\ supply \end{bmatrix} = f \begin{bmatrix} import\ quantity, \\ domestic\ use\ of \\ domestic\ output \end{bmatrix}$$

Composite supply is the combination of domestically produced and imported goods (entered as inputs in the production process). It is captured by a CES aggregation function as shown in equation A.12. This function shows the imperfect substitutability between imported and domestically sold output.

Import-domestic demand ratio:

$$\frac{QM_c}{QD_c} = \left[\frac{PD_c}{PM_c} . \frac{\delta_c^q}{1 - \delta_c^q}\right]^{\frac{1}{1+\rho_c^q}} \tag{A.13}$$

$$\begin{bmatrix} import - \\ domestic \\ demand\ ratio \end{bmatrix} = f \begin{bmatrix} domestic - \\ import \\ price\ ratio \end{bmatrix}$$

Equation A.13 indicates the import-domestic demand ratio. It shows the optimal between domestic and imported output in the case of export and domestic sales.

Composite supply for non-imported commodities:

$$QQ_c = QD_c \tag{A.14}$$

$$\begin{bmatrix} composite \\ supply \end{bmatrix} = \begin{bmatrix} domestic\ use\ of \\ domestic\ output \end{bmatrix}$$

Equation A.14 gives the quantity of the commodity that is produced and sold domestically, where there are no imports involved at any stage of production or sale.

Output transformation (CET) function:

$$QX_c = \alpha_c\left[\delta_c . QE_c^{\rho c} + (1 - \delta_c)QD_c^{\rho c}\right]^{\frac{1}{\rho_c}} \tag{A.15}$$

$$\begin{bmatrix} domestic \\ output \end{bmatrix} = f\begin{bmatrix} export\ quantity, \\ domestic\ use \\ of \\ domestic\ output \end{bmatrix}$$

Domestically produced commodities are sold on domestic and international markets (exports). The output transformation function is used to split domestic production into two segments, which involves a transformability assumption between the destinations, as shown in equation A.15.

Export-domestic supply ratio:

$$\frac{QE_C}{QD_C} = \left[\frac{PE_C}{PD_C} . \frac{1-\delta_C}{\delta_C}\right]^{\frac{1}{\rho_{C-1}}} \tag{A.16}$$

$$\begin{bmatrix} export - \\ domestic \\ supply\ ratio \end{bmatrix} = f\begin{bmatrix} export - \\ domestic \\ price\ ratio \end{bmatrix}$$

Equation A.16 indicates that the ratio of exports to domestic supply provides an optimal mix of commodity supply between two destinations, i.e., exports and domestic sales.

Output transformation for non-exported commodities:

$$QX_c = QD_c \tag{A.17}$$

$$\begin{bmatrix} domestic \\ output \end{bmatrix} = \begin{bmatrix} domestic\ sales\ of \\ domestic\ output \end{bmatrix}$$

In some cases, output is either used domestically or fully exported. Hence, equation A.17 provides the framework for non-exported commodities that are domestically consumed.

(iii) Institution Block

Factor income:

$$YF_f \quad = \quad shry_{\ hf} \textstyle\sum_{\alpha \in A} WF_f \, . \, WFDIST_{fa} \, . \, QF_{fa} \tag{A.18}$$

$$[\,factor\ income] = \begin{bmatrix} income\ share\ to \\ household\ h \end{bmatrix} . [factor\ income]$$

Total income of each factor of production is defined in equation A.18. This equation includes factor market distortion ($WFDIST_{fa}$) to capture all the income obtained from different markets. It also shows the sum of all factors of production income in the economy.

Household income:

$$YH_h = \ \textstyle\sum_{f \in F} YF_{hf} + \ tr_{h,gov} + EXR.\, tr_{h,ROW} \tag{A.19}$$

$$\begin{bmatrix} household\ income \\ from\ factor\ f \end{bmatrix} = \begin{bmatrix} factor \\ incomes \end{bmatrix} + \begin{bmatrix} transfer\ from\ government \\ \\ rest\ of\ world \end{bmatrix}$$

Equation A.19 is the total income received by households. It is the summation of the income received from a factor of production and the transfer payments by other institutions.

Household consumption demand:

$$QH_{ch} = \frac{\beta_{ch}.(1 - mps_h).(1 - ty_h).YH_h}{PQ_c} \tag{A.20}$$

$$\begin{bmatrix} household\ demand \\ for\ commodity\ c \end{bmatrix} = f\begin{bmatrix} \text{household income,} \\ \text{composite price} \end{bmatrix}$$

The level of income determines the consumption of households. The right-hand side terms of equation A.20 are divided by the composite commodity price, *PQ*, to make the demand function explicit.

Investment demand:

$$QINV_c = \overline{qinv}_c . IADJ \tag{A.21}$$

$$\begin{bmatrix} investment\ demand \\ for\ commodity\ c \end{bmatrix} = \begin{bmatrix} based\ year\ investment \\ times\ adjustment\ factor \end{bmatrix}$$

Equation A.21 indicates investment demand. Investment demand is the product of base year investment quantity and the adjustment factor. The adjustment factor is exogenous, thus the investment quantity is also exogenous.

Government revenue:

$$\begin{aligned} YG &= \textstyle\sum_f YH_{ht} * ty_h + EXR * tr_{Gov,Row} + \sum_{c\in CM}(tq_c * PQ_c * QD_c) + (PM_c * QM_c) \\ &+ \textstyle\sum_{c\epsilon CM} tm_c * EXR * pwm * QM_c + \sum_{c\epsilon CE} te_c * EXR * pwe_c * QE_c \\ &+ \textstyle\sum_{c\epsilon CM} m_c * EXR * pwm_c + yg_i \end{aligned} \tag{A.22}$$

$$\begin{bmatrix} government \\ revenue \end{bmatrix} = \begin{bmatrix} direct\ taxes \\ from \\ institutions \end{bmatrix} + \begin{bmatrix} transfer \\ from \\ ROW \end{bmatrix} + \begin{bmatrix} sales \\ tax \end{bmatrix} + \begin{bmatrix} import \\ tariffs \end{bmatrix} + \begin{bmatrix} export \\ taxes \end{bmatrix} + \begin{bmatrix} AVEs \\ of \\ NTMs \end{bmatrix}$$

Equation A.22 shows the sum of income/revenue received by the government through various sources – direct taxes on households, import tariffs on the commodities that enter the country, foreign aid, or any other transfers to the government. As AVEs of NTMs are treated as tariff equivalents, they also generate revenue for governments.

Government Expenditure:

$$EG \quad = \sum_c PQ_c \,.\, QG_c + \sum_h tr_{h,GOV} \tag{A.23}$$

$$\begin{bmatrix} government \\ expenditure \end{bmatrix} = \begin{bmatrix} governmet \\ consumption \end{bmatrix} + \begin{bmatrix} household \\ transfer \end{bmatrix}$$

Government expenditure is defined as the sum of total government spending and transfer payments, as shown in the equation A.23.

Real gross domestic product:

$$RGDP \quad = \sum_c (\sum_h QH_{ch} + QG_c + QINV_c) + \sum_c QE_c - \sum_c QM_c \tag{A.24}$$

$$\begin{bmatrix} Real \\ GDP \end{bmatrix} = \begin{bmatrix} real\ household\ consumption + \\ real\ government\ spending + \\ real\ investment + \\ real\ export - real\ import \end{bmatrix}$$

Equation A.24 provides the framework for the calculation of real GDP (*RGDP*). It is the sum of real household consumption, government spending, investment and net exports.

(iv) System Constraint Block

Factor market:

$$\sum_{a \in A} QF_{f\,a} = \; QFS_{\,f} \tag{A.25}$$

$$\begin{bmatrix} demand\ for \\ factor\ f \end{bmatrix} = \begin{bmatrix} supply\ of \\ factor\ f \end{bmatrix}$$

Equation A.25 shows that the sum of each primary input (labour and capital) employed across production sectors is equal to the quantity of supplied factors. This is a necessary condition for equilibrium in the factor market.

Composite commodity market:

$$QQ_c \;=\; \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{c\,h} \;+ qg_c\,. + QINV_c \tag{A.26}$$

$$\begin{bmatrix} composite \\ supply \end{bmatrix} = \begin{bmatrix} composite\ demand; \\ sum\ of\ intermediate, \\ household, \\ government, \\ and\ investment\ demand \end{bmatrix}$$

Equation A.26 gives the demand and supply equilibrium of composite commodities. The demand side includes demand for intermediate goods, household consumption, firms' investment, and government spending on final goods. The supply side is compiled from marketed output and imports.

Current account balance:

$$\sum_{C \in CE} pwe_c . QE_c + \sum_i tr_{i,ROW} + \overline{FSAV} = \sum_{C \in CE} pwm_c . QM_c + irepat + yfrepat_{CAP} + yfrepat_{LAB} \quad (A.27)$$

$$\begin{bmatrix} export \\ revenue \end{bmatrix} + \begin{bmatrix} transfer\ from \\ RoW\ to\ households \\ and\ givernment \end{bmatrix} + \begin{bmatrix} foreign \\ saving \end{bmatrix} = \begin{bmatrix} import \\ spending \end{bmatrix}$$

Equation A.27 shows the current account balance. It represents the country earnings and spending balance. Exchange rates are flexible as they act as an equilibrating variable in the current account balance, while foreign savings remain fixed.

Savings-investment balance:

$$mps_h .\ (1 - ty_h) * YH_h + (YG - EG) + (EXR.\ \overline{FSAV}) = ygi + (EXR. irepat) + \sum_{c \epsilon C} PQ_c . QINV_c + WALRAS_t \quad (A.28)$$

$$\begin{bmatrix} household \\ savings \end{bmatrix} + \begin{bmatrix} government \\ savings \end{bmatrix} + \begin{bmatrix} foreign \\ savings \end{bmatrix} = \begin{bmatrix} fixed \\ investment \end{bmatrix} + \begin{bmatrix} WALRAS \\ dummy \\ variable \end{bmatrix}$$

Equation A.28 expresses the saving-investment balance. It states there is equality of total savings and investment. Total savings constitute household savings, government savings and foreign savings. Foreign savings are expressed in domestic currency. Additionally, total investment comprises the sum of gross fixed capital formation and inventories.

Appendix B: Sector Aggregation

Sectors	Sectors from IO 2010
SEC1 – Agriculture	1-12
SEC2 - Mining and quarrying	13-16
SEC3 - Meat and meat production	17
SEC4 – Seafood	18
SEC5 - Fruits and vegetables	18
SEC6 - Dairy products	20
SEC7 - Oils and fats	21
SEC8 - Grain mills	22
SEC9 - Bakery products	23
SEC10 – Confectionery	24
SEC11 - Other food processing	25
SEC12 - Animal feeds	26
SEC13 – Beverages	27-28
SEC14 - Other manufacturing	29-92
SEC15 – Services	93-124

Appendix C: Product Concordance for Processed Food

Sub-Sector	MSIC 2008	HS6-digit
Meat and meat production	10101, 10102, 10103, 10104, 10109	020110, 020120, 020130, 020210, 020220, 020230, 020311, 020312, 020319, 020321, 020322, 020329 020410, 020421, 020422, 020423, 020430, 020441, 020442, 020443, 020450, 020500, 020610, 020621, 020622, 020629, 020630, 020641, 020649, 020680, 020690, 020711, 020712, 020713, 020714, 020724, 020725, 020726, 020727, 020732, 020733, 020734, 020735, 020736, 020810, 020830, 020840, 020850, 020890, 020900, 021011, 021012, 021019, 021020, 021091, 021092, 021093, 021099, 150100, 150200, 160100, 160220, 160231, 160232, 160239, 160241, 160242, 160249, 160250, 160290, 160300, 230110

Seafood	10210, 10202, 10203, 10204, 10205	030270, 030311, 030319, 030321, 030322, 030329, 030331, 030332, 030333, 030339, 030341, 030342, 030343, 030344, 030345, 030346, 030349, 030351, 030352, 030361, 030362, 030371, 030372, 030373, 030374, 030375, 030376, 030377, 030378, 030379, 030380, 030411, 030412, 030419, 030421, 030422, 030429, 030491, 030492, 030499, 030510, 030520, 030530, 030541, 030542, 030549, 030551, 030559, 030561, 030562, 030563, 030569, 030611, 030612, 030613, 030614, 030619, 030729, 030739, 030749, 030759, 030799, 051191, 160411, 160412, 160413, 160414, 160415, 160416, 160419, 160420, 160430, 160510, 160520, 160530, 160540, 160590
Vegetables and fruits	10301, 10302, 10303, 10304, 10305, 10306	071010, 071021, 071022, 071029, 071030, 071040, 071080, 071090, 071120, 071140, 071151, 071159, 071190, 071220, 071231, 071232, 071233, 071239, 071290, 081110, 081120, 081190, 081210, 081290, 081400, 110510, 110520, 200110, 200190, 200210, 200290, 200310, 200320, 200390, 200410, 200490, 200520, 200540, 200551, 200559, 200560, 200570, 200580, 200591, 200599, 200791, 200799, 200811, 200819, 200820, 200830, 200840, 200850, 200860, 200870, 200880, 200891, 200892, 200899, 200911, 200912, 200919, 200921, 200929, 200931, 200939, 200941, 200949, 200950, 200961, 200969, 200971, 200979, 200980, 200990
Dairy products	10501, 10502, 10509	040110, 040120, 040130, 040210, 040221, 040229, 040291, 040299, 040310, 040390, 040410, 040490, 040510, 040520,040590, 040610, 040620, 040630, 040640, 040690, 170211, 170219, 210500
Oils and fats	10401, 10402, 10403, 10404, 10405, 10406, 10407	120810, 120890, 140420, 150300, 150410, 150420, 150430, 150600, 150710, 150790, 150810, 150890, 150910, 150990, 151000, 151110, 151190, 151211, 151219, 151221, 151229, 151311, 151319,151321, 151329, 151411, 151419, 151491, 151499, 151511, 151519, 151530, 151550, 151590, 151610, 151620, 151710, 151790, 152110, 152200, 230400, 230500, 230610, 230620, 230630, 230641, 230649, 230650, 230660, 230690

Grain mills	10611, 10612, 10613, 10619, 10621, 10622, 10623	100620, 100630, 100640, 110100, 110210, 110220, 110290, 110311, 110313, 110319, 110320, 110412, 110419, 110422, 110423, 110429, 110430, 110610, 110620, 110630, 190410, 190420, 190430, 190490, 190120, 110811, 110812, 110813, 110814, 110819, 110820, 110900, 151521, 151529, 170230, 170240, 170250, 170260, 170290, 190300
Bakery products	10711, 10712, 10713, 10714	90510, 190520, 190531, 190532, 190540, 190590
Confectionery	10721, 10722, 10731, 10732, 10733	170111, 170112, 170191, 170199, 170220, 170310, 170390, 170410, 170490, 180310, 180320, 180400, 180500, 180610, 180620, 180631, 180632, 180690, 200600
Other processed food	10741, 10742, 10750, 10791, 10792, 10793, 10794, 10795, 10799	040811, 040819, 040891, 040899, 090112, 090121, 090122, 090190, 090210, 090230, 160210, 190110, 200510, 190190, 200710, 210111, 210112, 210120, 210130, 210210, 210220, 210230, 210310, 210320, 210330, 210390, 210410, 210420, 220900, 210610, 210690, 190211, 190219, 190220, 190230, 190240
Animal feeds	10800	230910, 230990
Beverages	11010, 11020, 11030, 11041, 11042	220110, 220190, 220210, 220290, 220300, 220410, 220421, 220429, 220430, 220510, 220590, 220600, 220710, 220720, 220820, 220830, 220840, 220850, 220860, 220870, 220890, 110710, 110720

Note: MSIC – Malaysia Standard Industrial Classification; HS – harmonised system.
Source: DOS (2008).