Second-Hand-Clothing Imports in Least-Developed-Countries: The Collapse of Local Clothing Manufacturing and Remedial Measures[[1]](#footnote-1)

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**Abstract:** Considering the overwhelming global trend of second-hand clothing trade, domestic clothing manufacturing industries in many Least Developed Countries (LDCs) have collapsed. Governments of many LDCs, therefore, have imposed tariff policies on the imports of second-hand clothing. Motivated by the real-world practices, we develop a two-stage Stackelberg supply chain gaming model to study the competition between the locally manufactured new clothing product and the imported second-hand clothing product. We first explore whether import tariff protection can help boost domestic clothing manufacturing industries in LDCs in the light of risk considerations and what the optimal import tariff structure is. We find that in the uncertain LDC market, imposing a high import tariff or a highvalue-added tax (VAT) on the imported second-hand product may not help local manufacturing. Instead, implementing a carrot-and-sticks (CaS) scheme, which includes an import tariff, a VAT and an extra incentive, can help. The LDC governments are suggested to adjust the CaS scheme’s structure based on factors like risk attitudes of supply chain members, the unit product supply costs, social health risk, and consumer acceptance level of the second-hand product. Finally, we extend our analyses to study the social welfare and the Extended Importer Responsibility (*EIR*) legislation. We find that if the sterilization cost of the second-hand product is sufficiently low, imposing the *EIR* legislation in the uncertain LDC market is not beneficial to the domestic clothing manufacturing industry. Specific conditions under which imposing a higher import tariff is beneficial or harmful to the LDC society are identified.

**Keywords:** Supply Chain Management;Import Tariff; Second-hand Clothing; Risk Considerations; Least Developed Countries.

**1. Introduction**

**1.1. Background and Motivation[[2]](#footnote-2)**

As released in the research on “experimental approach to alleviating global poverty”, which has won the Nobel Memorial Prize in Economic Sciences 2019, more than 700 million people still subsist on extremely low incomes nowadays. Under the gigantic pressure of poverty, second-hand clothing has gained a significant market share across various Least Developed Countries (LDCs) like Mozambique, Rwanda, Senegal, Tanzania, and Zambia over the past decades. Among the top 15 global import markets of second-hand clothing in 2015, three of them are LDCs[[3]](#footnote-3); and Sub-Saharan Africa (SSA)[[4]](#footnote-4) even imported approximately 20 percent of the world’s second-hand clothing as a whole in 2016 (see Note 1 in Table D1), which was far more than any other regions in the world. Consumers in these markets, which live on an extremely low income, e.g., less than US$2 per day (Uppari et al. 2018), rely heavily on these imported second-hand clothing as it is much cheaper than the locally manufactured one[[5]](#footnote-5). In the meantime, however, the second-hand clothing import threatens the development of domestic clothing manufacturing industry in LDCs (Brooks and Simon 2012). As consequence, to support domestic clothing manufacturing industries, some LDCs (e.g., Rwanda, South Sudan, Tanzania, Burundi, Uganda, and Kenya) have imposed tariff policies on second-hand clothing imports.[[6]](#footnote-6) Some LDCs even plan to outlaw all second-hand clothing imports (see Note 3 in Table D1). Given the popularity of the second-hand clothing import in LDCs, this paper is therefore developed to explore the performance of the proposed import tariff protection and the import tariff structure design for helping domestic clothing manufacturing industries in LDCs.

On the other hand, complaints are launched claiming that the import tariff policies would kill the second-hand clothing imports business in LDCs (see Note 4 in Table D1). Countries like Kenya even have suddenly stopped their import tariff policy from 2017. Besides, some LDCs which are categorized as one of the biggest markets of second-hand clothing import (e.g., Angola, Benin, Democratic Republic of the Congo, Guinea, Mozambique, Senegal, and Togo) (see Note 5 in Table D1) have never imposed import tariffs. Such diversified reactions and attitudes towards import tariff protection also motivate us to explore why LDCs take different actions and what impacts the import tariff scheme can bring. For instance, the local importers may either sell the imported second-hand product via the traditionally independent retailers (see Table D3b in the Appendix D and Baden and Barber (2005) for the detailed practices of most cases in LDCs) or sell directly to local consumers (such as the example of Frip Ethique). Different supply chain (SC) structures therefore are considered in this paper when we investigate how the CaS scheme performs in LDCs.

In the literature, although many prior studies have examined the competition between a new product and a second-hand one (e.g., Huang et al. 2001; Yin et al. 2010; Huang et al. 2018), this paper is the first one exploring the influences of import tariff policies on the competition in LDC markets with second-hand clothing products. This also complements the tariff literature (e.g., see the identified research gaps found in Dong and Kouvelis (2020)). Furthermore, the second-hand clothing products are usually not properly sterilized and the associated health risk issues are emphasized by the doctors in practice. For instance, health issues like scabies, lice, and ringworm can be caused by the second-hand clothing products, which can severely damage the functions of human bodies and also impose a significant cost on health-care systems of the governments. Especially, under epidemic outbreaks and pandemics (e.g., the 1918 influenza, SARS, Ebola, and COVID-19), the health risks of the second-hand clothing products can even be catastrophic. In addition to the high infection rate of the disease itself, for example, lice can also lead to a mortality rate which is as high as 50% (due to the louse-borne typhus fever and louse-borne relapsing fever) during epidemics when compared with the chance of 10-40% otherwise. The associated health risk issues therefore make the second-hand clothing different from other product types and deserve deep investigation.

Besides, firms nowadays are facing an increasingly complex marketing environment with various uncertainties such as random demand arrivals (Shi et al. 2014). In particular, the clothing industry is widely known for its inherent market demand uncertainties (Choi et al. 2006). Prior studies like Cohen and Lee (2020) and Dong and Kouvelis (2020) have also highlighted the significant roles of operational risks such as price volatility, market demand uncertainties, and the increasing uncertainties in countries’ trade policies in global supply chains. In light of the inherent market uncertainties, we therefore explore the market competition in LDC markets in the light of risk considerations, regarding the operational risks induced by demand uncertainties.

**1.2. Research Questions and Major Findings**

Motivated by both the observed real practices and the open research gap, we aim to investigate the implementation of import tariff schemes in LDC markets. Given that both the clothing industry and global supply chains are with inherent market uncertainties, we focus on exploring the competition between the imported second-hand clothing product and the locally manufactured new clothing product under the considerations of operational risks induced by the market uncertainties. Specifically, the following research questions (RQs) are addressed:

**RQ 1:** i) Does the import tariff protection really help boost domestic clothing manufacturing industries in LDCs under the competitive market? ii) If yes, what is the optimal import tariff structure?

**RQ 2:** How does the import tariff scheme benefit the whole society of LDCs? Does an *EIR* legislation help?

**RQ 3:** Regarding social welfare of LDCs, can restricting the second-hand product import bring more benefits?

For RQ1, given that decision makers can have different risk attitudes towards uncertainties and risks (Smith and Ulu 2017), we explore the risk trade-off objectives (between risks and benefits) of supply chain members. We define ‘the optimal import tariff structure’ as a structure containing the components (see the carrot-and-sticks (CaS) scheme below) that can achieve the highest mean-risk benefit (MRB) level among all candidate structures under considerations[[7]](#footnote-7). As a general case, we first examine the CaS scheme, which comprises three components, namely an import tariff imposed on the local importer (for each imported second-hand product) [the first “stick”], a value-added tax (VAT) charged to both the local importer and the retailer who sells the imported second-hand product [the second “stick”], and an extra incentive offered to the domestic manufacturer to encourage local manufacturing [the “carrot”]. The structure of the CaS scheme follows the real-world practices of Kenya and the LDCs like Rwanda, South Sudan, Tanzania, Burundi, and Uganda (as shown in Table D3a and Table D3b in Appendix D). We develop a two-stage Stackelberg gaming model to capture the competition between the locally manufactured new product and the imported second-hand product, with the consideration of the social health risk (SHR) of the second-hand product (defined as the health risk associated with the second-hand product). The risk attitudes of supply chain members are also considered. We uncover that compared with other tariff scheme structures, the CaS scheme holds the best performance in boosting domestic clothing manufacturing industries in LDCs under the competitive market, especially when all the supply chain members are risk seeking while the LDC market size has a large variance. Moreover, we examine the respective impacts of the three different components included in the CaS scheme. We show that imposing a high import tariff and a highVAT on the second-hand product is not necessarily the most efficient action to deal with the overwhelming imported second-hand products. Instead, the LDC governments should adjust the structure of the CaS scheme to the unit supply cost for each imported second-hand product and the domestic manufacturer’s per-unit production cost of the new product. In addition, a centralized structure of Supply Chain *N* (the supply chain responsible for selling the locally manufactured new product) does not mean Supply Chain *N* can always benefit more from the CaS scheme. In fact, if the market uncertainty is relatively low, a decentralized structure can help bring more value to the domestic clothing manufacturing industry.

Then for RQ2, we extend to study how the import tariff scheme benefits the consumers and the whole society of LDCs. Three findings are derived. First, when imposing the import tariff scheme, the LDC governments should pay close attention to the direct healthcare system cost of the second-hand product and make a reasonable trade-off between consumer surplus and the overall profit. In particular, when the direct healthcare system cost of the second-hand product is sufficiently high, the overall profit-oriented LDC governments can benefit more from a CaS scheme with large values of all three components (i.e., the import tariff, the VAT, and the manufacturing incentive). Second, we show numerically that when the consumer acceptance level for the second-hand clothing products is high, the consumer surplus oriented LDC governments should emphasize more on the extra manufacturing incentive provided to the locally manufactured new products rather than the import tariff or the VAT. Finally, the CaS scheme outperforms the *EIR* legislation when the extra sterilization cost on the second-hand product is low while the LDC government is consumer surplus oriented.

Besides, in real-world practices, while some LDCs have prohibited the import of the second-hand products, some have proposed the CaS scheme rather than restricting the second-hand product import. We therefore have RQ3. For RQ3, we find that despite the higher direct healthcare system cost and the reduced consumer utility of buying the second-hand product, a higher SHR of the second-hand product can also increase the social welfare if the LDC government is more profit-oriented. That is, although the second-hand product can bring SHRs to consumers, allowing the second-hand product in the LDC market can still benefit the society, as long as the consumers are well informed with the potential SHR.

**1.3. Contribution Statements**

Contributions of this paper include three folds: i) To the best of our knowledge, this paper is the first analytical study exploring *the structured design of import tariff scheme in a competitive LDC market with a locally manufactured new clothing product and an imported second-hand one*, and emphasizing the crucial roles of *the second-hand product’s SHR and supply chain members’ risk attitudes*. Our equilibrium analyses enable us to decide the most effective structure of the import tariff scheme for the LDC markets in the light of risk considerations. ii) The findings in this paper provide *a guideline to policy makers in LDCs to boost their domestic manufacturing industries*. This guideline is not only limited to those LDCs which have already launched the import tariff scheme (e.g., Rwanda, Tanzania, Uganda, Burundi, and South Sudan), but also to other import tariff-free LDCs whose markets are also challenged by the thriving imports of second-hand clothing (e.g., Benin, Guinea, Mozambique, Senegal, and Togo). iii) This paper *highlights the importance of public health systems in the developing economies*. It addresses the highlights in the global poverty research done by Nobel laureates Abhijit Banerjee, Esther Duflo and Michael Kremer. That research, which has won the Economics Nobel prize 2019, indicates that developing economies have suffered a lot owing to the limited attention paid to the public health and the highly dysfunctional health systems. Findings from our LDC model hence can serve as a good reference to the policy makers in LDCs in enhancing the overall social welfare.

**2. Literature Review**

**2.1 Operations in LDCs and Developing Economies**

This paper belongs to an emerging stream of research, which remains scant, on operations in LDCs and developing economies. Recent research in this emerging area mainly focuses on export operations and imperfect contract enforcement (e.g., Kranton and Swamy 2008; Macchiavello and Morjaria 2015), market structure (e.g., Jerath et al. 2016; Taylor and Xiao, 2019), government intervention (e.g., Liao et al. 2017; Gui et al. 2018; Yu et al. 2018), and knowledge and information sharing (e.g., Chen et al. 2015). Among these studies, Kranton and Swamy (2008) study the transactions between exporters and producers through the case of East India Company operations in colonial Bengal. The authors show that due to the absence of formal contract enforcement, the bargaining powers of exporters and local producers and the market structure play crucial roles in the developing economies. Macchiavello and Morjaria (2015) investigate the value of buyer’s beliefs about seller’s reliability in Kenyan’s export operations from the perspective of supply shock. They reveal that for LDCs with imperfect contract enforcement, the trade volume heavily depends on the value of the relationship. Jerath et al. (2016) study the influences of licensed retailers on the competition among mom-and-pop stores. The authors find that the presence of licensed retailing can induce the bulk purchasing behavior of consumers and lead to the economic wastage. Taylor and Xiao (2019) explore the recent shift of socially-desirable product donations (e.g., malaria drugs) from non-commercial to commercial channels in the developing economies. The authors show that different from the traditional non-commercial distribution channel, the donor can be hurt by the increased consumer awareness level in the channel with commercial distribution. In the field of government intervention, Liao et al. (2017) examine the impacts of the government’s information provision policies on farmers’ optimal market selection in developing economies. The authors find that providing information to all farmers is in fact not optimal. Instead, a selective information provision policy with a nominal fee for “signal access” can be beneficial to individual farmers. Gui et al. (2018) investigate the impacts brought by the government’s control over market competition on the effectiveness of retailers’ replenishment strategies in developing economies. The authors reveal that the government should make a careful trade-off between the market participation of microretailers and consumer welfare. Yu et al. (2018) explore the government’s subsidy program design in developing economies with the consideration of an earmarked budge. The authors show that the structure of the optimal subsidy program depends on both the market selling price for products, and the government’s trade-off between consumer welfare and manufacturer profit. Besides, Chen et al. (2015) explore the incentive of knowledge sharing among farmers in developing economies under a knowledge learning and sharing platform. The authors find that although charging for the platform usage may discourage uninformative answers from the core users, it may also discourage them from sharing the knowledge with other farmers.

The above papers show that markets in LDCs and developing economies are challenged by various issues such as the absence of formal contract enforcement and information sharing, the existence of unorganized retailers, as well as low consumer awareness of the products. With these unique characteristics, markets in LDCs and developing economies deserve deep investigation, and the local governments should be mindful when making the trade-off between the profits of supply chain members and consumer welfare. This paper complements the operations literature in LDCs and developing economies by providing new implications regarding the structured design of import tariff schemes for helping domestic clothing manufacturing industries in the competitive LDC market.

**2.2 Second-hand Market**

This paper relates to the second-hand market. In the operations management literature, the second-hand market has been studied extensively. Some typical topics include the return timing and quantity of second-hand products (e.g., Atasu and Cetinkaya 2006; Guide Jr et al. 2006), government policy (e.g., Zhang and Zhang 2018), as well as market competition. Specifically, Atasu and Cetinkaya (2006) explore the influences of the return timing and quantity of second-hand products on the remanufacturing activities and the resale market. The authors discover that the fastest and most responsive reverse supply chain (e.g., with frequent shipments) may not be the most efficient and profitable one. Guide Jr et al. (2006) model the time value of commercial product returns, which will be remanufactured and sold in a secondary market. The authors uncover that for the high recoverable value products, the companies should enhance the responsiveness (e.g., speed) in their return networks if the return rate is also high. Under the trade-in remanufacturing economy, Zhang and Zhang (2018) investigate the strategic purchasing behaviors of consumers and the remanufacturing efficiency of the firm. The authors find that to achieve socially optimal remanufacturing efficiency, the government can propose a simple linear incentive scheme with either extra subsidies or taxes on production and remanufacturing. Competition games in the second-hand market are also explored in the literature. For example, Huang et al. (2001) explore the competition game between new and second-hand goods in a market where both selling and leasing services are available to consumers. They show that the consumer segment is affected by the transaction costs of selling the second-hand products, and price discrimination is the major motivation for the manufacturer to offer a leasing program. Yin et al. (2010) examine the product upgrade strategy of the manufacturer and the pricing strategy of the primary market retailer. The authors reveal that the introduction of the second-hand goods market can discourage the introduction of new versions of the products in the original primary market and restrain the rise in retail prices of unused products. Oraiopoulos et al. (2012) analyze an original equipment manufacturer (OEM)’s relicensing strategies in the competition game with the third-party entrant’s second-hand product. The authors show that an appropriate design of the relicensing fee and the new product’s retail price can allow the OEM to mitigate the new product’s low profit margin and enjoy the price premium from the resale value effect.

With the unique features of the second-hand market in mind (e.g., the low retail price, the dependence on consumer returns and the long return time), the above reviewed papers have presented many important insights. For instance, it is found that government policies are effective in influencing the second-hand market and price premium can substantially influence the second-hand market under competition. Similarly, this paper also explores the competition game between the second-hand product and the new product, and highlights the roles of the low retail price feature of the second-hand product, consumer preference, as well as government intervention. In the meantime, different from all of them, this paper contributes to the domain of second-hand market operations by examining the competition between an imported second-hand clothing product and a locally manufactured new clothing product in a global LDC based market. Moreover, trading issues (e.g., tariffs) in LDCs, and health risk problems of the second-hand products are investigated in this paper, but not in the above reviewed studies. In addition, notice that although some papers focus on the international second-hand clothing trade in LDCs (e.g., Brooks and Simon 2012), their objectives are to empirically show the economic impacts of second-hand clothing imports, which is different from our paper.

**2.3 Socially Responsible Operations**

In the literature of socially responsible operations, popular areas include socially responsible sourcing (e.g., Guo et al. 2015; Plambeck and Taylor 2015; Chen and Lee 2016; Orsdemir et al. 2019), social responsibility of producers (e.g., Gui et al. 2015; Iyer and Soberman 2016), as well as supply chain transparency (e.g., Chen et al. 2018a). Concerning socially responsible sourcing, Guo et al. (2015) analyze the sourcing strategies between selecting socially responsible suppliers and the suppliers which may violate the rule. The authors argue that the proportion of “socially conscious consumers segment” plays a strategic role, and governments should impose harsh fines on the responsibility violation from a risky supplier. Plambeck and Taylor (2015) explore the case when the supplier tries to hide information from the buyer’s social responsibility audit. The authors find that “nongovernmental organizations” (NGOs) or the government should directly penalize the suppliers for social responsibility violations. Chen and Lee (2016) discuss the buyer’s sourcing contracting problem in the presence of supplier responsibility risk. The authors find that a combination of multiple incentives can achieve a better performance in mitigating supplier responsibility risk, and the local government should increase the supplier’s “responsibility violations costs”. Orsdemir et al. (2019) explore the influences of horizontal sourcing feasibility on the firm's sourcing strategy. The authors reveal that when horizontal sourcing is feasible, NGOs should check the corporate social and environmental responsibility violations of the firms and provide violation reports. As for social responsibility of producers, Gui et al. (2015) explore cost allocation mechanisms for reducing the producers’ cost under the extended producer responsibility (EPR) systems. They show that information on each producer’s e-waste flow is crucial. Iyer and Soberman (2016) consider both intrinsic and extrinsic social responsibility preferences of consumers. The authors prove that social comparison costs can stimulate a higher increase in the producer’s social responsibility investment than social comparison benefits. Finally, concerning supply chain transparency in socially responsible operations, Chen et al. (2018a) analyze the buyer’s optimal revelation strategy of its supplier list, which can influence NGO’s perception of the supplier and lead to different scrutiny efforts. The authors reveal that the buyer has a stronger incentive to disclose its supplier list when there is an increase in the penalty charged by the local government on the supplier for responsibility violations.

These papers prove the crucial roles of government penalties and NGOs on enhancing the social and environmental sustainability performance of the supply chains. Besides, consumer preference and their willingness to pay for the products are highlighted, together with the importance of information disclosure (e.g., the violation reports). Following these papers, this paper also emphasizes on the strategic roles of government intervention and consumers’ willingness to pay on socially responsible operations. However, notice that the above papers only mention that government penalties can be beneficial, while no relevant real-practice based government policies on socially responsible operations are modeled and compared. To bridge this gap, this paper establishes a real-practice based model on government intervention under an LDC market with both domestic and imported products, and compares the performance of different import tariff schemes. Furthermore, this paper incorporates the unique feature of the product itself into model formulation, i.e., the SHR of the second-hand products, which is neglected in all prior socially responsible operations related literature.

**2.4 Tariff and Import Protection**

This paper is also related to the tariff and import protection (TIP) problem in operations. This stream of research tends to focus on the optimal import tariff policies design (e.g., Broda et al. 2008; Ossa 2014), the impacts of TIP on prices and production costs (e.g., De Loecker et al. 2016), and global trade in LDCs (Kohnert 2018). Among these papers, Broda et al. (2008) examine the influence of import countries’ market power on the design of import tariff policies. The authors prove that the market power of import countries can have significant effects on import tariff policies design, and import countries will set higher import tariffs on the goods with lower export supply elasticities. Ossa (2014) examines the optimal import tariff design, under the trade-off between the mean welfare gain of the local government with the mean welfare loss of other influenced governments. The author finds that trade negotiations can yield significant welfare gains under cooperative tariff schemes while free trade is close to the efficiency frontier. De Loecker et al. (2016) investigate the impacts of trade reforms and trade liberalization on prices, markups as well as marginal costs of multi-product firms. De Loecker et al. (2016) show that tariff liberalization can lower both factory-gate prices and marginal costs of the firms, and the most likely beneficiaries of trade liberalization are the domestic Indian firms who have lowered production costs but increased markups. Kohnert (2018) studies the effects of Trump’s tariff policies on the global trade operations of steel, aluminium and cars in African countries. The author reveals that African developing countries have limited power in global trade and the African Growth and Opportunity Act (AGOA) access to the export market like the US is of great importance to these countries.

As a remark, there exists a stream of TIP research that studies market competition. For instance, Amador and Bagwell (2013) explore both perfect competition and monopolistic competition between the home and foreign countries. The authors focus on the scenario where the home government selects its preferred import tariff under the considerations of political pressures induced by the import-competing industry. Specific conditions for the optimality of import tariff caps in both competition settings are provided. Haaland and Venables (2016) examine the optimal trade and domestic taxes design for a small open economy which consists of various firms with different productivity levels. The authors prove that domestic tariff protection can bring a benefit to the “home monopolistically competitive” sector, and the benefit increases with the number of product varieties but decreases with the heterogeneity of foreign exporters.

As we can see from the above, TIP schemes have substantial influences on the competitive global market and can be beneficial to home countries only when the local governments can well design the TIP schemes under careful considerations of market structure, production costs of the products, as well as product variety. Similarly, this paper also explores the conditions under which the TIP schemes can benefit the home country in a competitive global market and focuses on the significant roles of the products’ production. In the meantime, notice that none of the above papers have explored the second-hand clothing’s import challenges and the debate on the use of import tariff in a competitive LDC market (with the imported second-hand product and the locally manufactured new product). This paper hence represents the first attempt to examine how import tariff schemes influence the competitive LDC market with imported second-hand products.

**3. Basic Supply Chain Model Formulation**

***Cost and revenue parameters:*** Observing that retailers in LDCs usually compete on prices (Gui et al. 2018), this paper addresses the aforementioned research questions in a chain-to-chain setting with price competition. Following the real-world practices (Table D3b in Appendix D), Supply Chain *N*, which consists of a domestic manufacturer and Retailer *N* (as shown in Figure 1), is responsible for selling the locally manufactured new product.[[8]](#footnote-8) In the meantime, Supply Chain *SH* competes with Supply Chain *N* by selling the imported second-hand product. We use subscripts to represent variables and parameters for the locally manufactured new product and the imported second-hand product, respectively. Besides, following Ferrer and Swaminathan (2006) and Abbey et al. (2019), we consider the case with unconstrained product supply for both the locally manufactured new product and the imported second-hand product. The new product’s retail price is decided by Retailer *N*, and the second-hand product’s retail price is set by Retailer *SH*. The domestic manufacturer produces the new product with a unit production cost , and supplies the new product to Retail *N* as a unit wholesale price . The local importer gets the second-hand product from the exporters in other countries with a unit cost , and sells it to Retailer *SH* with a unit wholesale price . The domestic manufacturer and the local importer maximize their own profits by controlling the values of and , respectively.

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**Figure 1.** The chain-to-chain competition under the basic model.

In the meantime, the LDC government imposes a CaS scheme (i.e., a hybrid import tariff scheme) to support the locally manufactured new product (see Figure 1). Under the CaS scheme, in addition to paid to the overseas exporter, the local importer (in the LDC) is required to pay a percentage import tariff () of the unit supply cost for each unit of second-hand product to the local government. In addition, both the local importer and Retailer *SH* have to pay a value-added tax (VAT) (), at the respective unit value of and for each second-hand product. Furthermore, the LDC government also offers an extra unit incentive (where ) to the domestic manufacturer for each unit of production. Note that this CaS scheme is based on the real-world practices (as shown in Table D3a and Table D3b in Appendix D). In particular, to capture the essence of the import tariff scheme in the competitive LDC market, we consider that , , and are exogenously determined by the government. A similar modelling approach can be observed in literature like Gui et al. (2018). Besides, discussions on the imported new product are excluded in this paper as the CaS scheme is set by the LDC government for addressing the extremely low retail price pressure from the imported second-hand product, which is much lower than the imported new product.

As emphasized by the doctors in practice, the public should pay attention to the health risks associated with the second-hand clothing products, which are usually not properly sterilized and may induce scabies, lice, and ringworm (see Note 9 in Table D1). As reported by World Health Organization (WHO), for example, scabies can severely damage both renal and cardiovascular functions of human bodies and impose a major cost on health-care systems of the governments. Children infected with scabies may even suffer from permanent kidney damage. While for lice, it can easily cause louse-borne typhus fever and louse-borne relapsing fever, the mortality rates of which can be as high as 10-40% and up to 50% (during epidemics), respectively. More details can also be found in Table A6 in Online Supplementary Appendix A. Especially, under epidemic outbreaks and pandemics (e.g., the 1918 influenza, SARS, Ebola, and COVID-19), the health risks associated with the second-hand clothing products like the infection of the disease should be seriously considered. We thus consider a unit social health risk (SHR) on the consumers who purchase the imported second-hand product, where . Accordingly, the LDC governments also has a direct healthcare system cost induced by each unit second-hand product, where . This also addresses the concerns raised in Taylor and Xiao (2019), which find that the expensive drugs to treat diseases can lead to a heavy burden on the public health systems in developing regions. The list of notations is provided in Table C1 in Appendix C. Besides, notice that in practices, retailing in remote areas of many LDCs is usually managed by small-sized family-owned stores or street carts (see Table D3b in the Appendix D and Gui et al. 2018), which are known as “*microretailers*”. These *microretailers* are characterized by not only their informality but also prohibitive operating constraints and poor income. As a result, it is difficult for the LDC governments to force the local importer to sterilize the imported second-hand clothes. Therefore instead of in the main model, we explore the case with sterilization in the extended analysis.

***Market demand:*** Following the operations literature like Chen et al. (2018a), the LDC market includes *N* consumers where *N* is a random variable following a symmetric distribution with mean and standard deviation . Each consumer makes their purchase decisions: 1) buy or not, and 2) if buy, then “which product”, to maximize their individual utility. Denote , and as the utility a consumer gets from purchasing the locally manufactured new product and the imported second-hand product, respectively. The consumers have perfect information about both products, and therefore can differentiate between the new product manufactured by the domestic manufacturer and the second-hand product imported by the local importer. Following the literature such as Agrawal et al. (2016) and Huang et al. (2018), each consumer buys at most one unit. Based on the utility derived from purchasing the locally manufactured new product or the imported second-hand product, consumers decide whether to buy a product or not and make the option of which product to buy. Specifically, the consumer has a valuation for the locally manufactured new product, and a valuation for the imported second-hand product. measures the consumer’s acceptance level for the imported second-hand product, which is a result of consumer perceived quality factor including attributes such as physical appearance of the second-hand product. To address the real practices that the imported second-hand product has the same functionality as the locally manufactured new product, but is viewed inferior in quality by the consumer, we have . A larger implies that the consumer accepts the second-hand product more. Consumer heterogeneity in product valuations (i.e., the willingness to pay) is captured by taking to be uniformly distributed over [0,1], with a p.d.f.. Here, in line with the extant literature such as Chen et al. (2018b), Li et al. (2019), and Liu and Xiao (2019), in this paper is common for all consumers in the LDC market. It represents the fact that the maximum price that the consumers are willing to pay for the locally manufactured new product (the imported second-hand product) is independent of the retail price offered by Retailer *N* (Retailer *SH*). Allowing for differences in does not change the insights of this paper, as is not a decision variable. That is, although consumers can have different willingness to pay in practices, all the insights in this paper still hold. Accordingly, the utilities of a consumer generated from buying a new product and a second-hand product are expressed as , and , respectively. Since the consumer valuation is bounded between 0 and 1, we can easily get that it is never profitable to set and . Plus, to avoid trivial cases, we let and . A consumer will buy the new product if and; buy the imported second-hand product if and ; and does not make a purchase, otherwise. This leads to the following expected demand functions, corresponding to three regions:

***Region 1.*** . In this region, consumers whose valuation is in the interval will buy the new product, and no consumers want to buy the second-hand product. Hence, the demand for the new product is , where *N* is randomly distributed with mean . Taking expectation with respect to *N*, the expected number of consumers who will buy the new product at a retail price is: . The expected market demand for the second-hand product is .

***Region 2.*** . In this region, consumers with valuation in the interval prefer to buy the second-hand product, and consumers with valuation in the interval [, 1] prefer to buy the new product. Thus, the expected market demand for the new product is , and that for the second-hand product is .

***Region 3.*** . In this region, no consumers will buy the new product, and consumers with valuation in will buy the second-hand product. Therefore, the expected market demand for the new product is , and that for the second-hand product is .

Note that in Regions 1 or 3, either the new product or the second-hand product has zero market share. In these cases, only one product exists in the market and we are no longer able to study the effect of import tariff with product competition. Hence, in this paper, we restrict our attention to Region 2, where the new product and the second-hand product coexist in the market with positive market shares. This is also consistent with the real-world practices in LDCs. Similar treatment is common in the literature (e.g., Selove 2013; Borenich et al. 2020).

***Sequence of events:***

To explore the problem, the two-stage problem is adopted in this paper for analytical tractability which is common in the literature (e.g., see Ferrer and Swaminathan (2006) and Guo et al. (2015)). Following the real-world practices (e.g., Baden and Barber (2005)), we have the sequences of events as follows.

In the first stage, the domestic manufacturer and the local importer compete and uncooperatively choose their corresponding unit wholesale prices for each unit sold to their retailers, i.e., and at the same time. Accordingly, in the second stage, Retailer *N* and Retailer *SH* simultaneously determine the respective retail prices of their products, i.e., and . Hence, the competition system in this paper includes two Nash games connected with a Stackelberg game. We proceed backwards to derive the equilibrium. Notice that in this paper, we exclude the influences of information in market interaction by focusing on the case when all supply chain members have the same access to the market information.

***Objectives and social welfare function:***

In practice, both the clothing industry and global supply chains are with operational uncertainties and risks. Given that decision makers can have different risk attitudes towards uncertainties and risks, we consider and discuss the risk trade-off objectives (between the risks and benefits) of supply chain members in this paper. Following Weber et al. (1992), we define the operational risks that the supply chain members may face as the market uncertainty, which can lead to the variance of outcomes (i.e., profit). Accordingly, we have Retailer *N*’s profit as: . The operational risk is quantified by the variance of Retailer *N*’s profit . Both the upside and downside variations from the “mean” profit, which can lead to unexpected outcomes, are counted as risk. Taking variance with respect to *N*, we have: It is straightforward that the standard deviation of Retailer *N*’s profit is: We denote Retailer *N*’s risk attitude parameter as . The risk attitude parameter if Retailer *N* is risk averse (avoiders of risk), if Retailer *N* is risk neutral (neutral to risk), and if Retailer *N* is risk seeking (lovers of risk). The property of a constant risk attitude parameter is commonly adopted in risk attitude literature like Gallego et al. (2015). In reality, decision makers are not always risk neutral. Risk aversion, for example, is an important consideration in practice when the decision makers are facing uncertain benefits (e.g., when purchasing a new technology) (Smith and Ulu 2017). A survey conducted by Koller et al. (2012) also reveals that executives can show extreme levels of risk aversion even when the benefits are expected to be strongly positive. In addition, notice that as mentioned in classic economics and social science literature like Kahneman and Tversky (1979), decision makers can be risk seeking in the domain of gains. Following Kahneman and Tversky (1979), although it is traditionally true that many firms facing operational risks tend to be risk-averse, the risk seeking attitude can still happen given that the operational risks in this paper only induce the variance of profit (i.e., gains) but not losses. A typical example in practices is the shipping firms, which are known for their risk-taking preferences in the presence of a risky market situation (Ishizaka et al. 2018; Choi et al. 2020). To ensure the reliability and robustness of our findings, all the three aforementioned risk attitudes are considered in this paper. In order to make (1) reasonable, Retailer *N*’s risk attitude parameter cannot be extremely big (i.e., bounded by ). Following Choi et al. (2019), we define the mean-risk (MR) objective function of Retailer *N* as , which shows Retailer *N*’s trade-off between the “expected profit” and the operational risks induced by the “variance of profit”. Such a MR objective function captures both the uncertainty level of unexpected outcomes (by simultaneously considering the expected payoff (i.e. the “mean”) and the standard-deviation of profit (i.e. the “risk”)) and the decision-maker’s different risk attitudes towards to the unexpected outcomes. To enhance the presentation, we use the term “MR benefit” (MRB) to denote the MR objective function value in the following.

***1) Retailer N:*** . (1)

Following the same logic, with , where , the respective MRB functions of Retailer *SH*, the domestic manufacturer, and local importer are:

***2) Retailer SH:*** . (2)

***3) Domestic manufacturer:*** . (3)

***4) Local importer:*** . (4)

***5) Social welfare:*** Following Benjaafar et al. (2018) and Zhang and Zhang (2018), the social welfare in this study is defined as the sum of supply chain members’ (i.e., Retailer *N*, Retailer *SH*, the domestic manufacturer, and local importer) profits and the government’s income, plus the consumer surplus. Notice that the governments’ objective is always to maximize the long-term social welfare. Firms are risk neutral when their objectives are to maximize the long-run profits (Demirel et al. 2018). Accordingly, only the expected profits of supply chain members are considered in the LDC government’s expected social welfare function rather than their MRBs. We therefore derive the expected social welfare as follows.

The expected income of the government is:

*.*

The expected consumer surplus is:

.

Similar to Zhang and Zhang (2018) and Murali et al (2019), in order to highlight the performance of the import tariff scheme in boosting the domestic manufacturing industry, the LDC government’s other revenues and costs (e.g., the VAT on the domestic new products) are not included.[[9]](#footnote-9) Moreover, it is known that social welfare policies are developed by the governments to address a variety of different and often competing social objectives (Thompson 1995). No single social welfare policy will be able to optimize all the objectives and choices are actually made based on the relative importance of these various objectives. We therefore explore the generalized case in which the LDC government puts different emphases (measured by the government’s affinity indicator ) on consumer surplus and the overall profits. Various types of governments in practice are differentiated by different values of the affinity indicator , which measures the performance of the import tariff scheme (in improving the social welfare) differently. Special interests driven indicators like this are also highlighted in the economics and social science literature like Mitra (1999), in which governments’ decision-making is explained as a response to their special interests. Here, notice that the healthcare system cost induced by the second-hand product is included in the income of the government given that it is a direct economic cost paid by the government to support the local healthcare system. It is inherently different from the environmental cost and damage mentioned in the sustainability literature (e.g., Murali et al. 2019), which is an environmental efficiency metric and difficult to measure.

**Assumption 1.** *The LDC government places different emphases on consumer surplus and the total profit of the supply chain members as well as the government, i.e., with on the total profit and with on consumer surplus, .*

The government affinity (i.e., the relative importance of competing social objectives) can vary from country to country and from time to time. This social welfare structure covers both the most commonly seen social welfare format in literature (with the same emphases on consumer surplus and the total profit, i.e., ) and other general cases with different emphases. Specifically, refers to the case when the LDC government is more consumer surplus oriented (more “weight” to consumer surplus) while means the LDC government is more overall profit-oriented (more “weight” to the total profit). For example, with the goal of raising its economic development to a medium-income level by 2020, Ghana’s government puts a tepid interest in consumer surplus but a sharper emphasis on overall profit in recent years (Julian and Ofori‐dankwa, 2013). Similar emphasis on economic development can also be found in emerging governments such as the sub-Saharan African government. Both cases can be reflected by with a value in the range of . As the government affinity varies under the ever-changing government strategies, the indicator , which captures the dynamic preference of the LDC government, also makes the findings in this paper more applicable to real-world practices. Consequently, the government’s expected social welfare function is:

. (5)

**4. Analysis**

**4.1 Equilibrium Decisions**

Using backward induction, we can derive the equilibrium decisions of supply chain members under the CaS scheme to be the following:

*,*

*,*

, and

.

We can verify that in the equilibrium, and .[[10]](#footnote-10) We analyze the impacts of , , in Section 4.2 and impacts of and in Section 5. All abbreviations in this paper are available in Table A1 in Online Supplementary Appendix A.

**4.2 Discussions: Structure Design of the Import Tariff Scheme**

In this subsection, we begin our analyses on whether the CaS scheme is effective in boosting domestic clothing manufacturing industries in LDCs and which structure of import tariff schemes is most effective.

**4.2.1. Effects of Import Tariff Protection and Optimal Import Tariff Structure**

By simplifying one or more of the three components in the CaS scheme to zero, we accordingly have other import tariff cases listed in Table 1, all of which carry practical meanings. Specifically, Case *T1* refers to some LDCs that are categorized as one of the biggest markets of second-hand clothing but have not yet adopted the import tariff scheme (e.g., Benin, Mozambique, Senegal, and Togo; see Note 10 in Table D1). Case *T2* represents the case when the LDC government imposes a pure import tariff scheme (i.e., a percentage import tariff ) on the imported second-hand product. For instance, many other non-LDCs, like Uzbekistan, Zimbabwe, South Africa, and Vietnam, have launched a high tariff rate to explicitly discourage the second-hand clothing import in their local markets (see Note 11 in Table D1). Cases *T3* and *T4* are considered for comparisons. In addition, as the major focus of this paper is import tariff protection, other non-import tariff schemes, like the pure VAT scheme and the pure manufacturing incentive scheme, are all excluded.

|  |  |  |
| --- | --- | --- |
|  | **Definitions** | **Components in the import tariff scheme** |
| **Case *T1*** | The case without import tariff protection, i.e., , , . |  |
| **Case *T2*** | The case with the pure import tariff scheme, i.e., , , . |   |
| **Case *T3*** | The case with both the import tariff and the VAT, i.e., , , . | ,  |
| **Case *T4*** | The case with both the import tariff and the manufacturing incentive, i.e., , , . | ,  |
| **Case *TH*[[11]](#footnote-11)** | The case with the CaS scheme, i.e., , , . | , ,  |

**Table 1.** Definitions of different types of import tariff schemes.

By comparing Cases *T1*, *T2*, *T3*, *T4,* and *TH*, we have Proposition 1.

**Proposition 1.***In a competitive LDC market with a new product and an imported second-hand product, we have:*

*i) ,*

*ii) ;*

*iii) ;*

*iv) .*

Proposition 1 reveals several insights. First, we can find that no matter which import tariff scheme is adopted, the mean-risk benefits (MRBs) of the firms in Supply Chain *N* are always higher than those in the case without import tariff protection (i.e., and for any ). In contrast, the MRBs of the firms in Supply Chain *SH* are always lower than those in the case without import tariff protection (i.e., and for any ). This verifies the effectiveness of LDC governments’ practices in boosting its domestic clothing manufacturing industry via tariffs, which is irrespective of supply chain members’ risk attitudes. Second, we uncover that the MRBs of the supply chain members in Supply Chain *N* are largest in Case *TH* whereas the MRBs of the supply chain members in Supply Chain *SH* are lowest in Case *TH*. This means that the CaS scheme is the most effective one to raise (resp., reduce) the MRBs of the supply chain members in Supply Chain *N* (resp., the MRBs of the supply chain members from Supply Chain *SH*) among all four import tariff schemes. This provides an important implication to the countries that have imposed a pure import tariff scheme (i.e., Case *T2* like Uzbekistan, Zimbabwe, South Africa, and Vietnam) as well as the countries who have not yet adopted any import tariff scheme (i.e., Case *T1* such as Benin, Mozambique, Senegal, and Togo). Especially, the CaS scheme can achieve the best performance (i.e., the highest MRBs of supply chain members in Supply Chain *N* and the lowest MRBs of supply chain members in Supply Chain *SH*) when all the supply chain members are risk seeking while the LDC market size is with a large variance. Decision makers have the desire for high potential return (Scholer et al. 2010). When the LDC market size is with a larger variance, although more risky (i.e., a higher variance of profit), risk seeking supply chain members may incline to believe that market demand may be substantially large and therefore enjoy the possibility of achieving higher MRB levels. This interesting finding is also in line with the very recent literature Jiang and Liu (2019), which reveals that hiring optimistic managers in a competitive market can bring benefits. This in fact also explains that why risk seeking behaviours exist in practices (Ishizaka 2018).

**4.2.2 Influences of Different Components of the CaS Scheme**

By Proposition 1, we know that irrespective of supply chain members’ risk attitudes, the CaS scheme is the most effective scheme among all import tariff schemes. In the following, therefore, we discuss the influences of the CaS scheme (as is shown in Figure 1) in Tables 2a, 2b, and 3, followed by core findings shown in Propositions 2 and 3. Interested readers can also refer to Tables A2a, A2b, A3a, and A3b in Online Supplementary Appendix A for more details.

|  |  |  |
| --- | --- | --- |
|  | **Equilibrium decisions:**, , ,  | **Expected market demand:**,  |
|   |  | , |
|   | , , all ; if and only if; if and only if. | , |
|   |  | , |

**Table 2a.** Impacts of increasing different components of the CaS scheme on equilibrium decisions, and the expected market demand.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **1) Marginal profit of Retailer *N*:** ;**2) MRB of Retailer *N*:**  | **1) Marginal profit of Retailer *SH*:** ;**2) MRB of Retailer *SH*:**  | **1) Marginal profit of domestic manufacturer:**;**2) MRB of domestic manufacturer:**  | **1) Marginal profit of local importer:**;**2) MRB of local importer:**  |
|   | Both and  | Both and  | Both and  | Both and  |
|   | Both and  | Both and  | Both and  | Both and  |
|   | Both and  | Both and  | Both and  | Both and  |

**Table 2b.** Impacts of increasing different components in the CaS scheme on the marginal profits and final MRBs for all firms in the two supply chains.

|  |  |
| --- | --- |
| **Conditions** | **Effectiveness of different components in boosting the domestic clothing manufacturing industry** |
| When is sufficiently small (i.e., ) |  |
| When is medium (i.e., ) |  |
| When is sufficiently large (i.e., ) |  |

**Table 3.** Conditions governing which component in the CaS scheme is most effective in increasing the marginal benefits in the profits of Retailer *N* and the domestic manufacturer.

As shown in Table 2a and Table 2b, an increase in any component of the CaS scheme (i.e., the import tariff , the VAT , or the manufacturing incentive ) will: (i) Stimulate the expected market demand of domestically manufactured new products, and result in higher MRBs for the domestic manufacturer and Retailer *N*. (ii) Reduce the expected market demand of imported second-hand products, and lower the MRBs for the local importer and Retailer *SH*. These facts indicate that an increase in any component of the CaS scheme helps reduce the appeal of second-hand clothing in the LDC markets and boost domestic clothing manufacturing industries in LDCs. This highlights a critical insight that in addition to the dominant advantage in achieving more MRBs of the supply chain members in Supply Chain *N* (see Proposition 1), the CaS scheme also shows a higher flexibility in structure design. For instance, the second-hand product’s retail price is many times cheaper than the new one in Uganda[[12]](#footnote-13), which makes it difficult for local clothing manufacturing companies to thrive. As a result, the Uganda government has increased the tariff imposed on its import second-hand clothing from 15% to 20% in 2018 (see Note 12 in Table D1). The increased tariff can help reduce the retail price difference[[13]](#footnote-14), and consequently part of the second-hand product’s demand will switch to the new product if the retail price of the second-hand product increases. To make full use of the CaS scheme’s flexibility in structure design, we next compare the respective marginal benefits brought by the three different components for Retailer *N* and the domestic manufacturer. Accordingly, we have Proposition 2.

**Proposition 2.***In a competitive LDC market with a new product and an imported second-hand product: i) When is sufficiently large (i.e., when ), raising the unit VAT on the imported second-hand product is the best choice for helping to boost the domestic clothing manufacturing industry and enhancing the MRBs of both the domestic manufacturer and Retailer N; ii) When is sufficiently small (i.e., when ), raising the unit manufacturing incentive is the most desirable action.*

As we all know, low costs can contribute to competitive advantages for a firm. Proposition 2 thus highlights “how the effectiveness of the three different components in boosting the LDC domestic clothing manufacturing industry” depends on (i) the domestic manufacturer’s per-unit production cost of the new product(i.e.,) and (ii) the domestic local importer’s per-unit production cost of the second-hand product (i.e.,). From Table 3 (as well as Table A3a and Table A3b in Online Supplementary Appendix A), we find that the performance of the import tariff may not be as obvious as the other two components (i.e., the VATandthe manufacturing incentive). To be specific, when both and are sufficiently large, raising the unit VATon the imported second-hand product can have the best performance in boosting the domestic clothing manufacturing industry in the competitive LDC market and simultaneously discouraging the market on the imported second-hand product[[14]](#footnote-15). When is sufficiently small, instead of raising the cost of the imported second-hand product (e.g., through increasing the unit import tariff or the unit VAT*),* reducing the cost of the locally manufactured new product by offering a high manufacturing incentiveis most helpful.

Note that Proposition 2 highlights the considerations on cost efficiency and provides a crucial guideline to the policy makers in LDCs. We know that LDCs are facing huge difficulties in fighting poverty (Kalkanci et al. 2018) and large population in LDCs such as Burundi and Uganda, is the low-income earners[[15]](#footnote-16). These low-income earners, which hold low purchasing power and limited affordability, have a high reliance on the second-hand product and will insist to buy the second-hand product even if its retail price is increased (as long as it is still much cheaper than the new product). Therefore, when both the unit supply cost for each imported second-hand product and the domestic manufacturer’s per-unit production cost of the new productare sufficiently large, LDCs are suggested to focus more on charging a higher VATon the second-hand product. This is most efficient in reducing the retail price difference between the imported second-hand product and the locally manufactured product. This can therefore contribute to a highest expected market demand increase for the locally manufactured new product and ensures the MRBs of the domestic manufacturer and Retailer *N*. While for the case when the unit supply cost for each imported second-hand product is sufficiently small, extra incentives from the LDC governments to the domestic manufacturing sector can be most helpful. This is because different from the influences brought by the import tariff and the unit VAT (which can lead to an increased final retail price), the extra manufacturing incentive can help reduce the financial burden of the domestic manufacturer and Retailer *N*. This is beneficial to the consumers. Moreover, considering the international trades with other countries, the LDC governments can never infinitely increase the tariff charged on the imported second-hand product. For example, some LDCs which have launched the import tariff scheme on the second-hand product (e.g., Tanzania, Uganda and Rwanda) are facing severe trade threats from the US, by restricting the eligibility of the domestic manufacturers in these LDCs for AGOA and duty-free access to the export market like the US for all eligible exports (see Note 14 in Table D1 and Kohnert 2018).[[16]](#footnote-17) As claimed by The World Bank Report 2006, however, clothing products’ access to AGOA can stimulate substantial increase in LDCs’ clothing products export. The restricted eligibility for AGOA will limit the (duty-free) benefits and can subsequently lead to considerable negative effects on the exports business of the related LDCs. Kenya, which relies heavily on AGOA and has exported to the US nearly $600m (£450m) in 2017 (considerably higher compared to just $43m (£32m) for Rwanda), has even stopped its import tariff on the second-hand product since Year 2017 to ensure its eligibility for AGOA (see Note 15 in Table D1). As a result, it can be seen that the practicable range of the import tariff is always bounded in the real-world practices.

***Managerial Implication 1 from Proposition 2*:** *Imposing a high import tariff and a high VAT is not necessarily the most efficient action to deal with the overwhelming imported second-hand products. The LDC governments are suggested to adjust the CaS scheme based on the unit supply cost for each imported second-hand product and the domestic manufacturer’s per-unit production cost of the new product.*

**4.2.3 Performance of the CaS Scheme under Different SC Structures**

Following the real practices (see Table D3b in the Appendix D and Baden and Barber (2005)), the competition system in this paper is based on two decentralized supply chains (i.e., Case *C0*), with Retailer *N* and one domestic manufacturer in Supply Chain *N*, and Retailer *SH* and one local importer in Supply Chain *SH*. In some cases, however, the local importer may also sell the imported second-hand product to the LDC market directly (Norris, 2015). As an example, Frip Ethique bypasses the traditionally local middlemen in the secondary market in Senegal (i.e., plays as an integrated retailer) and sells its second-hand clothing (imported from the UK and overseas) directly to local consumers. To address the existence of integrated retailers in practices, we next consider different supply chain (SC) structures in practice and explore how the CaS scheme performs differently under different SC structures of Supply Chain *SH* (as listed in Table 4 below). Notice that *a centralized supply chain* means a supply chain that is controlled by one single SC planner (i.e., by an integrated retailer in this paper) like the case of Frip Ethique. Besides, as independent retailers can be more risk averse than integrated retailers (Agrawal and Seshadri 2000), we next follow Yang et al. (2018) and introduce the concept of supply chain risk attitude as the composite risk attitude of the whole supply chain. The supply chain risk attitude is independent of the risk attitudes of individual supply chain members. We denote Supply Chain *N*’s and Supply Chain *SH*’s risk attitude parameters as and , respectively, which means the central SC planners in Supply Chain *N* and Supply Chain *SH* can both be either risk averse, risk neutral, or risk seeking. In the following, we use the term ‘the risk attitude of Supply Chain *N* (Supply Chain *SH*)’ to represent the central SC planner’s risk attitude.

|  |  |
| --- | --- |
|  | **Definitions** |
| **Case *C0*** | Both Supply Chain *N* and Supply Chain *SH* are decentralized. |
| **Case *C1*** | Both Supply Chain *N* and Supply Chain *SH* are centralized. |
| **Case *C2*** | Supply Chain *N* is decentralized while Supply Chain *SH* is centralized. |
| **Case *C3*** | Supply Chain *N* is centralized while Supply Chain *SH* is decentralized. |

**Table 4.** Definitions of different SC Structures.

**Lemma 1.***In a competitive LDC market with a new product and an imported second-hand product, regardless of the SC structures: i) The unit VAT always has better performance than the import tariff in enhancing the MRBs of both the domestic manufacturer and Retailer N; ii) Raising the unit VAT on the imported second-hand product is always the best choice for boosting the domestic clothing manufacturing industry when is sufficiently large (i.e., when in Case C1 and Case C2, and when in Case C3); iii) Raising the unit manufacturing incentive is always the most desirable action when is sufficiently small (i.e., when in Case C1 and Case C2, and when in Case C3).*

Previous discussions on Proposition 2 are based on the case when both the Supply Chain *N* and Supply Chain *SH* are decentralized (i.e., Case *C0*). The interest conflicts between different supply chain members in the decentralized system, however, is widely known in the literature (e.g., Li et al. (2015), Xu et al. (2015), Chen et al. (2018c), Tao et al. (2018), Wang et al. (2019)). Taken their different risk attitudes towards uncertainties and risks into considerations, each individual supply chain member focuses on their trade-off between the “expected profit” and the operational risks induced by the “variance of profit” and tries to maximize their own “MR benefit” (MRB) accordingly. The subsequent double marginalization can influence the performance of a decentralized supply chain, such as by triggering the price distortion (Dellarocas 2012; Li et al. 2013). Some therefore may also wonder that the superior performance of the VAT found in Proposition 2 can be a result of double marginalization, as both the local importer and Retailer *SH* are charged for VAT under the decentralized supply chain structure (i.e., charged twice). Lemma 1, however, shows that Proposition 2’s conclusion is robust under different SC structures. That is, even there is no double marginalization (i.e., the VAT is charged once only under a centralized Supply Chain *SH*), the VAT can still show a better performance in enhancing the MRBs of the domestic manufacturer and Retailer *N* than the import tariff. This provides a critical reference to the LDC government that no matter whether the imported second-hand clothing is traditionally sold to local consumers via Retailer *SH* or sold directly by the local importer, imposing a high import tariff is never the best solution as it not only brings loss from international threats, but also yields limited profit increase to the domestic manufacturer and Retailer *N*. Instead, the LDC government should pay more attention to the unit VAT and the unit manufacturing incentive.

**Proposition 3.***Regarding the MRB of Supply Chain N , : i) When Supply Chain SH is decentralized: a) If , then ; b) If , then if and only if ; ii) When Supply Chain SH is centralized: a) If , then ; b) If , then if and only if .*

Proposition 3 explores the impacts of vertical integration (i.e., centralization) on the performance of the CaS scheme in boosting the domestic clothing manufacturing industry under a competitive environment. Vertical integration, which can effectively eliminate double marginalization, has been widely recommended to achieve an optimal supply chain. In practice, firms are also increasingly engaging in supply chain integration for achieving more competitive advantages (Wei et al. 2020). Interestingly, Proposition 3 reveals a counter-intuitive result that an integrated (i.e., centralized) structure of Supply Chain *N* does not always guarantee a better performance of the CaS scheme in boosting the domestic clothing manufacturing industry. Instead, it depends on the SC structure of Supply Chain *SH*.

As seen from the above, competing with a decentralized Supply Chain *SH*, if the market uncertainty is relatively low (i.e., ), a decentralized Supply Chain *N* can always benefit more from the CaS scheme than a centralized Supply Chain *N*. This is true even when the risk aversion level of Supply Chain *N* is relatively low (i.e., ). While if the market uncertainty is sufficiently high ((i) when competes with a decentralized Supply Chain *SH*; (ii) when competes with a centralized Supply Chain *SH*), a decentralized structure can also be ideal if Supply Chain *N* is more risk averse ((i) when competes with a decentralized Supply Chain *SH*; (ii) when competes with a centralized Supply Chain *SH*). Therefore, a centralized Supply Chain *N* is not always beneficial. Instead, although independent retailers may be more risk averse than integrated retailers, such a higher risk aversion level can sometimes bring more MR benefits under competition. For example, if Supply Chain *SH* follows the most commonly seen case that sells the imported second-hand clothing to local consumers via Retailer *SH*, the integration of Supply Chain *N* can do more harm than good to the domestic clothing manufacturing industry when the market uncertainty is relatively low.

***Managerial Implication 2 from Proposition 3:*** *A centralized structure of Supply Chain N does not mean Supply Chain N can always benefit more from the CaS scheme. Instead, if the market uncertainty is relatively low, a decentralized structure can help bring more value to the domestic clothing manufacturing industry.*

**5. Social Health Risk of Second-hand Product**

As is discussed in Section 3, the second-hand clothing products may induce diseases like scabies, lice and ringworm. Under epidemic outbreaks and pandemics like the 1918 influenza, SARS, Ebola, and COVID-19, the health risks associated with the second-hand clothing products can even be catastrophic. The potential social health risk (SHR) therefore will no doubt affect the consumers’ purchasing decisions, and also the firms’ equilibrium pricing decisions. In this subsection, we explore the impacts brought by the SHR of the second-hand clothing product on the performance of the CaS scheme and how SHR of the second-hand product affects the LDC governments’ motivation of adopting the CaS scheme. To this end, we define the value of tariff protection (*VTP*) as the MRB difference of Supply Chain *N* between the case with the CaS scheme (i.e., Case *TH*) and the case without tariff protection (i.e., Case *T1*), i.e., . Accordingly, we have Proposition 4.

**Proposition 4.** *In a competitive LDC market with a new product and an imported second-hand product: i) The VTP is always positive. ii) Any increase in the SHR of the second-hand product will increase the VTP. iii) If Retailer N and the domestic manufacturer are both risk seeking, any increase in the market demand uncertainty or in the risk seeking level of Retailer N (or the domestic manufacturer) will increase the influences of the SHR of the second-hand product on the VTP.*

Proposition 4 i) verifies our previous result that adopting the CaS scheme can lead to a higher MRB level for Supply Chain *N*. Proposition 4 ii) shows that a higher SHR of the second-hand product will make the CaS scheme more efficient in boosting the domestic manufacturing industry. The findings in Proposition 4 are reasonable as by referring to Table A2b (Online Supplementary Appendix A), we can find that a higher SHR of the second-hand product always increases the retail price difference between the locally manufactured new product and the second-hand product, and accordingly increases the influences of all the three components in the CaS scheme (i.e., *,* , and ).[[17]](#footnote-18) In practice, for instance, the retail price difference between the locally manufactured new product and the second-hand product in Burundi may increase from the 2 to 4 times to be as high as more than 10 times (just like the Uganda market)[[18]](#footnote-19), if the SHR of the second-hand product increases significantly. Under this case, the CaS scheme can be of great help in relieving the increase in the retail price difference brought by a high SHR and thus protect the domestic clothing manufacturing industry. Besides, the LDC market is associated with uncertainties and risks. Proposition 4 iii) points out that although the CaS scheme can substantially enhance the overall profit level of Supply Chain *N*, it can also bring an increased operational risk level. The risk trade-offs therefore should be carefully considered and weighted by the policy-makers. Given that both the CaS scheme (as proved in Section 4) and a high SHR can help. Next, we explore which one can be more influential on the domestic manufacturing industry.

***Proposition 5.*** *In a competitive LDC market with a new product and an imported second-hand product: i) When both and are sufficiently small (i.e., and ), the unit increase brought by the SHR of the second-hand product in the MRBs of Retailer N and the domestic manufacturer can be much larger than all the three components in the CaS scheme. ii) When is sufficiently large (i.e., ), and is sufficiently small (i.e., ), the unit decrease brought by the SHR of the second-hand product in the MRBs of Retailer SH and the local importer can also be much larger than all the three components in the CaS scheme.*

Proposition 5 supplements the findings in Proposition 2 and shows the significant impacts of the SHR of the second-hand product under some conditions. To be specific, personal financial circumstances determine consumers’ behaviour (Coughlan et al. 2010) and the low-income consumers in LDCs are known for their high sensitivity to the retail price while limited knowledge on the SHR of the second-hand product. Proposition 5, however, reveals that devoting more efforts to enhancing the SHR awareness among the low-income consumers can sometimes bring more benefits than the CaS scheme. For instance, we can see that when the unit production cost of the locally manufactured new product and the unit purchasing cost of the imported second-hand are both sufficiently small, the unit increase in the MRBs of Retailer *N* and the domestic manufacturerinduced by the SHR of the second-hand product can be much larger than the unit increase brought by all the three components in the CaS scheme. This critically reveals the potential limitations of the CaS scheme compared with the impacts of a high SHR of the second-hand product. To this end, the LDC governments can encourage entities like the government ministries of health and other non-governmental socially-responsible organizations to launch public health media campaigns about the SHR of the second-hand products. Countries including Poland, Philippines and Pakistan can all be a good reference here, in which their markets favour second-hand products less. Alternatively, to inform consumers the SHR of the second-hand product, the LDC government can also follow the practices of India and require all imported second-hand product affixed with a certificate including details regarding where the second-hand product is from. Otherwise, since any increase in the import tariff or VAT on the second-hand product can lead to higher retail prices of both products, an overly high import tariff or VAT under the CaS scheme brings an additional financial burden to the consumers of both the second-hand product and the locally manufactured new product. Consequently, consumers of the locally manufactured new product also suffer. This result is also in line with the extant literature such as Zhao et al. (2018), which highlights the influential role of information disclosure (regarding product attributes) under a competitive market.

Proposition 5 is especially pertinent for catastrophes like the 1918 influenza, SARS 2002, and the COVID-19 outbreak, and can provide important references for the future epidemics/pandemics. The extremely high infection rate of the COVID-19 and the subsequent mortality rate, for example, can both bring a high SHR of the second-hand product. Meanwhile, the mass unemployment and the shrinking individual incomes also brings huge financial burden to the consumers. Given these challenges induced by the COVID-19 outbreak and the personal financial circumstances of the low-income consumers in the LDC markets, focusing on the SHR of the second-hand products can benefit the consumers more than the CaS scheme. Furthermore, the spending in healthcare systems is tremendous (KC et al. 2020; Keskinocak and Savva 2020). As the examples of the largest European countries, around 9%–12% of their gross domestic products was spent on the healthcare systems in 2017 (Sawyer and Cox 2018). Such healthcare spending is non-sustainable for the LDC governments, especially under the current circumstances characterized by a sluggish economy. Findings in Proposition 5 therefore can also help relieve the pressure on the LDC governments when facing the limited healthcare budget and help avoid large government deficits induced by the high SHR of the second-hand product under disease outbreaks.

***Managerial Implication 3 from Propositions 4 and 5*:** *It is beneficial to impose import tariff protection especially when the SHR level of the second-hand product is high. Besides, the LDC governments are also suggested to increase the education efforts (or require relevant certificates) for enhancing the consumers’ SHR awareness of the second-hand products, which can sometimes outperform import tariff protection.*

**6. Social Welfare and Extended Importer Responsibility**

Previous findings can be a good reference to governments, such as the Ghana government and the sub-Saharan African government, whose current priority is mainly on their economic development rather than the consumer surplus. Serving as a public sector, however, the LDC government still needs to think about the overall social welfare. Therefore, we extend to analyse the social welfare of the LDC and aim to solve RQ 2 and RQ 3. Different government preferences under the ever-changing government strategies are captured by the affinity indicator . Following the previous discussions, we continue to focus on Case *TH* below. While for other four cases listed in Table 1, similar results can be derived by setting one or more of the three components (i.e., , , and ) into zero. In addition, governments usually have budget constraints in practice (Huang et al. 2014). The discussions next therefore mainly focus on the case with a relatively high direct healthcare system cost of the second-hand product, which is more crucial to the LDC government given its limited public resources and poor health infrastructure. This also addresses the shrinking economy and the limited government healthcare budget under catastrophe like the 1918 influenza and COVID-19. While for the case with a low direct healthcare system cost, findings can be obtained by following a similar logic.

**6.1 Impacts of the CaS Scheme on Social Welfare**

As is introduced in Section 3, the LDC government can either be consumer surplus oriented or profit-oriented, with denotes the LDC government’s emphases on profits and represents the LDC government’s emphases on consumer surplus. Accordingly, we have Proposition 6, which solves RQ 2.

**Proposition 6.** *In a competitive LDC market with a new product and an imported second-hand product: a) When the direct healthcare system cost of the second-hand product is sufficiently high (i.e., ): i) The overall social welfare increases in the VAT , the import tariff , and the extra manufacturing incentive if the LDC government puts enough emphasis on the overall profit (i.e.,); ii) The overall social welfare decreases in the VAT , the import tariff , and the extra manufacturing incentive if the LDC government puts enough emphasis on the consumer surplus (i.e.,. b) When the direct healthcare system cost of the second-hand product is sufficiently high (i.e., ): i) An increase in the unit SHR of the second-hand product can reduce the overall social welfare if and only if the LDC government puts enough emphasis on consumer surplus (i.e.,); ii) An increase in the unit SHR of the second-hand product can increase the overall social welfare if and only if the LDC government puts enough emphasis on the overall profit (i.e.,).[[19]](#footnote-20)*

|  |  |
| --- | --- |
|  | **Social welfare:**  |
|  | i) When : |  if and only if ;  if and only if . |
| ii) When :  |  if and only if ;  if and only if . |
|  | i) When :  |  if and only if ;  if and only if . |
| ii) When : |  if and only if ;  if and only if . |
|  | i) When : |  if and only if ;  if and only if . |
| ii) When :  |  if and only if ;  if and only if . |
|  | i) When :  |  if and only if ;  if and only if . |
| ii) When : |  if and only if ;  if and only if . |

**Table 5.** Impacts of increasing different components in the CaS scheme and the unit SHR on social welfare.

The relative importance of different competing social objectives (i.e., the overall profit and consumer surplus in this paper) can vary from country to country and from time to time. No single social welfare policy is always optimal at all times and in all societies. Proposition 6 therefore shows the influences brought by the CaS scheme and a high SHR of the second-hand product on social welfare, under the consideration of different social welfare options of the LDC government. From Proposition 6a), it can be found that when the direct healthcare system cost of the second-hand product is sufficiently large, a more profit-oriented LDC government can launch a CaS scheme with large values of all three components (i.e., the import tariff , the VAT , and the manufacturing incentive ) to increase the social welfare of the LDC society. This is because although such a CaS scheme would increase the retail prices of the new product and the second-hand product and reduce consumer utilities, the LDC government values the increased overall profit more, especially the MRB difference of Supply Chain *N*. Similarly, Proposition 6b) shows that despite the higher direct healthcare system cost and the reduced consumer utility of buying the second-hand product, a higher SHR of the second-hand product can also increase the social welfare if the LDC government is more profit-oriented. That is, although the second-hand product can bring SHRs to consumers, allowing the second-hand product in the LDC market can still benefit the society, as long as the consumers are well informed with the potential SHR. This is an interesting finding and also explains why some LDCs have not prohibited the second-hand products but proposed the CaS scheme instead. Following the same logic, if the LDC government puts enough emphasis on the consumer surplus rather than the overall profit, the high SHR of the second-hand product, and the low consumer utilities of buying a new product and a second-hand product under the CaS scheme will be the major concern of the LDC government. As a result, social welfare suffers. Interested readers can also refer to Table 5 above and Table A4 in Online Supplementary Appendix A for more details. Proposition 6 therefore explains why the LDC government would still implement the CaS scheme even under the cases when the consumers may suffer (e.g., due to an increased VAT or import tariff).

***Managerial Implication 4 from Proposition 6*:** *When imposing the import tariff scheme, the LDC governments should pay close attention to the direct healthcare system cost of the second-hand product and make a reasonable trade-off between consumer surplus and the overall profit. In particular, when the direct healthcare system cost of the second-hand product is sufficiently high, the overall profit-oriented LDC governments can benefit more from a CaS scheme with sufficiently heavy weights on the import tariff, VAT, and manufacturing incentive.*

Following the set of parameters values in Online Supplementary Appendix B1, and let (i.e., when the LDC government puts the same emphasis on consumer surplus and the overall profit)[[20]](#footnote-21), we next numerically explore the impacts of the consumer acceptance level for the second-hand product (i.e.,) on social welfare.[[21]](#footnote-22)

**Observation 1*.*** *i) A higher consumer acceptance level for the second-hand product (i.e.,) can not only increase consumer surplus (i.e., ) and social welfare (), but also increase the performance of the extra manufacturing incentive in increasing consumer surplus; however, it can also reduce the performance of the import tariff and the VAT in increasing marginal benefits in consumer surplus and social welfare; ii) A higher consumer acceptance level for the second-hand product (i.e.,) can relieve the influences induced by a higher SHR .*

The results in Table B1b (Online Supplementary Appendix B2) show the robustness of our analytical results derived in the previous sections. In the meantime, it also reveals that a higher consumer acceptance level for the second-hand product (i.e., larger) can lead to a larger decrease in consumer surplus when the LDC government increases the import tariff, and the VAT charged on the second-hand product. This is because when the consumer acceptance level for the second-hand product is high, the market demand of the second-hand product is also high. As a result, any increase in the retail price induced by an increased import tariff, or an increased VAT can considerably reduce the overall consumer surplus. This also reduces the performance of the import tariff, and the VAT in increasing the overall social welfare. Therefore, when the consumers have a higher acceptance level for the second-hand product, the LDC government should increase the consumer surplus by increasing the extra manufacturing incentive provided to the local manufacturer. This can not only decrease the retail price of the new product, and but also effectively dampen the negative influences brought by a high SHR of the second-hand product (which can even be more influential than all the three components in the CaS scheme). Consequently, both consumers and the LDC society are benefitted.

***Managerial Implication 5 from Observation 1*:** *The LDC governments should pay close attention to the impacts of the consumer acceptance level on social welfare. For instance, when the consumer acceptance level for the second-hand clothing products is high, the consumer surplus oriented LDC governments should emphasize more on the extra manufacturing incentive provided to the locally manufactured new products rather than the import tariff or the VAT.*[[22]](#footnote-23)

**6.2 Extended Importer Responsibility: Sterilization of the Second-hand Product**

Sterilization certificates for the second-hand products are popular in practice. According to American Law Label, Inc., for instance, some states in the USA (e.g., California, New York, and Texas) and Canada require the used products to be sterilized before import and the second-hand labels with full information about the sanitizer are mandatory.[[23]](#footnote-24) Similarly, some LDCs like Uganda and Tanzania also require sterilization certificates for the second-hand products at the time of import. Given the importance of SHR and hygiene and the popularity of sterilization certificates, we therefore explore the case with the Extended Importer Responsibility (*EIR*) legislation on the second-hand product in this section. Under the *EIR* legislation, no import tariff is charged but the local importer has to sterilize the second-hand product first (and attach the sterilization certificate) before selling it to Retailer *SH*. By doing so, the local importer has an extra sterilization cost () and the per unit import cost of each second-hand product thus becomes . Under this scheme, both the SHR of the imported second-hand product and the LDC government’s direct healthcare system cost are eliminated, as well. Accordingly, we have Propositions 7 and 8.

**Proposition 7.***Under the EIR legislation: i) When , we have , , , ; ii) When , we have , , , ; iii) When , we have , , , ; iv) When , we have , , , .[[24]](#footnote-25)*

Interestingly, Proposition 7 shows that only when the extra sterilization cost is sufficiently high (), can forcing the local importer to sterilize the second-hand product be a better choice for boosting the domestic manufacturing industry. Otherwise, if the extra sterilization cost is sufficiently low (e.g., ), the *EIR* legislation will only yield lower MRBs of both the domestic manufacturer and Retailer *N*, but bring more MRBs to the local importer and Retailer *SH*. In fact, when is sufficiently low, we have . For this case, although the LDC government can increase the local importer’s cost and meanwhile eliminate the SHR by forcing the local importer to sterilize the second-hand product, it only brings more harm than good to the domestic clothing manufacturing industries. Launching import tariff schemes like the pure import tariff scheme (Case *T2*) and the CaS scheme (Case *TH*), therefore, is always a better solution when is sufficiently low, rather than imposing the *EIR* legislation.

**Proposition 8.***Under the EIR legislation: i) An increased sterilization cost benefits the domestic manufacturer and Retailer N (i.e., and ) if and only if the per unit sterilization cost is sufficiently large (i.e.,); ii) For social welfare: a) When the sterilization cost is sufficiently low (i.e., ), the overall social welfare increases in the sterilization cost if the LDC government puts enough emphasis on the overall profit (i.e.,)[[25]](#footnote-26); b) When the sterilization cost is sufficiently high (i.e., ), the overall social welfare increases in the sterilization cost if the LDC government puts enough emphasis on the consumer surplus (i.e.,).*

Proposition 8 shows that replacing the import tariff schemes by forcing the local importer to sterilize the “imported second-hand clothing” is not necessarily beneficial to the whole society. This finding, together with Proposition 7, shows that launching import tariff schemes like the pure import tariff scheme (Case *T2*) and the CaS scheme (Case *TH*) can be a better solution. In fact, contrary to the “uncontrollable” sterilization cost of the second-hand product, which depends on factors like the quality and the sourcing countries, import tariff schemes also give the LDC government better control over second-hand clothing import management.

***Managerial Implication 6 from Propositions 7 and 8*:** *Under some cases, imposing the Extended Importer Responsibility (EIR) legislation on the local importer to sterilize the second-hand product can also harm the whole society.*

**7. Conclusion**

**7.1. Concluding Remarks**

Considering the overwhelming trend of the second-hand clothing trade in LDCs, the domestic manufacturers in LDCs have suffered tremendously. Many LDC governments, therefore, have imposed tariff policies on the imports of second-hand clothing. Motivated by this observed real-world practice, this paper establishes a stylized game-theoretic model to explore whether the import tariff policies really help boost domestic clothing manufacturing industries in LDCs and uncover the optimal structure design of the import tariff schemes under the “carrot-and-sticks (CaS) structure”. A two-stage Stackelberg gaming model that captures the competition game between the locally manufactured new product and the imported second-hand product is established, and the risk attitudes of supply chain members have been considered. Besides, benefits of the import tariff policies to the whole society of LDCs are also examined with the considerations of various important factors like the SHR of the second-hand product.

From our analyses, we find that the CaS scheme, which includes a percentage import tariff (the first “stick”) and a value-added tax (VAT) charged on the imported second-hand product (the second “stick”), and an extra manufacturing incentive offered to the domestic manufacturer for locally produced new product (the “carrot”), is influential in affecting the pricing decisions of all supply chain members. In the meantime, however, LDC governments should pay close attention to the unit supply cost for each imported second-hand product, the domestic manufacturer’s per-unit production cost of the new product, the SHR of the second-hand product, as well as the consumers’ acceptance level of the second-hand product. For instance, when the consumer acceptance level for the second-hand clothing products is high, the consumer surplus oriented LDC governments should emphasize more on the extra manufacturing incentive provided to the locally manufactured new products rather than the import tariff or the VAT. Moreover, replacing the import tariff schemes by forcing the local importer to sterilize the “imported second-hand clothing” (e.g., by imposing the *EIR* legislation) is not necessarily beneficial to the whole society. This is especially unwise when the unit supply cost for each imported second-hand product is sufficiently low. Our research therefore provides an important guide for the LDC governments to design an effective import tariff scheme with respect to its relative emphasis placed on consumer welfare and the overall profit.

These findings complement the existing theories as follows. First of all, in the OM literature exploring LDCs and developing economies, most studies (e.g., Chen et al. 2015; Gui et al. 2018; Taylor and Xiao 2019) focus on the domestic market while no interactions with imported products are explored. Besides, when exploring the LDC government’s trade-off between the profits and consumer welfare, the government’s profit and the global trade conflicts are neglected. This paper hence contributes to the LDCs and developing economy theories by showing the performance of relevant real-practice based government policies with the considerations of all these factors. Secondly, in the second-hand market and socially responsible operations related theories, both the competition game in a global LDC based market and the health risk problems of the imported second-hand products have been neglected (e.g., Guide Jr et al. 2006; Zhang and Zhang 2018; Orsdemir et al. 2019). This paper incorporates these important aspects into the model and generates the respective insights. Thirdly, for the economic sciences of tariff and import protection (TIP), the majority of existing TIP research focuses on the purpose and design of the World Trade Organization (WTO) and the General Agreement on Tariffs and Trade (GATT) rules under a general country background (e.g., Broda et al. 2008; Amador and Bagwell 2013; Ossa 2014). However, the economics of import tariff schemes designed specifically for the LDCs and the associated feasibility remain unexplored. This paper thus bridges this gap. Finally, this paper also addresses public health and the governmental health systems challenges, which is emphasized in a global poverty research that has won the Economics Nobel prize 2019. Our work hence contributes to this area of research. Appendix A shows an elaborated discussion of the managerial implications.

**7.2. Future Studies**

Several extensions of this paper merit further investigation. First, an important policy goal of the import tariff scheme in this paper is to help boost the domestic manufacturing of LDCs. The major focus of this paper therefore is more on the firms in LDCs. For further studies, it will be interesting to study the import tariff practices with more emphases on the environment and people. From this perspective, how the government determines the optimal values of import tariff and other related parameters (e.g., the value-added tax and the local manufacturing incentive) becomes an interesting issue to explore. In addition, a variable SHR can also be considered, together with the investigation on government policy design for addressing the SHR associated with the second-hand clothing products. Second, we have not considered the presence of multiple domestic manufacturers and the respective competition effect in our model. It would be interesting to examine how this type of competition will affect the imposition of tariff policies in the LDCs. Third, more studies could be done in the area of the LDCs markets to derive more insights on the factors that influence operations of the domestic manufacturing firms (e.g., the innovative production schemes for new products with the consideration of competitive threats from the imported second-hand products).

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2. Notice that a list of all related key links is provided in Table D1 in Appendix D. [↑](#footnote-ref-2)
3. Interested readers can refer to Table D2a and Table D2b in Appendix D for more information. [↑](#footnote-ref-3)
4. Notice that according to the UN Development Program, among the current 46 SSA countries, 30 of them are LDCs. [↑](#footnote-ref-4)
5. In Burundi, the retail price of the second-hand products can be nearly 2 to 4 times cheaper than brand new clothes and shoes. While in Uganda, the difference is even more than 10 times. (Interest readers can refer to Table D4 in Appendix D for more information). [↑](#footnote-ref-5)
6. Detailed import tariff policies in these LDCs countries are listed in Table D3a and Table D3b in Appendix D. [↑](#footnote-ref-6)
7. The value of each component is exogenously given as our aim is not to determine the optimal regulation parameters, rather to understand the performance of different schemes in practices. A similar setting can also be found in the government intervention literature like Gui et al. (2018). This in fact also addresses the real-world practices, as with various political concerns under international trades, the LDC government can never arbitrarily set the optimal value of each regulation component. [↑](#footnote-ref-7)
8. Notice that this paper focuses on the clothing products. For the sake of simplicity, unless otherwise specified, in later discussions, we use the word “product” to denote “clothing product”. [↑](#footnote-ref-8)
9. Notice that adding other schemes (e.g., a constant VAT on the domestic new product) does not influence the robustness of our findings. [↑](#footnote-ref-9)
10. As we have explained in Section 3, we only focus on Region 2 (among the three market demand scenarios) in this paper, i.e., the case when $\frac{-ρ(1-t\_{SH})^{2}}{C\left(1+k\_{SH}\right)}<m\_{SH}<\frac{ω(1-t\_{SH})^{2}}{B\left(1+k\_{SH}\right)}$. This is reasonable because when the unit wholesale price of the imported second-hand product (i.e., $m\_{SH}$) is too low or too high, only one product exists in the market and we are no longer able to study the effect of the import tariff scheme on the competition between products. The feasible range of $m\_{SH}$ is not empty if and only if $m\_{N}<\frac{1}{1-h\_{N}}$ (while this condition always holds because $m\_{N}<1$ and $\frac{1}{1-h\_{N}}>1$). [↑](#footnote-ref-10)
11. Notice that, throughout this paper, when we mention the CaS scheme, it refers to Case *TH*. [↑](#footnote-ref-11)
12. Interested readers can refer to Table D4 in Appendix D for more details about the degree of retail price differentiation between the second-hand product and the new product in LDCs. [↑](#footnote-ref-13)
13. By taking the first-order derivative of the retail price difference (i.e., $∆p^{\*}=p\_{N}^{\*}-p\_{SH}^{\*}$) with respect to these three different components, it can be found that the CaS scheme is effective in reducing the retail price difference (as is shown in Table A2a in Online Supplementary Appendix A). [↑](#footnote-ref-14)
14. Referring to Table A3a and Table A3b in Online Supplementary Appendix A, we can see that raising the unit VAT$t\_{SH}$ is the most effective one for discouraging the profits of Retailer *SH* and the local importer when $m\_{N}>\frac{Bξ\_{SH}-2δDF}{δC(1-h\_{N})}$ and $m\_{SH}>(1-t\_{SH})^{2}$. The conditions for raising the profits of both Retailer *N* and the domestic manufacturer are listed in Proposition 2. Therefore, when $m\_{N}$ and $m\_{SH}$ are sufficiently large (i.e., satisfy both Proposition 2 i) as well as $m\_{N}>\frac{Bξ\_{SH}-2δDF}{δC(1-h\_{N})}$ and $m\_{SH}>(1-t\_{SH})^{2}$), raising the unit VAT$t\_{SH}$ on the imported second-hand product can have the best performance in boosting the domestic clothing manufacturing industry in the competitive LDC market and simultaneously discouraging the market on the imported second-hand product. [↑](#footnote-ref-15)
15. As classified by the World Bank in 2018, LDCs like Burundi, Rwanda, Tanzania and Uganda are all listed as Low income Region. Therefore, it is reasonable to believe that the large population in LDCs is the low-income earners. Interested readers can refer to Note 13 in Table D1 for more information. Besides, more details can also be found in Table D3b in Appendix D. [↑](#footnote-ref-16)
16. The AGOA trade scheme stands at approximately 6,500 product tariff lines, including the tariff lines for items such as apparel and footwear, a variety of chemicals, as well as many others. [↑](#footnote-ref-17)
17. Notice that the SHR of the second-hand product $ξ\_{SH}$ here can never be infinite. Because as we have explained in Section 3, we only focus on Region 2 (among the three market demand scenarios) in this paper, i.e., the case when $\frac{-ρ(1-t\_{SH})^{2}}{C\left(1+k\_{SH}\right)}<m\_{SH}<\frac{ω(1-t\_{SH})^{2}}{B\left(1+k\_{SH}\right)}$. As a result, we have $ξ\_{SH}\in (\frac{\left[B\left(1-h\_{N}\right)m\_{N}-EF\right]\left(1-t\_{SH}\right)^{2}-\left(1+k\_{SH}\right)m\_{SH}}{\left(1-t\_{SH}\right)^{2}},\frac{\left[C\left(1-h\_{N}\right)m\_{N}+2DF\right]δ\left(1-t\_{SH}\right)^{2}-\left(1+k\_{SH}\right)m\_{SH}}{\left(1-t\_{SH}\right)^{2}})$. [↑](#footnote-ref-18)
18. Interested readers can refer to Table D4 in Appendix D for more details about the degree of retail price differentiation between the second-hand product and the new product in LDCs. [↑](#footnote-ref-19)
19. $\overbar{Γ\_{SH}}=max⁡(\frac{AG\left(1-t\_{SH}\right)^{2}[δCm\_{N}-B(m\_{SH}+ξ\_{SH})]-φ\_{k\_{SH}}^{π}+φ\_{k\_{SH}}^{cs}}{ABG\left(1-t\_{SH}\right)^{2}},\frac{AG\left(1-t\_{SH}\right)^{2}[Bm\_{N}-C(m\_{SH}+ξ\_{SH})]-φ\_{h\_{N}}^{π}+φ\_{h\_{N}}^{cs}}{ACG\left(1-t\_{SH}\right)^{2}})$, and $̿=\frac{AG\left(1-t\_{SH}\right)^{2}[δCm\_{N}-B(m\_{SH}+ξ\_{SH})]-φ\_{ξ\_{SH}}^{π}+φ\_{ξ\_{SH}}^{cs}}{ABG\left(1-t\_{SH}\right)^{2}}$*.* [↑](#footnote-ref-20)
20. Notice that the numerical results under different ranges of $α$ (i.e., $α\in (0.25, 0.75)$) are also provided in in Table B1b in Online Supplementary Appendix B2, which covers both the case when the LDC government is more consumer surplus oriented (i.e., $0<α<0.5$) and the case when the LDC government is more profit-oriented (i.e., $0.5<α<1$). [↑](#footnote-ref-21)
21. Interested readers can also refer to Online Supplementary Appendix B1 for the numerical robustness check of our previous findings and other detailed influences of the consumer acceptance level (for the second-hand product) on the performance of the CaS scheme. [↑](#footnote-ref-22)
22. This insight is supported by the results shown in Table B1b, together with Table B2a, Table B2b, Table B2c and Table B2d in Online Supplementary Appendix B2, which represents different cases of the LDC government’s different emphasis on the overall profit and consumer surplus. [↑](#footnote-ref-23)
23. Interested readers can refer to <https://americanlawlabel.com/law-label-learning-center/> and <https://portal.ct.gov/DCP/Trade-Practices-Division/New-and-Used-Furniture-Labeling-Requirements> for more details. (Retrieved in January, 2021) [↑](#footnote-ref-24)
24. $\overbar{S\_{SH}}=\frac{1+k\_{SH}}{(1-t\_{SH})^{2}}-1+\frac{ξ\_{SH}}{m\_{SH}}+\frac{δCh\_{N}m\_{N}}{Bm\_{SH}}$, $̿=\frac{1+k\_{SH}}{(1-t\_{SH})^{2}}-1+\frac{ξ\_{SH}}{m\_{SH}}+\frac{Bh\_{N}m\_{N}}{Cm\_{SH}}$. [↑](#footnote-ref-25)
25. $\hat{S\_{SH}}=\frac{\left(ABG-3CH\right)m\_{SH}-δC\left(AG+3\right)m\_{N}+2δDF(δM+2CE)}{3CHm\_{SH}}$, and $α^{S\_{SH}}=\frac{φ\_{s\_{SH}}^{cs}}{AG(δCm\_{N}-Bm\_{SH})-φ\_{s\_{SH}}^{π}+φ\_{s\_{SH}}^{cs}}$. [↑](#footnote-ref-26)