HEC MONTRÉAL
École affiliée à l'Université de Montréal

Sustainable product packaging: exploring the organizational buying decision and the effect of the weight-based packaging tax

par
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Thèse présentée en vue de l'obtention du grade de Ph. D. en administration
(option Gestion des opérations et de la logistique)

Juillet 2021

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École affiliée à l'Université de Montréal

Cette thèse intitulée :

Sustainable product packaging: exploring the organizational buying decision and the effect of the weight-based packaging tax

Présentée par :

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Résumé

L'emballage est une préoccupation majeure pour l'environnement, car il est de plus en plus associé à la production de déchets. Il représente environ 30 à 35% des déchets municipaux dans les pays industrialisés et environ 15 à 20% dans les pays en développement. D'où l'urgence de réduire l'impact environnemental des emballages. Cependant, la décision de choix des emballages est complexe, dynamique, multifonctionnelle et interdisciplinaire. Elle implique plusieurs acteurs de la chaîne logistique et exige la conciliation d'un large éventail de critères qui s'avèrent souvent conflictuels. L'aspect environnemental n'est pas nécessairement considéré comme un critère décisionnel prioritaire. Considérant ces enjeux, le premier objectif de cette thèse est de comprendre le comportement d'achat organisationnel des emballages de produits. Le deuxième objectif est d'explorer les incitatifs, les barrières et les bénéfices potentiels associés aux emballages écologiques. Le troisième objectif est d'examiner l'effet de la taxation sur la réduction à la source des emballages, laquelle constitue l'alternative privilégiée dans la hiérarchie de la gestion des déchets. La thèse se subdivise ainsi en trois projets de recherche présentés ci-après.

Le premier projet de recherche investigue la structure du centre d'achat, le processus d'achat et les facteurs qui influencent la décision d'achat des emballages des produits périssables. L'investigation empirique est basée sur l'étude de cas d'un important détaillant alimentaire québécois. Les résultats montrent que le processus décisionnel d'achat des emballages change selon que le produit est qualifié de plus ou moins stratégique pour l'organisation, ce qui conditionne le niveau requis de personnalisation de l'emballage. La structure du centre d'achat se complexifie à mesure que la personnalisation des produits augmente. Étant donné la multifonctionnalité et l'interdisciplinarité des emballages, une grille d'analyse multicritère a été proposée afin d'accroître l'efficacité de cette décision d'achat et fluidifier la communication entre les acteurs du centre d'achat.

Le deuxième projet explore les incitatifs, les barrières et les résultats de performance associés aux emballages écologiques. Une revue systématique de littérature est menée sans aucune limite temporelle. La méthodologie *Methodi Ordinatio* est appliquée, ce qui a permis de retenir 48 articles pertinents publiés dans 26 revues scientifiques. Sept facteurs incitatifs clés sont identifiés et définis: la chaîne logistique intégrée et collaborative, les capacités et les ressources environnementales, les instruments basés sur le marché, la réduction des coûts, la pression des consommateurs, l'avantage concurrentiel et la pression réglementaire. Trois principales barrières sont identifiées et définies: l'ambiguïté coût / bénéfice, les coûts supplémentaires et les compromis complexes entre

les exigences d'emballage. Les incitatifs et les barrières à la durabilité des emballages dépendent de la taille de l'entreprise. Les emballages durables affectent positivement les performances environnementales, sociales et économiques ; cependant, sa performance opérationnelle nécessite une chaîne logistique proactive et intégrée. Nos résultats soulignent l'importance des décisions d'emballage intégrées à trois niveaux différents pour améliorer la durabilité des emballages : intégration verticale et horizontale, intégration en amont et en aval et intégration produit-emballage. Des propositions de recherche et des avenues de recherche sont élaborées pour orienter les recherches futures dans ce domaine.

Le troisième projet examine l'effet de la taxe sur les emballages sur la décision des manufacturiers et des détaillants alimentaires de produire moins d'emballages à la source. Nous utilisons des données longitudinales sur les quantités d'emballage générées entre 2005 et 2017 dans la province de Québec (Canada). Deux modèles à effets fixes sont d'abord estimés, ensuite les résultats sont triangulés avec des données qualitatives issues d'entrevues en profondeur et d'un groupe de discussion avec des parties prenantes clés. Les résultats montrent que l'effet de réduction de la taxe sur les emballages est sensible aux particularités des emballages. Les manufacturiers et les détaillants sont prêts à supporter des taxes élevées sur les emballages lorsqu'ils présentent des avantages opérationnels, environnementaux et techniques. Par conséquent, les décideurs ne doivent pas s'attendre à ce que seule l'augmentation des taxes produise l'effet de réduction pour l'ensemble des emballages. Cependant, la variation des taxes en fonction de la recyclabilité des matériaux d'emballage s'avère efficace. La taxe sur les emballages étant facturée sur la base du poids, les décideurs sont enclins à saisir l'opportunité de réduire leurs coûts en substituant les matériaux hautement taxés par des matériaux faiblement taxés. La disponibilité locale des matériaux d'emballage façonnerait cette élasticité de substitution. L'absence d'un cadre réglementaire combiné aux prix élevés des matériaux recyclés, leurs difficultés techniques et leurs problèmes de disponibilité, amènent les manufacturiers à choisir des matériaux vierges. Quant aux détaillants, ils sont prédisposés à payer un prix élevé pour renforcer leur image de marque. Des recommandations sont formulées pour améliorer l'efficacité de la taxe sur les emballages.

Mots clés : Emballage écologique, comportement d'achat organisationnel, incitatifs, barrières, résultats de performance, réduction à la source des emballages, instruments basés sur le marché, taxe sur les emballages, responsabilité élargie du producteur.

Méthodes de recherche : Étude de cas, revue de littérature systématique, étude longitudinale, entrevues semi-structurées, groupe de discussion.

Abstract

Packaging is a major environmental concern since it is increasingly associated with waste production. It accounts for about 30 – 35% of the municipal waste in industrialized countries and about 15 – 20% in developing countries. This has placed enormous pressure on the packaging industry to reduce its environmental impact. However, the packaging decision is complex, dynamic, multifunctional, and interdisciplinary. It involves multiple supply chain actors and necessitates fulfilling various and sometimes conflicting requirements arising both from the business and the wider supply chain. The environmental attribute of packaging is not a priority decision criterion. Considering this, the first objective of this thesis is to gain a better understanding of the organizational buying behaviour of product packaging. The second objective is to explore the drivers, barriers, and performance outcomes of sustainable packaging. The third objective is to examine the effectiveness of the weight-based packaging tax on the reduction at source of product packaging, which is the most preferred alternative in the waste management hierarchy. The thesis is split into three research projects as follows.

The first project investigates the structure of the buying centre, the buying process, and the factors that influence buying decisions for perishable-products packaging. The empirical investigation is based on the case study of a major Quebec food retailer. We show that the buying decision process of packaging changes significantly depending on whether the product is considered as strategic for the organization, which determines the required level of packaging customization. Buying centre structure becomes more complex as packaging customization increases. Given the multifunctionality and the interdisciplinarity of packaging, we propose a multi-criteria analysis grid to improve buying decision efficiency and to streamline communication between the various levels of the buying centre.

The second project presents a comprehensive overview of the influencing factors that incentivize or deter firms from pursuing sustainable packaging as well as its performance outcomes. A systematic literature review is conducted within no time limit of sustainable packaging research. The *Methodi Ordinatio* methodology is applied, which resulted in retaining 48 relevant articles and high impact articles published in 26 journals with various scopes. Seven key drivers are identified and defined: the integrative and collaborative supply chain, environmental capabilities and resources, market-based instruments, cost reduction, consumer pressure, competitive advantage, and regulatory pressure. Three main barriers are identified and defined: cost/benefit ambiguity, additional costs, and complex trade-offs between packaging requirements. The review shows that the drivers

and barriers to packaging sustainability are contingent to firm size. Sustainable packaging positively affects the environmental, social, and economic performance; however, its operational performance requires a proactive and integrated supply chain. Our results highlight the importance of integrated packaging decisions at three different levels to improve packaging sustainability: vertical and horizontal integration, upstream and downstream integration, and product-packaging integration. We developed research propositions and provided insightful directions for future research.

The third project examines the effect of the packaging tax policy on food manufacturers' and retailers' decision to produce less packaging at the source. We analyze a longitudinal data set for the packaging quantities generated from 2005 to 2017 in the province of Quebec (Canada). Two fixed effect models are estimated, then the results are triangulated with qualitative evidence from in-depth interviews and a focus group with key stakeholders. We show that the reduction effect of the packaging tax is sensitive to the targeted packaging particularities. Manufacturers and retailers are willing to bear high tax fees for food packaging when it has important operational, environmental, and technical benefits. Hence, policymakers should not expect that only increasing taxes will always produce the expected reduction effect for all packaging, because other important decision-making criteria come into play when choosing the food packaging. However, varying taxes according to packaging material recyclability is found to be effective. Indeed, since the packaging tax is charged on a weight basis, decision makers are inclined to seize the opportunity of reducing their costs by substituting high-taxed materials with low-taxed materials. The local availability of packaging materials would shape this substitution elasticity, hence applying the "material levies" suggested by previous studies might be an ineffective approach if the expected reduction at source is to be achieved. The absence of a regulatory framework combined with high-priced recycled materials, technical difficulties, and availability issues, lead manufacturers to choose virgin materials while retailers are predisposed to pay a high price to benefit from the recycled content branding. Practical recommendations are proposed to enhance the effectiveness of the packaging tax.

Keywords: Sustainable packaging, organizational buying behaviour, drivers, barriers, performance outcomes, reduction at source of packaging, weight-based packaging tax, extended producer responsability.

Research methods: Case study, systematic literature review, longitudinal study, semi-structured interviews, focus group.

Table of contents

List of figures

List of tables

Dédicace

À la mémoire de mon père (1945-2014), un père exemplaire qui a su me transmettre toutes ses belles valeurs. Que ce travail soit le fruit de tous ses sacrifices.

Remerciements

Une thèse est un chemin long et laborieux où la patience et la détermination sont continuellement mises à l'épreuve. Je n'aurais pu mener ce parcours seule sans l'appui et le soutien de plusieurs personnes pour lesquelles j'ai une très vive reconnaissance et une immense gratitude.

Mes plus vifs remerciements s'adressent en premier lieu à mes deux directeurs de recherche, Claudia Rebolledo et Jacques Roy. Je suis particulièrement reconnaissante à votre rigueur, attention, patience et écoute. Vos commentaires éclairés et vos conseils avisés dans des moments cruciaux m'ont permis d'affiner ma réflexion et d'aller au bout de cette thèse. Votre complémentarité exceptionnelle a été précieuse et stimulante. Vous avez su me transmettre les valeurs de responsabilité, d'intégrité et d'engagement. Des valeurs essentielles qui façonneront ma carrière dans le milieu académique. Merci Claudia. Merci Jacques.

Avec une immense gratitude, je tiens à remercier Francine Rodier et David B. Grant pour leurs commentaires rigoureux et leurs précieux conseils. Je tiens également à remercier Daniel Parent pour ses conseils en économétrie et Fabien Durif pour son apport pendant la phase II de mon doctorat. Tous mes remerciements aux autres membres du jury.

Il m'est également agréable d'exprimer ma reconnaissance envers l'ensemble des participants à la collecte de données qualitatives. Qu'ils soient remerciés pour leur précieuse collaboration. Ils ont volontiers accepté de contribuer au projet sans souvent compter leur temps. Sans leur confiance, les données recueillies n'auraient pas eu la même originalité. Ma gratitude s'adresse particulièrement à Éco Entreprises Québec. Je tiens à remercier Marie-Julie Bégin, Geneviève Dionne et Martin Leblond-Létourneau pour leurs conseils. Je tiens aussi à remercier Virginie Bussières pour sa précieuse aide lors de la phase de collecte des données qualitatives.

Tout au long de mon doctorat, j'ai côtoyé plusieurs personnes qui ont stimulé ma réflexion. Je pense ici à Sophie Bernard que je remercie infiniment pour son apport généreux et stimulant. Les échanges avec Sophie ont été l'occasion pour moi de remettre en question mon approche quantitative. Je tiens également à remercier Ann Langley pour ses précieux conseils en lien avec l'approche qualitative. J'ai aussi une pensée particulière aux professeurs du département de gestion des opérations et de la logistique de HEC Montréal, au personnel administratif et de la bibliothèque. En lisant ces lignes, ils sentiront mon appréciation sincère à leur égard.

Finalement, cette thèse n'aurait pu être menée à bien sans le soutien financier du Conseil de Recherche des Sciences Humaines du Canada (CRSH), du Fonds de Recherche Québec, Société et Culture (FRQSC), du Carrefour Logistique (HEC Montréal), de la Fondation HEC Montréal, d'Hydro-Québec, de la Famille Paul Simard et de MITACS. Je vous suis extrêmement reconnaissante de m'avoir permis de me consacrer pleinement à cette aventure. J'ai aussi une pensée particulière pour Marie-France Courtemanche-Bell pour son précieux soutien lors de l'élaboration des demandes de bourses. Je tiens également à remercier Nathalie Bilodeau et Julie Bilodeau pour leurs précieux conseils pendant des périodes charnières du parcours doctoral.

Je ne pourrais terminer sans exprimer mes pensées les plus profondes à mon défunt père. Sa présence continuelle dans mon esprit a été une véritable source d'inspiration et de motivation laquelle m'encourage à me remettre sur les rails dans les moments les plus difficiles. Une mention d'exception à mon mari qui a su faire preuve de patience et de support continu. Merci à ma fille Rim qui est née en plein milieu de mon parcours doctoral. Sa naissance m'a incitée à exiger le meilleur de moi-même pour lui garantir un bel avenir. Mes remerciements les plus vifs à mes chers mère, sœur et frères ainsi qu'à toute ma famille. Sans vous tous, rien n'aurait été possible.

« *Devant moi, il y avait deux routes,*
j'ai choisi la moins fréquentée
et cela a fait toute la différence »
Paulo Coelho

Chapter 1
Introduction

"From breakfast to bedtime, from private occupations to professional activities, humans do not know, do not want and cannot live without packaging" (Pothet, 2008: XIII)

The Environmental Code defines packaging as any product intended to contain and protect goods, ranging from raw materials to finished products, to allow their handling and transport from producer to consumer (Directive 94/62 / EC, article 3). Traditionally, packaging is often seen as a 'necessary evil' generating waste. However, research and practice have proved that it plays an imperative role in most industries, since it ensures numerous marketing, technical and logistical functions. For instance, packaging protects product against physical and chemical effects, ensures safe delivery, enables communication, maximizes sales while allowing efficient logistics and environmental efficiency in supply chain (e.g. Wohner *et al.*, 2019). Far from being subordinate, packaging that fulfills all these requirements can be a value generator for the organization. It is also an enabler of cost efficiency by reducing waste and improving logistics and transport efficiency (e.g. Pålsson, 2018).

However, in recent decades, packaging has become one of the main waste streams and it is increasingly associated with waste production (Singh *et al.*, 2021; Orzan *et al.*, 2018). The reason is that conventional packaging is commonly a one-time use item that is discarded upon reaching the consumer or after using the packed content (Wohner *et al.*, 2019). Concurrently the closure of the Chinese and the Indian waste management markets, which were the main buyers of recyclable materials, turns out to be very challenging and costly for most countries (Éco Entreprises Québec, 2020). Many thousands of tons of material bales are likely to accumulate in sorting centers, leading to multiple environmental, operational, and economic issues. This critical situation leads governments, businesses, and academic communities to reflect more on the environmental impact of packaging and to recognize the key role of packaging sustainability to overcome these challenges (e.g. Singh *et al.*, 2021; Petkoska *et al.*, 2021; Friedrich, 2020).

It has been established that 80% of the environmental impacts of packaging can be prevented at the source, namely at the design stage. This is in line with the principle of zero waste stipulating that "the best waste is that which is not produced" (Recyc-Québec, 2019). Therefore, informed buying decision of product packaging plays a vital role, because it would not only minimize the environmental impact of packaging at end-of-life, but also minimize supply chain costs and increase the value of packed products (e.g. Pålsson, 2018). However, the purchase of product packaging is a complex organizational decision that remains largely unexplored in the current literature. The decision-making unit in charge of this decision is required to conduct complex multicriteria analyzes to balance divergent attributes (e.g. Rundh, 2009; Vam Der Merwe *et al.*, 2013; Pålsson, 2018). There are potentially conflicting trade-offs between logistics, marketing, and environmental functions of packaging. Packaging buyers must reconcile technical, ergonomic, functional, informative, and environmental attributes in product packaging. For instance, marketing requirements for packaging size, consumer convenience, and aesthetic attributes may conflict with volume and weight efficient requirements in logistics (e.g. Pålsson, 2018). Packaging should also maintain the product integrity and quality throughout the supply chain and allow efficient handling, storage, and transport (White *et al.*, 2015; Vernuccio *et al.*, 2010; Verghese and Lewis, 2007).

Besides, packaging buying decision requires different information sources and involves inter-organizational relationships. Multiple stakeholders at the upstream and the downstream of the supply chain (e.g. suppliers, manufacturers, retailers, consumers) are concerned by this decision, but they often display conflicting rationalities. Consequently, several authors underscore the need to explore the buying decision of packaging to better manage trade-offs between requirements from actors in the supply chain (e.g. Garcia-Arca *et al.*, 2014; Jahre *et al.*, 2004; White *et al.*, 2015). The systematic analysis of the buying decision process, the buying center structure, the influencing factors, and the decision criteria will highlight the important parameters enabling optimal buying decision. Hence the first research objective of this thesis which responds to this need by using the case study methodology.

Moreover, the aforementioned stakeholders have various, sometimes even opposed, interests as to the attributes to be favored in a packaging (e.g. Niero *et al.*, 2017). This indicates the complexity to make informed trade-offs between packaging features for different stakeholders (e.g. Pålsson, 2018). The environmental attribute tends to be a relatively important decision-making criterion, but not necessarily a priority for all stakeholders, which further complicates sustainable packaging decisions (e.g. Afif *et al.*, 2020; Gustavo *et al.*, 2018). Some authors underscored that packaging buyers will be urged to reduce the environment impact of packaging only when there are economic gains

or operational cost advantage (e.g. Pullman and Wikoff, 2017; Gustavo *et al.*, 2018). The pressure exerted by the consumer (e.g. Magnier and Crié, 2015; Boz *et al.*, 2020), and by the regulator (e.g. Roine and Chin-Yu, 2006; Fernie and Hart, 2001) also encourage packaging buyers to adopt more sustainable packaging practices. However, other authors suggest that sustainable packaging design can be challenging and costly since it must be eco-friendly while fulfilling its integral functions (e.g. Singh *et al.*, 2021; Wohner *et al.*, 2019). Besides, the ambiguity surrounding the costs and benefits of sustainable packaging practices (e.g. Mollenkopf *et al.*, 2011) would deter packaging buyers from adopting such packaging. Other authors established that the waste reduction derived from sustainable packaging imply a positive influence on business performance through lowering cost and enhancing product quality (e.g. Yusuf *et al.*, 2017).

In sum, previous research has focused on specific drivers, barriers, and performance outcomes of sustainable packaging as well as on specific supply chain perspective, such as that of the consumer, retailer, or regulator. However, a literature overview that captures a comprehensive picture of these three topics and their research streams has not been provided so far. Moreover, considering the interdisciplinary nature of sustainable packaging decisions, this implies a deeper investigation of packaging studies to encompass broader economic, social, and environmental dimensions. Hence the second research objective of this thesis which aims to fill this gap by using the systematic literature review methodology.

To improve the environmental quality of packaging, the Waste Management Hierarchy (Canadian Council of Ministers of the Environment, 2014) suggests that the reduction at source practice is considered as the best solution that enables managing packaging waste effectively and efficiently. In other words, the priority within the waste management hierarchy is to reduce by as much as possible the amount of material that enters the recycling or the solid waste stream and the associated impact on the environment. This practice consists in reducing the quantity and variety of materials as well as optimizing the weight and volume of packaging (Çakir and Balagtas, 2014). To encourage packaging buyers to adopt such a practice, many governments have put in place environmental incentives, such as packaging taxes. The latter represents one of the most important instruments of the Extended Producer Responsibility policy (e.g. Mayers and Butler, 2013). Applied in the form of weight basis charges, the packaging tax aims at encouraging packaging buyers to choose more environmentally friendly packaging materials in order to reduce the amount of waste generated at the end of product life cycle (e.g. Roine and Chin-Yu, 2006; Dace *et al.*, 2014).

However, some authors were cautious about the idea that such instruments always lead to the desired change in firms' environmental practices, because they present firms with the

following dilemma: either decision makers adopt green practices to avoid potential costs related to environmental sanctions, or they bear these costs when they are lower than those incurred by adopting green practices (e.g. Chappin et al., 2009; Røine and Lee, 2006), or they decide to adopt these practices on a voluntary basis (e.g. Mayers and Butler, 2013; Ferreira *et al.*, 2017). Therefore, policymakers have stressed the need to resolve problems connected with the reduction at source of packaging and to promote it more effectively (Yamaguchi and Takeuchi, 2016). Several authors have examined the effectiveness of the packaging tax on different categories of packaging and in different contexts (e.g. Calcott and Walls, 2000; Cela and Kaneko, 2011; Friedrich, 2020), but with disputed results. The methodologies adopted are mainly surveys (e.g. Røine and Lee, 2006), simulations (e.g. Dace *et al.*, 2014) and economic analyzes (e.g. Calcott and Walls, 2000). However, few studies relied on longitudinal data (Cela & Kaneko, 2011; Cela & Kaneko, 2013). Hence the third research objective of this thesis, which responds to these shortcomings by using a mixed methodology combining the analysis of longitudinal and qualitative data.

The structure and the conceptual framework that underlie the thesis are briefly exposed below without going into the details presented in the subsequent chapters. The thesis consists of three research projects to meet the aforementioned research objectives. As illustrated in Figure 1.1, we have adopted a top-down approach. We started with the big picture to get then to more granular details while relying on different methodological approaches.

Figure 1.1. Progression of the thesis

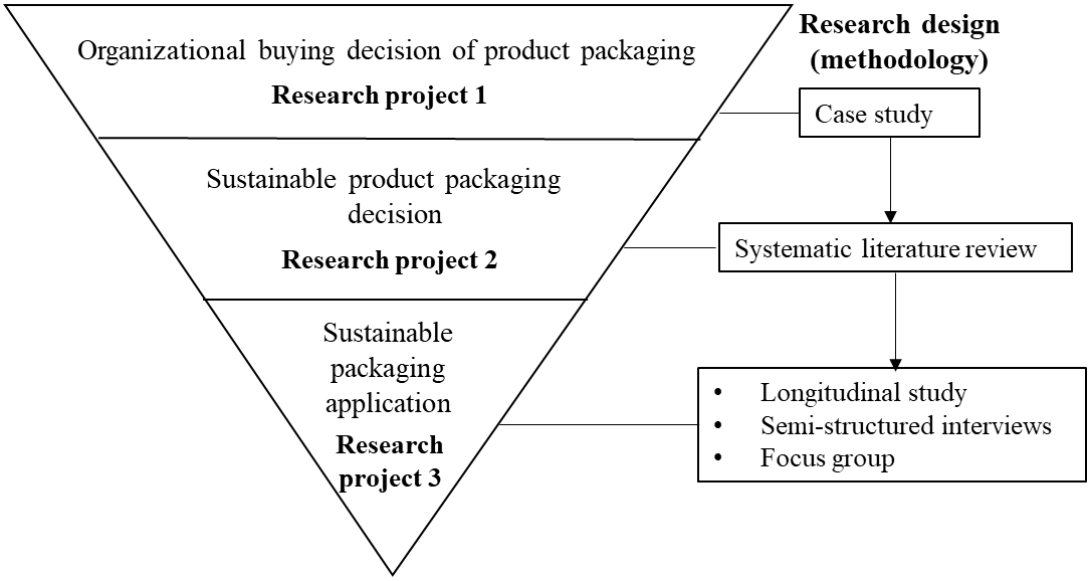
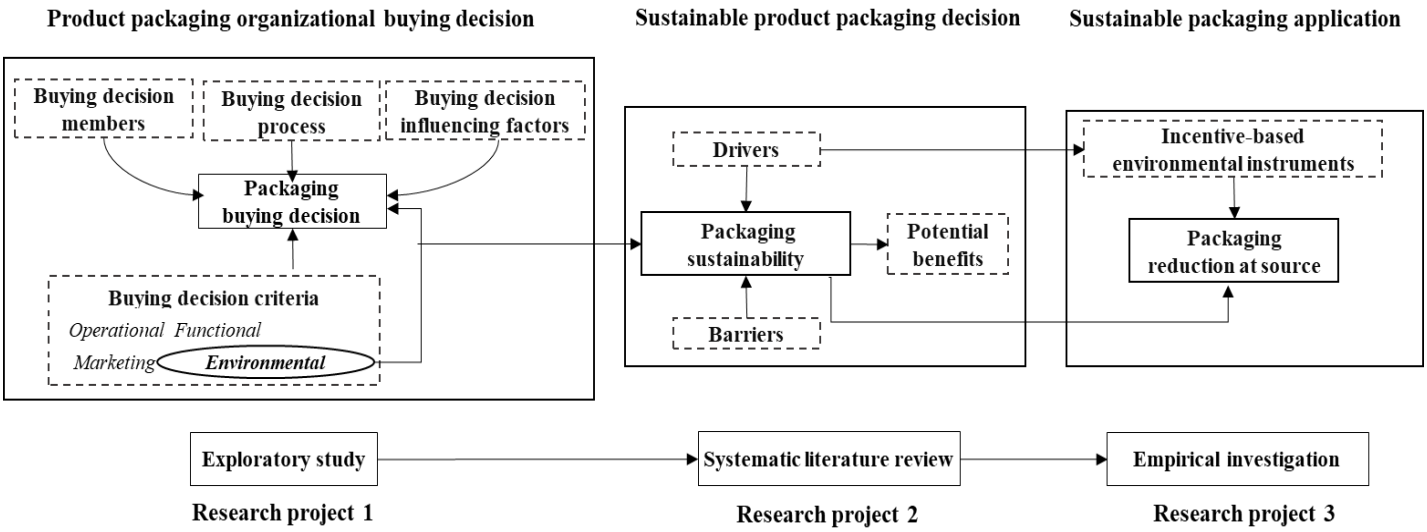


Figure 1.2. shows our conceptual framework. The first research project is the overriding foundation that informs the remainder of the thesis. This project is based on a qualitative exploratory approach to develop an in-depth understanding of the organizational buying behavior of packaging. We explored the buying centre structure (i.e. the actors involved and their roles), the buying decision process, the influencing factors, as well as the buying decision criteria.

The following research project looks at sustainable packaging decisions. It provides a comprehensive overview of previous research on the drivers, barriers, and performance outcomes of sustainable. In other words, we focused on the factors that encourage or deter buyers from pursuing more sustainable packaging practices as well as the potential performance outcomes arising from such practices. The systematic literature review methodology is adopted to identify the advancement of research in this field and to identify avenues for future research.

Once the antecedents and outcomes associated with sustainable packaging are understood, an empirical investigation is conducted to explore a specific sustainable packaging practice, namely the reduction at source. This third research project addresses one of the gaps identified in the second research project. More specifically, this project examines the effect of packaging taxes on the decisions of food manufacturers and retailers to produce less packaging at source. The study is based on longitudinal data on the quantities of packaging generated in the province of Quebec. The results obtained are triangulated with qualitative data from semi-structured interviews and a focus group with key stakeholders.

Figure 1.2. Conceptual framework of the thesis



Chapter 2
Organizational buying behaviour for perishable-food packaging in grocery retail

Chapter information

An article based on this chapter has been published in the Canadian Journal of Administrative Sciences: Afif, K., Rebolledo, C. and Roy, J. (2020). Organizational Buying Behaviour for Perishable-Food Packaging in Grocery Retail. *Canadian Journal of Administrative Sciences*, 37(4), pp. 483–494. This study uses data from 34 semi-structured interviews conducted in the researcher's master's thesis (Afif, 2016)[1]. This data was triangulated with other data collected from relevant stakeholers.

Abstract

This qualitative study investigates the structure of the buying centre, the buying process, and the factors that influence buying decisions for perishable-products packaging. This empirical investigation is based on the case study of a major Quebec food retailer. We show that the buying decision process of packaging changes significantly depending on whether the product is considered more or less strategic for the organization, which determines the required level of packaging customization. Buying centre structure becomes more complex as packaging customization increases. Given the multifunctionality and the interdisciplinarity of packaging, we propose a multi-criteria analysis grid to improve buying decision efficiency and to streamline communication between the various levels of the buying centre.

[1] Afif, K. (2016). Analyse du processus décisionnel et des facteurs de choix de l'emballage primaire des produits périssables. http://biblos.hec.ca/biblio/memoires/m2016NO117.pdf

2.1. Introduction

Packaging has a major impact on the performance of firms selling food products. In addition to brand differentiation, packaging protects food products during transport, handling, and storage (Marsh & Bugusu, 2007; Ragaert, Verbeke, Devlieghere, & Debevere, 2004). Thus, packaging procurement allows for potential savings at different levels in the food supply chain (Grönman et al., 2013; Niemelä-Nyrhinen & Uusitalo, 2013). Judicious packaging buying decisions can lead to cost savings between 3% and 5% throughout the supply chain (Sundip & Michael, 2011). In addition, a firm's environmental performance is increasingly associated with the quality of its products' packaging (Molina-Besch, Wikström, & Williams, 2018; Orzan, Cruceru, Balaceanu, & Chivu, 2018). The purchase of optimal packaging not only helps improve the efficiency of firm's logistic operations but also reduces its environmental footprint (García-Arca, Prado-Prado, & Garrido, 2014), which is attributable to an optimal product–packaging combination (Grönman et al., 2013). In an increasingly competitive market, packaging procurement is a crucial organizational decision that requires careful consideration (Grönman et al., 2013; Ragaert et al., 2004; Vam Der Merwe, Viljoen, De Beer, Bosman, & Kempen, 2013).

In recent years, researchers have paid increasing attention to food packaging. However, the organizational buying behaviour remains largely unexplored. Existing studies argue that the purchase of packaging is a complex multi-criteria decision (Vam Der Merwe et al., 2013), as decision-makers must reconcile conflicting attributes to achieve an optimal product–packaging combination (Prendergast & Pitt, 1996; Rundh, 2009). This multi-criteria analysis is more complex in the case of perishable foods because of their fragility and limited shelf life (Ragaert et al., 2004). However, existing studies do not account for the complexity and specificities of packaging buying decisions specifically for these products (Vam Der Merwe et al., 2013; Venter, Van der Merwe, de Beer, Kempen, & Bosman, 2011). In fact, several studies have stated the need to further explore this buying decision (Ragaert et al., 2004; Vam Der Merwe et al., 2013). A systematic analysis of the process of this buying decision, of the structure of the buying centre, and of the factors affecting the buying decision will provide both researchers and organizations with information on the main parameters that should be considered to make the best procurement decision.

This study responds to the aforementioned need and contributes to the field in that regard. Three research objectives are specifically targeted: What is the buying centre structure for these products (who are the actors involved, and what are their roles)? What are the steps in the buying process, and what decision criteria are considered? And, finally, what factors influence this buying decision?

We chose the food retail sector, because buying packaging for perishable food products is a major factor in this highly competitive sector (Nancarrow, Wright, & Brace, 1998; Rundh, 2009). Various organizational levels interact in this buying decision (Ragaert et al., 2004), whence the relevance of examining the nature of the dynamics of the buying processes that characterize this sector. We chose a qualitative approach to allow a thorough understanding of the organizational buying behaviour of these products to emerge (Eisenhardt, 1989; Yin, 2009).

We present the main results of the study in the form of research propositions. We contribute to the literature on the organizational buying behaviour of product packaging. First, we show that the complexity of the buying process and the structure of packaging buying centres change significantly depending on whether a product is more or less strategic for the organization, which determines the level of customization required. Second, we demonstrate the complex relationships between the different levels involved in buying centres for packaging with more extensive customization. Third, we show that these levels have conflicting objectives and interests - some are better represented, more influential, and play a dominant role in the buying centre - and hence the importance of an approach that focuses on the objectives of the buying process and on end-user expectations. In terms of management implications, this study will help improve the efficiency of packaging buying behaviour at different levels. We propose guidelines considering the multifunctional and interdisciplinary nature of packaging. We also present a multi-criteria analysis grid aimed at increasing the efficiency of packaging buying decisions and at facilitating communication between the different levels in buying centres. The results of this study can be used in packaging training, both in management and in sustainable development and design.

This chapter is organized as follows. The relevant literature and the conceptual framework of the study are first presented, followed by research methodology, and the study results and their analysis. The discussion outlines research propositions and theoretical contributions. Finally, management implications, study limitations, and avenues for future research are presented.

2.2. Literature review

A buying centre, or decision-making unit (DMU), is comprised of a group of people who collectively make specific buying decisions within an organization (Osmonbekov, Bello, & Gilliland, 2002). Understanding the structure of a buying centre provides relevant

information about the key actors involved in the buying process, their relative influence on buying decisions, and the main criteria considered in that decision process (Howard & Doyle, 2006). Buying centre structure shifts over time and differs from one organization to another. Within the same organization, buying centres may have different internal structures depending on the product being purchased. Their structure is also subject to influence from internal and external organizational factors (Lau, Goh, & Phua, 1999; Lewin & Donthu, 2005).

2.2.1. Organizational buying centre structure

The buying centre has actors working in several functional departments and reporting to different levels of formal or informal hierarchical authority (Ghingold & Wilson, 1998). Klass (1961) groups buying centre actors into four categories: contributors, participants, responsible, and directors. Wind and Webster (1972) classify their roles into five categories: users, buyers, influencers, deciders, and gatekeepers. Users are those who use the procurement products or services. Buyers are formally responsible for contracting services from suppliers. Influencers directly or indirectly impact buying decisions by providing information to evaluate the different buying options. Deciders make a choice among these options. Gatekeepers are responsible for controlling the flow of information and resources in the buying centre. Lewin and Donthu (2005) and Wind and Webster (1972) add that several actors may occupy the same role, and that one actor may play more than one role in the buying centre.

Regarding the degree of actors' involvement in buying centres, Howard and Doyle (2006) and Garrido-Samaniego and Gutiérrez-Cillan (2004) find that, as products require increased research and development, the role of buyers decreases, particularly in the early stages of the buying process, giving way to influencers. Like influencers, gatekeepers exercise both formal and informal power. They are largely responsible for guiding the buying decision process through the flow of information and material. Conversely, the role of buyers is central in standard buying decisions that require no innovation (Howard & Doyle, 2006; Osmonbekov et al., 2002).

A more fluid structure is generally required for new procurement decisions, while a more formalized structure is established when an organization has consistent procurement requirements (Lau et al., 1999; Lewin & Donthu, 2005). New purchasing situations involve a high level of uncertainty and complexity (Garrido-Samaniego & Gutiérrez-Cillan, 2004). Consequently, the actors involved in this buying decision rely on the recommendations and choices of the responsible, directors (Klass, 1961), and deciders (Wind & Webster, 1972) to prevent assuming full responsibility for the decisions taken (Lau et al., 1999).

2.2.2. Buying centre structure for product packaging

A buying centre for product packaging consists of an interdepartmental decision-making unit, including managers from different hierarchical levels. Vernuccio, Cozzolino, and Michelini (2010) emphasize the multi-functional nature of product packaging buying decisions in grocery retail. The marketing, logistics, and environment departments are potentially involved in making this buying decision. In addition to these internal actors, Rundh (2009) highlights the involvement of external actors such as suppliers, retailers, and consumers. Ghingold and Wilson (1998) suggest that the involvement of the various actors in buying centres is often dynamic, as they participate in specific sub-decisions depending on how clearly defined their role is, and on their function, decision-making power, hierarchical level, and experience.

In addition, White, Wang, and Li (2015) and Rundh (2009) specify that the purchase of appropriate packaging for a particular product is the result of teamwork based on sharing information related to the purchasing situation, and on effective coordination between buying centre actors. The objective is to combine the strengths of each management level to choose the best product–packaging combination. García-Arca et al. (2014) suggest that the proactive integration of a company's internal operations supports the purchase of optimal packaging solutions. This integration allows a better trade-off, between the logistical, marketing, and environmental considerations (Vernuccio et al., 2010). In addition, the specific needs of the different members in the supply chain - including distributors, points of sale, and consumers - must be considered jointly by buying centres (García-Arca et al., 2014; Saghir, 2002; White et al., 2015).

The buying centre structure, in terms of actors and their roles, is affected by personal, interpersonal, organizational, and interorganizational factors (Wind & Thomas, 1980). From both a personal and an interpersonal point of views, Garrido-Samaniego and Gutiérrez-Cillan (2004) argue that the function of certain actors, their position in the organization, and their interpersonal skills may lead them to exert a considerable influence on the buying centre dynamics. From an organizational point of view, Osmonbekov et al. (2002) point out that the structure of buying centres depends on the size of the organization, on the hierarchical level and functions of the various actors as well as the relevance of their involvement in the buying decision. The larger an organization, the less senior management is involved in the buying decision process (Daulatram, 1989). From an inter-organizational perspective, Garrido-Samaniego and Gutiérrez-Cillan (2004) suggest that the involvement of external actors in the organization's buying centre depends to a large extent on certain structural characteristics, such as level of specialization, flexibility, and the centralization and standardization of buying decisions. The buying centre structure becomes more complex depending on the strategic importance of the

buying decision for the organization, the time allocated to that decision, and the perceived risk (Garrido-Samaniego & Gutiérrez-Cillan, 2004; Lau and Phua, 1999).

2.2.3. Organizational buying process

Johnston and Lewin (1996) suggest that organizational buying is a complex process involving many people, multiple objectives, and potentially conflicting decision criteria. This process requires different sources of information and numerous inter-organizational relationships. Its duration depends on the number of participants involved and the complexity of the buying decision. It has been established that the larger the number of participants and the more complex a buying decision, the longer the process takes (Lau et al., 1999; Wilson, 2000). Actors are involved in the buying process insofar as their formal role within the organization, their expertise, and their function are deemed relevant to the objectives of the buying decision (Howard & Doyle, 2006).

Several different models from different industries have been proposed to identify the steps in the organizational buying process. For example, Bradley (1977), in a consideration of government buying decisions, suggests a four-step buying process: need recognition; exploration of alternatives; search for suppliers; and drafting of the contract with the selected supplier. Wind, Grashof, and Goldhar (1978) consider information services, and identify a 12-step buying process: need recognition; establishment of specifications; exploration of alternatives; search for suppliers; definition of purchase and use criteria; evaluation of alternatives; budget analysis; re-evaluation of the alternatives; negotiation; buying decision; execution; and post-buying evaluation. These authors' results underscore the complexity of the organizational buying process, which can vary from one industry to another and from one product to another (Lewin & Donthu, 2005; Wilson, 2000).

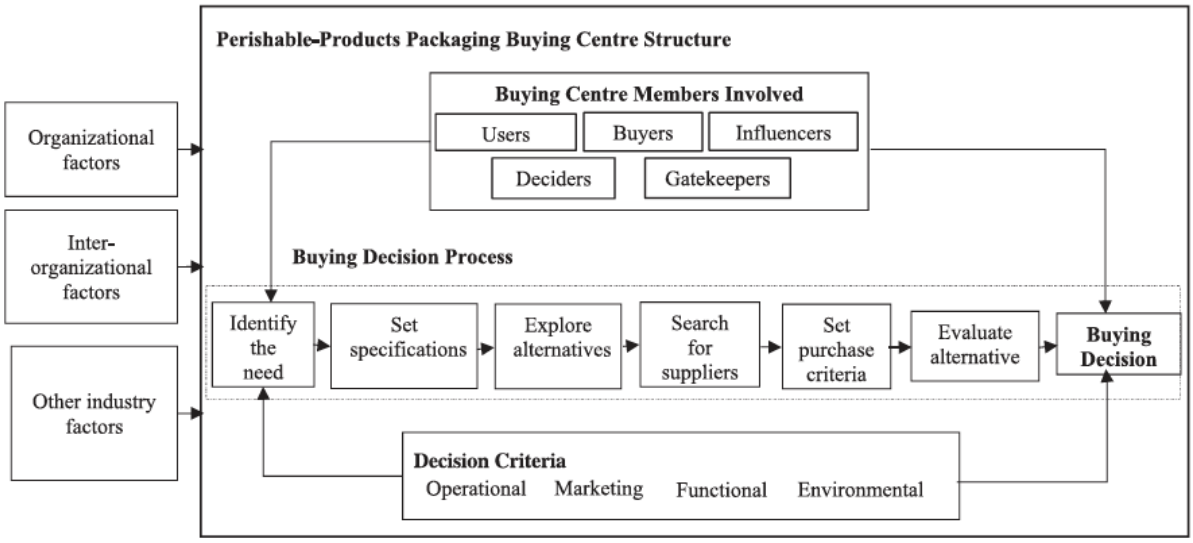
2.2.4. Factors influencing the buying decision of product packaging

The participants involved in the buying centre of product packaging face pressure resulting from the divergence of interests of internal and external stakeholders (e.g. Rundh, 2009; Prendergast & Pitt, 1996). The internal factors are related to organizational culture and operational performance requirements (Prendergast & Pitt, 1996; White et al., 2015), organizational size (Venter et al., 2011), and product characteristics (Rundh, 2009). The packaging buying centre must also reconcile multiple and sometimes conflicting logistics, marketing, and environmental requirements, and combine technical, functional, informational, operational, and environmental attributes in their packaging buying decision (Prendergast & Pitt, 1996; Vernuccio et al., 2010). Preserving product integrity and quality throughout the distribution chain, and maintaining logistical efficiency during handling, storage, and transport also affect buying decisions (Verghese & Lewis, 2007; White et al., 2015).

Regarding the external factors, Prendergast and Pitt (1996) highlight the regulatory and environmental requirements, since organizations must comply with strict norms and standards. Rundh (2009) adds the influence of technological development and competition. Vam Der Merwe et al. (2013) and Scott and Vigar-Ellis (2014) refer to pressure from consumers, who require packaging with highly protective properties. Other inter-organizational factors come from intermediaries up and downstream in the distribution channel, including manufacturers, suppliers, retailers, and consumers (Prendergast & Pitt, 1996; Verghese & Lewis, 2007), who often have specific needs in terms of the functional properties of packaging (Saghir, 2002). The priority afforded to environmental issues varies from one department to another (Bone & Corey, 2000). The buying centre must therefore reconcile all these factors to reach a compromise (Verghese & Lewis, 2007).

Through the conceptual model of this study (Figure 2.1), our objective is to explore the research propositions suggested in isolation in previous studies regarding buying centres, buying processes, and influencing factors. Vam Der Merwe et al. (2013) and Ragaert et al. (2004) argue that there is a need to study perishable-food–packaging buying decisions. This study therefore seeks to examine the particularities of organizational buying behaviour in the context of these products. The buying decision process, the structure of buying centres, and internal and external organizational factors are explored.

Figure 2.3. Conceptual framework



2.3. Method

To explore the particularities of organizational buying behaviour for perishable-food packaging, the case study methodology is adopted. The latter is appropriate to answer research questions aimed at explaining the "how" of phenomena (Yin, 2009: 9). This method provides a flexible research framework and allows for the collection of comprehensive information and richly descriptive examples for the phenomenon under consideration in a real context (Eisenhardt, 1989; Patton, 2002). Yin (2009) suggests that case study is particularly appropriate for studying organizational processes, as it provides an in-depth examination based on a holistic view of the phenomenon studied.

2.3.1. Case study design

This study uses an embedded single-case design (Yin, 2009, p. 48), which applies in the presence of several sub-units of analysis and allows a thorough analysis of the single case studied. We chose to focus on a major Quebec grocery retailer. The two main analytical units are the buying centre and the perishable-food–packaging buying decision process. The sub-units are the supply chain actors who are directly or indirectly involved in the retailer's buying process. These actors are studied separately to define their roles and the nature of their involvement in the buying process. The selected stakeholders are the manufacturer, the main packaging supplier, the sustainable design consultant, and consumers of the retailer's perishable food products. The eligibility criterion used to select respondents was their participation in the studied buying decision.

2.3.2. Case selection

A major Quebec grocery retailer is chosen as the case to be studied. This retailer has a broad point-of-sale network and is organized into five sections of perishable products (i.e. fruits and vegetables, prepared meals, meat, fish, and bakery products) for which packaging buying decisions are required. The retailer has made significant advances in perishable-products packaging. According to Yin (2003), a single- case study is valid and relevant when the case selected represents a complex, representative, revealing, and significant typical case (Yin, 2009: 47). The retailer selected for the present study is sufficiently complex given its size and strategic positioning in the Quebec retail sector. The retailer is also a major player on the grocery market and provides a representative instance of food-distribution companies. The case is also revealing and significant, as it documents each aspect of our research question. In addition, Yin (2009) recommends selecting relevant respondents consistent with the research objective. The choice of this retailer allowed us to target several respondents who work in the packaging buying centre. In sum, the targeted retailer is a valid and relevant single case.

2.3.3. Data collection

The data were primarily collected from the retailer. The buying centre in charge of packaging buying decisions is multi-functional. As shown in Table 2.1, 34 semi-structured interviews were conducted with key respondents from operations, merchandising, marketing, and purchasing, as well as point-of-sale managers. The retailer's packaging buying process also involves several inter-organizational relationships. Additional interviews were conducted with the manufacturer, the main packaging supplier, and the sustainable design consultant (Table 2.1). A focus group was also conducted with consumers of packaged perishable products. The main methods of data collection are semi-structured interviews, focus groups, and active observation of the retailer workplace. The interviews with each category of respondents and the focus group were conducted using separate interview guides. The use of various data sources in combination with the selection of key respondents helps strengthen the validity of this study (Yin, 2009).

Table 2.1. Data collection from targeted stakeholders

Distribution Chain Component	**Key Respondent**	**Number of Interviews**	**Data Collection Method**
Retailer	Store manager	8	- Semi-structured interview - Internal product-packaging documentation analysis - Retailer workplace observation
	Operations	15	
	Merchandising	5	
	Marketing	3	
	Purchasing	3	
Retailer’s primary packaging supplier	Account manager for case-study retailer	1	Semi-structured interview
Retailer’s packaging manufacturer	Consumer products packaging sales director, who works with head office and with the retailer’s stores	1	Semi-structured interview
Retailer’s sustainable design consultant	Consultant who advises the retailer on sustainability issues in packaging	1	Semi-structured interview
Perishable food product consumer	Consumers from different age groups	4	Focus groups

2.3.4. Data analysis

As suggested by Langley (1997), Smith (2002), and Yin (2009), data analysis was conducted in two phases. The first phase was the separate analysis of the data from each respondent category. The interviews were first transcribed manually then consolidated by respondent category and coded using Atlas TI. Preliminary codes were retained, and the relevant segments identified and categorized by key aspects (Charmaz, 2006). A hierarchy was then drawn up, with sub-codes assigned to each main code (Charmaz, 2006). Data for each respondent category were structured in grids, and relevant quotes and statements from respondents were reported (Smith, 2002). A lexical analysis was also conducted by respondent category to highlight salient aspects. The second phase was an inter-category respondent cross-analysis. This analysis was initiated by a rigorous observation of the consolidated data (Smith, 2002). To formulate research proposals, the data structure approach was used (Corley & Gioia, 2004) to construct a theoretical structure by moving from detailed original elements to more synthetic elements (Langley, 1997).

2.4. Results and analysis

Interviews with the various respondent groups provided an opportunity to explore in depth the buying centre structure, the decision process and criteria, and the factors affecting the buying decisions of the organization being studied. This section presents and analyzes our main results. Relevant quotes from key respondents are included for illustrative purposes.

2.4.1. Buying Centre structure

Two categories of perishable-products packaging were identified in the company, customized and standard packaging. The vice-president of retail operations pointed out that the former is characterized by “the development of a distinctive concept specific to the retailer, and provides the retailer with competitive advantage,” while the latter consists of “classic containers that can be used by several merchants and do not afford any differential advantage.”

2.4.2. Buying centre dynamics depending on the nature of the products

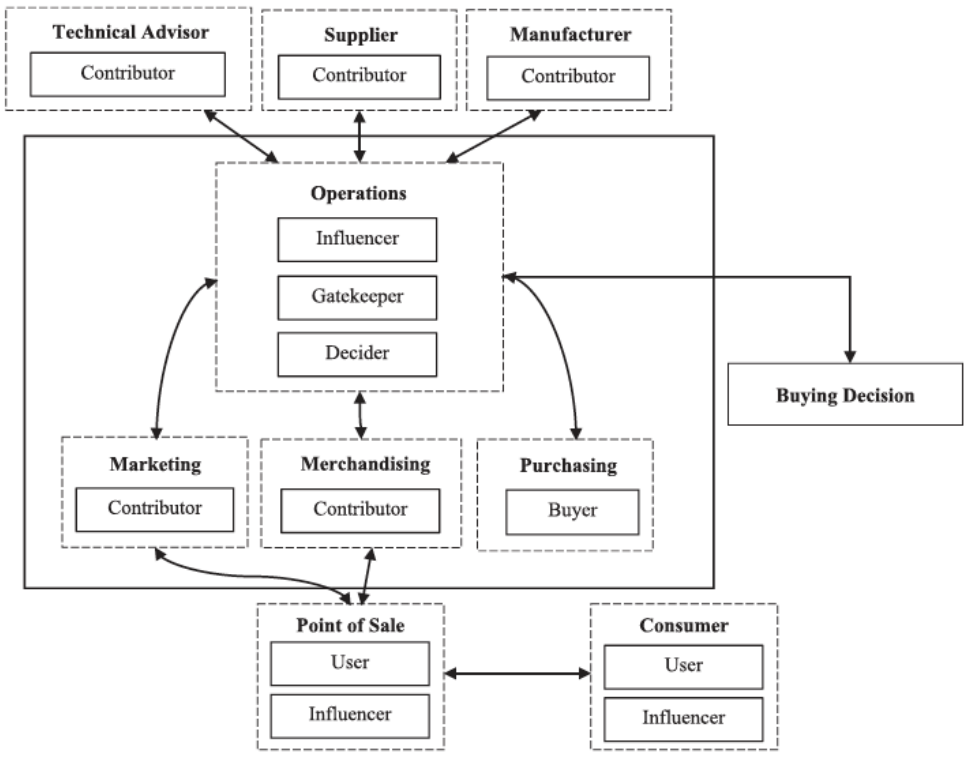
The buying centre responsible for buying decisions for custom packaging includes operations, merchandising, marketing, and purchasing, as well as point-of-sale managers. Each level comes into the buying centre when a particular specialization and level of knowledge of the buying process is considered relevant to the buying decision. The involvement of some departments (such as the environment department) is optional, while it is mandatory for others (such as operations and purchasing). In addition, other sub-

groups interact and provide recommendations to the main buying centre before a final buying decision is made. These sub-groups include external stakeholders such as the manufacturer, supplier, and sustainable design consultant. The objective of this decision-making unit is to meet the needs of consumers whose buying behaviour guides the buying centre's choices. The exchange dynamics in a standard packaging buying centre are less complex, because fewer participants are involved, and fewer interactions are required. The main internal stakeholders involved are operations and purchasing, as well as point-of-sale managers.

2.4.3. Buying centre operational involvement

Operations is the most influential function in packaging buying decisions. Operations participants contribute significantly at different stages of the decision process. Besides being the most represented department in the buying centre, operations control the budget allocated to product packaging and coordinates most inter-organizational interactions (Figure 2.2). A respondent from merchandising noted, “operations manage all relationships with buying partners, including the manufacturer, supplier and sustainable design consultant.” The purchasing director confirmed this key role in making the final purchase. Operations therefore holds a strategic position in the buying centre.

Figure 2.4. Roles of participants in the perishable product packaging buying



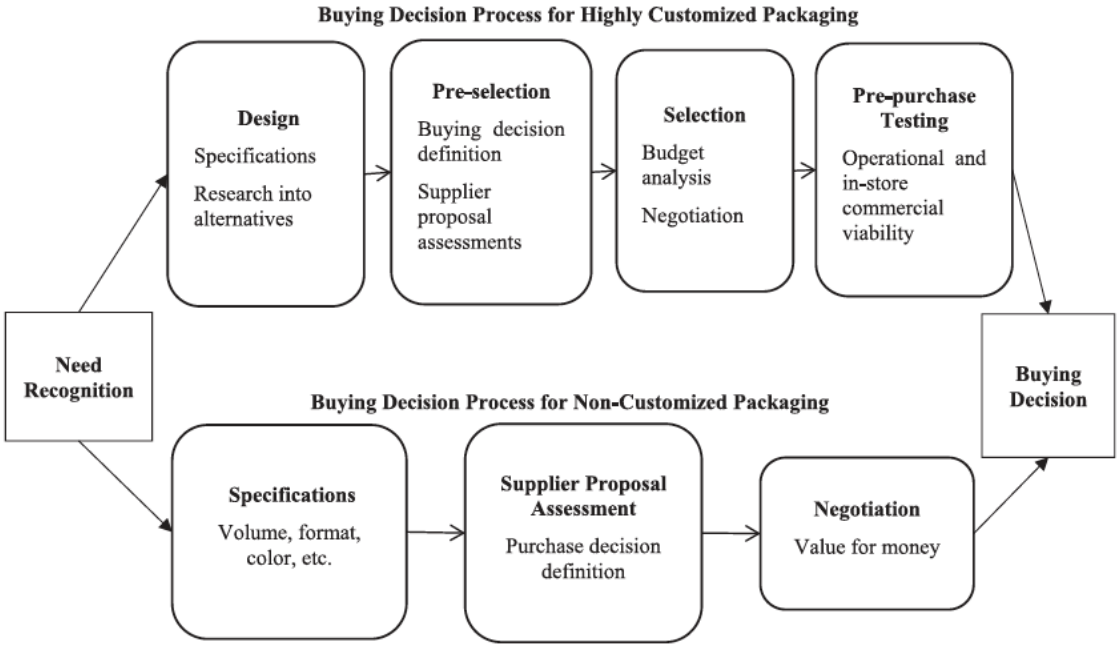
2.4.4. Role of buying centre partners

Suppliers are particularly involved during the phases of need recognition, pre-selection, and packaging-purchase validation. The supplier stated that, in some cases, they might even initiate the need: “Based on an analysis of current market trends or competitive benchmarking, it might be recommended that points of sale replace packaging. This recommendation triggers the process of buying new packaging.” The packaging manufacturer carries out studies and testing at its research centre to improve the technical characteristics and packaging design and materials. As a sales manager pointed out, these analyses help the retailer cut costs by adopting more efficient practices. The retailer also relies on the skills of the sustainable design consultant, who provides personalized support at specific stages of the buying process. Based on strategic and documented monitoring of product packaging trends, this consultant makes recommendations that focus on improving the ecological attributes of the packaging.

2.4.5. Buying decision process

The decision to purchase custom packaging is based on a complex buying process that takes place through six phases (Figure 2.3) and over several months. Respondents in operations affirm that such a structure is more effective because it allows for flexibility throughout the buying decision process, and to adapt to changing circumstances. The initial phases of the customized-packaging–buying process operate in relative isolation, and there is little coordination between the levels involved and staff within each one. As the process advances and buying activities grow more complex, interactions between participants in the buying process become more fluid. Conversely, the decision to purchase standard products is based on a less complex process (Figure 2.3), as it includes fewer steps and requires fewer human and material resources. The purchasing director explained that these are “routine purchases that do not require the implementation of customized actions, and that it is better for the decision process to remain unchanged.” Other respondents in operations stated that such a structure works well because these products offer no competitive advantage in the market.

Figure 2.5. Packaging purchase decision processes by level of customization or standardization required



2.4.6. Buying decision criteria

This study reveals different perceptions of decision criteria between the actors involved in packaging-purchase decisions. Each actor tends to prioritize specific criteria given its context. As part of the support provided to retailers, the manufacturer stated, “there are several participants involved in the decision to purchase packaging and they often have divergent considerations. For example, the operations team is looking for functional and easy-to-use packaging, while the marketing team focuses on aesthetics.”

Interestingly, packaging quality is articulated around different criteria depending on the department. For purchasing, the quality of a container is related to its ability to store food and its cost. For marketing, quality refers to the aesthetic aspect of a container and its ability to enhance the presentation of the product. For operations, quality combines several attributes including food preservation, sustainability, operational feasibility, ecological considerations, and cost. For consumers, quality refers to cost, reusability, and functionality. The notion of quality also varies according to the section to which a product belongs. For example, in the meat and fish section, food preservation is the priority. The operations manager explained that “these products are expensive, which is why it's important to optimize their shelf life.” In the bakery, aesthetics and product enhancement are the key factors that determine the point-of-sale success of a product. This range of

perceptions can cause disagreements between decision-makers and buyers regarding the final choice of packaging. It is often difficult to meet the needs of each actor and product section to reach a consensus.

2.4.7. Buying decision factors

There are specific factors that affect perishable-food packaging buying decisions. The lexical analysis shows the number of times each factor was cited in the interviews. The factors were then grouped into three categories - organizational, inter-organizational, and market factors. From an organizational point of view, the nature of product, its fragility, and the degree of preservation required were the most frequently cited factors. At the inter-organizational level, the best-practice recommendations from procurement partners and the requirements of other partners in the distribution chain were the most frequently cited factors. As for market factors, consumer requirements as reflected in buying behaviour and survey results, food packaging trends, competitor practices, and environmental regulations were the main factors cited. Another important market factor is retailers' mandatory contribution to municipal packaging collection programs. This factor compels retailers to choose packaging options that optimize costs. For instance, the sustainable design consultant illustrates that “the increase in the polystyrene fee encourages retailers to migrate to other more economical resins such as polyethylene terephthalate (PET).”

2.5. Discussion

The marketability of perishable foods is related to the shelf life their packaging helps ensure; this decision-making criterion determines the purchase of packaging in grocery retail. The specificities of the food products to be packaged determine to a large extent the degree of packaging customization. It should be noted that in-store prepared meals, some bakery products, and fruits and vegetables are the products with the most customized packaging, while more standardized packaging is used for meat and fish. The first three product categories have a more limited shelf life than those in the fourth category, and retailers tend to develop packaging with distinctive concepts that extend their shelf life. These products' packaging not only increases sales, but also reflects the quality of the product. Retailers thus attach significant strategic importance to these products, which add value to their brand image and provide a competitive advantage in the retail market. For this reason, it is important to make them stand out using customized packaging. For example, some retailers package croissants in customized airtight containers that extend the pastries' shelf life, improve their presentation, and enhance their artisanal appearance. Meat and fish are packed in simple, transparent trays with standard plastic wrap. Retailers attach less strategic importance to the purchase of packaging for

meat and fish because they are packaged identically by several merchants in the industry and therefore do confer no distinctive advantage. In fact, the high sales volume and high price of meat and fish make packaging standardization more advantageous by optimizing operating costs, preventing stock shortages, and facilitating order management; cost thus becomes the priority decision-making criterion in the purchase of standardized packaging.

> ***Proposition 1***. *The degree of perishable-food–packaging customization depends primarily on the shelf life of these products and on their strategic importance to the organization. The shorter their shelf life and the greater their strategic importance, the more decision-making units are driven to develop customized packaging solutions that improve the marketability of packaged products and give retailers a competitive advantage.*

The buying centre for perishable-product packaging, which is of strategic importance, has a multi-functional structure. The unit in charge of buying decisions conducts a complex multi-criteria analysis, as these products require the purchase of packaging with several specific attributes. In particular, the packaging must be compatible with the nature of the product, preserve its quality over a longer period, and protect it from external contaminants. Regulatory directives of food safety and sustainable development in the food industry add an additional challenge to this buying decision. The purchase of customized packaging for perishable products notably involves a high level of risk and uncertainty for the organization and requires an external network of specialized technical skills to make an optimal buying decision. The low levels of specialization, standardization, and centralization of the buying decision for these products lead decision-makers to use external buying partners such as manufacturers and suppliers to benefit from their technical skills. The latter act as contributors (Klass, 1961) and influencers (Wind & Webster, 1972), because they share information that has a major impact on an organization's buying decisions. These associates interact in sub-groups in the buying centre and contribute to specific sub-decisions. According to Lewin and Donthu (2005) and Garrido-Samaniego and Gutiérrez-Cillan (2004), inter-organizational relationships are often important but not essential in an organization's procurement decision-making. On the other hand, our study shows that the involvement of relevant external partners in buying centres contributes to the purchase of optimal packaging that is better adapted to the specificities of perishable food.

> ***Proposition 2***. *The technical requirements of strategically important perishable foods entail a complex multi-functional structure for the customized packaging buying centres. The low levels of specialization, standardization, and centralization of this buying decision lead buying centres to rely on specialized skills from among buying partners.*

The greater the standardization of packaging, the simpler the multi-functional structure of the buying centre. Buying decisions for standardized packaging involve a low level of risk and uncertainty for the organization, because these products have been market-tested, either by the organization itself or by its competitors. The high standardization and the centralization of this decision lead buying centres to choose suitable packaging for products without the need for specialized external technical skills. This explains the simplified dynamics of organizational and inter-organizational exchanges in buying centres for these products.

> ***Proposition 3****. The structure of a standardized packaging buying centre is simple. The low levels of risk and uncertainty associated with the purchase of these products lead buying centres to centralize buying decisions within the organization.*

The assignment of roles and the degree of involvement of each department in the perishable-food–packaging buying centre vary from one organizational function to another. Some functions are better represented than others and have a strong influence in the buying centre. For instance, the operations staff tend to be influencers, deciders, and gatekeepers (Wind & Webster, 1972). The strong influence of this function is due to the sway it holds over several important dimensions of buying decisions. In particular, the operations staff analyze the validity of the need and the operational feasibility of purchases for users (Wind & Webster, 1972), which gives them considerable decision-making power in buying centres. Marketing and merchandising play the role of contributors (Klass, 1961). Their involvement in the procurement decision takes place at specific times and at the request of operations staff. The role of purchasing is limited in buying packaging that requires a high level of customization, particularly during the early stages of the process when the contribution of the other functions- operations, marketing, and merchandising - is more significant. This finding supports the suggestion of Howard and Doyle (2006) and Osmonbekov et al. (2002) that the role of buyers decreases as buying process requires increased research and development. Figure 2.2 illustrates the distribution of roles among participants in the perishable-product packaging buying centre. In addition, although the structure of the buying centre is dynamic and varies according to the nature of each purchase (Lewin & Donthu, 2005; Osmonbekov et al., 2002), the level of representation of some central functions, such as operations, remains relatively stable in all packaging buying decisions.

> ***Proposition 4****. Perishable-food packaging buying centres are strongly represented by operations managers, who are influencers, decision-makers, and gatekeepers. Marketing and merchandising managers are contributors. The role of buyers*

becomes less prominent as the requirement for innovative purchasing increases.

The complexity of packaging-purchase decisions depends on the degree of customization required. Figure 2.3 illustrates the different steps of the buying process by level of customization or standardization. The more recent the buying activity, the higher the level of risk and uncertainty, making a flexible and less formalized buying structure more advantageous for the decision-making unit. The duration and the number of participants involved vary according to the extent of the research and development and specialized support required. Roles and responsibilities in buying centres are assigned informally at the beginning of the buying process. This makes it difficult to model the decision process, which is flexible and informal, particularly during the initial stages of the process. On the other hand, the process tends to become progressively more formal as it progresses and as purchasing becomes more complex. Contrary to Wilson's (2000) suggestions, the number of participants in the packaging buying centre when a high level of customization was required is not static or standardized. On the other hand, the buying process for extremely standardized packaging is centralized, formalized, and more rigid—these are routine purchases that require little by way of human and material resources and few steps to make decisions quickly. In the case of standard-packaging purchases, the duration of the process and the number of participants remain relatively stable over time, counter to Lau et al.'s (1999) suggestion that buying processes evolve over time. In addition, buying centre structure is not affected by the hierarchical levels of the participants, which invalidates the suggestion of Osmonbekov et al. (2002) that participants are involved in buying centres according to hierarchy. In addition, senior management is not involved in the decision process, which supports Daulatram's (1989) suggestion that the larger an organization, the less senior management is involved in procurement.

> ***Proposition 5****. The greater the customization of packaging, the more complex, informal, dynamic and time-consuming the buying decision process. Conversely, the higher the level of standardization, the easier, more formal, more stable, and quicker the process.*

Pre-purchase testing for highly customized products is an important phase typical of buying processes in grocery retail. This phase allows decision-making units not only to gauge the buying behaviour of consumers but also to assess the quality of food preservation at points of sale. The results of this phase allow decision-makers to align their choices toward optimal solutions and to achieve cost savings. The pre-purchase testing phase does not appear in the model suggested by Wind et al. (1978) in the information-services sector, nor in Bradley's (1977) model for public institutions, nor in Howard and Doyle's (2006) biotechnology model. This finding reaffirms that buying processes vary according to the nature of the products and the sector of activity (Lewin &

Donthu, 2005; Wilson, 2000).

> ***Proposition 6.*** *Pre-purchase testing is a key step in the buying process for packaging that requires significant customization. In-store impact assessments allow buying centres to optimize buying decisions by selecting more efficient packaging solutions that are better adapted to the perishable foods' requirements*.

The purchase of packaging for perishable products is based on conflicting decision criteria set by the participants involved in the decision. These criteria are perceived differently by the different associates according to the positions they hold. In this case, marketing foregrounds the aesthetic attributes of the packaging. Operational and food preservation attributes are priorities in operations, while cost is the priority for buyers. These divergent perceptions require effective coordination between buying centre participants. The main buying decision criteria are used to proceed by arbitration to determine the strengths and weaknesses of possible alternatives. Decision makers in operations, who wield significant decision-making authority in buying centres, reconcile differences to make the final buying decision. They tend to favour operational criteria, in particular the preservation of food products for as long as possible and in an optimal way throughout the distribution chain. Given the importance of this decision, the buying process is participatory; participants act as a team and collectively share the objectives of the buying decision.

> ***Proposition 7****. Divergent perceptions regarding buying criteria for food packaging leads to a decision process based on consensus between those involved in buying decisions. The sensitivity of perishable foods to time and to environmental factors leads decision-makers to prioritize operational criteria that optimize food preservation throughout the distribution chain.*

In addition to organizational and inter-organizational factors, other market factors impact the decision to purchase perishable-food packaging. In addition to confirming the influence of competitor practices (Rundh, 2009), consumer buying behaviour (Vam Der Merwe et al., 2013) and regulatory and environmental requirements (Prendergast & Pitt, 1996), our study reveals the significant influence of food packaging trends in local and foreign markets. The food packaging industry is highly competitive, and retailers tend to keep an active watch on the packaging practices of their direct and indirect competitors.

> ***Proposition 8****. The purchase of perishable-food packaging is dynamic and evolves over time. Current food packaging trends in local and foreign markets are an important market factor that impacts the purchase of these products.*

2.6. Conclusion

This study explores buying centre structure, the buying process, and factors that influence the decision to purchase perishable-food packaging for the grocery retail sector. The particularities of buying decisions in this sector are identified and presented in the form of research propositions. This section presents the main theoretical contributions, management implications, study limitations, and avenues for future research.

2.6.1. Theoretical contributions

Based on an exhaustive literature review and the case study of a complex, representative, and revealing case, we provide a better understanding of the specificities of buying centres and of the buying process for perishable-food packaging. We identify the degree of customization of packaging as a key variable that determines the complexity of buying centres and buying decisions. This variable is guided by the strategic importance an organization attaches to the product in question: the more strategically important, the more extensive and complex the multi-criteria analysis of possible alternatives in the buying process. The packaging for strategically important products requires an advanced level of customization. Their purchase involves a complex multi-functional buying centre structure. The decision process for highly customized packaging is difficult to model, informal, dynamic, and time-consuming. The level of customization is also determined by the shelf life of food products. Finally, we identify two specific features of perishable-food packaging purchasing, namely the strong representation and significant power of operations and the significant influence of food packaging trends.

2.6.2. Management implications

This study contributes to improving the efficiency of organizational buying behaviour for packaging at four levels. First, managers can benefit from modelling packaging buying processes according to whether they require a high or low level of customization (Figure 2.3). In addition to understanding the different stages of the buying decision process, managers can adjust the proposed modelling to the specificities of other purchasing situations. In an increasingly competitive environment, the purchase of packaging is a dynamic organizational decision. Companies must continually adjust their packaging decisions according to the opportunities and risks they face.

Second, the decision to purchase packaging is based on potentially conflicting criteria that decision-makers must reconcile to achieve an optimal product–packaging combination. To address this issue, we recommend the implementation of a grid based on the multi-criteria decision aid method. This method is an important step in buying decisions, as it leads to the choice of optimal packaging solutions by promoting exchange between the

different levels in buying centre. Table 2.2 exemplifies a model of a weighted multi-criteria analysis grid. This grid is a tool to aid in packaging buying decisions and can be adjusted according to the level of customization required. It depicts which buying criteria are present or absent in packaging alternatives and to what extent each criterion is verified in each alternative. The choice of criteria can also be adjusted according to whether the buying situation is strategic for the organization. Decision-makers can use the grid to objectively compare different packaging alternatives and choose the best option. The overall assessment of the different options will depend on the objectives for each buying situation, whence the importance of weighting each criterion according to its importance.

Table 2.2. Example of a multi-criteria customized packaging purchase analysis grid

Nature of Criteria	Priority Buying Criteria	Weight	Packaging Option A	Packaging Option B	Packaging Option C
Operational requirements	Cost	5	1A (+++)	1B (++)	1C (+++)
	Ease of handling	4	2A (++)	2B (---)	2C (++)
	Ease of storage	2	3A (-)	3B (+++)	3C (+)
	Ease of transport	4	4A (++)	4B (-)	4C (---)
	Durability	6	5A (+)	5B (+)	5C (+++)
Product technical requirements	Preservation quality	8	6A (++)	6B (+++)	6C (+)
	Quality of materials	5	7A (+)	7B (+++)	7C (++)
Commercial requirements	Product enhancement	7	8A (--)	8B (++)	8C (--)
	Aesthetic appeal	4	9A (-)	9B (+++)	9C (++)
Environmental requirements	Recyclability	6	10A (+)	10B (+)	10C (+)
	Reusability	6	11A (-)	11B (+++)	11C (-)
	Container versatility	3	12A (---)	12B (+++)	12C (---)
	Local supply	3	13A (-)	13B (+++)	13C (++)

Note. Factors are weighed from one to 10, from 1 = least important to 10 = most important.

Third, the study shows that packaging buying centres should not focus on a single requirement or follow a fragmented approach. The multi-functional and interdisciplinary nature of packaging requires the prioritization of a coordinated internal and external approach by objectively combining the contributions of each level in the buying centre (e.g. merchandising, purchasing, marketing, operations) and external buying partners. It is also important for buying centres to establish priorities for each packaging purchase based on the level of customization required and on whether a buying situation is considered strategic for the organization.

Fourth, the results of this study can be used to illustrate the complex multi-functional nature and the interdisciplinarity of packaging decisions in the many disciplines related to the topic, including marketing, purchasing, operations and logistics, sustainable

development, and design. The study can be used to illustrate the organizational buying process and the structure of packaging buying centres.

2.6.3. Study limitations and avenues for future research

This study has two limitations. First, the single case method has a lack of external validity (Eisenhardt, 1989). To mitigate this limitation, we triangulated data from various sources (Yin, 2003). The study sample was also expanded to include relevant respondents, who provided complementary information and who allowed derive a more comprehensive view of the phenomenon being studied in the supply chain (Langley, 1997). Second, the decontextualization and structuring of data. The study includes various categories of respondents with different approaches. The subjectivity that characterizes the process of sorting the data to identify relevant aspects was reduced using a rigorous analytical approach based on Yin (2003), Smith (2002), and Langley (1997). The Atlas TI tool made it possible to categorize data by key aspect, which helped structure the data.

This study allows formulating research propositions based on organizational buying behaviour for products in the retail sector. Although the size and the composition of the study sample provides a good picture of the context, the potential for generalization of the results may be questioned. Further qualitative and quantitative studies are needed to test and review research propositions for other product categories and sectors.

ACKNOWLEDGEMENTS

We would like to thank the two anonymous reviewers and the associate editor of the Canadian Journal of Administrative Sciences for their valuable suggestions and comments on earlier drafts on this paper. The authors also thank all the participants who contributed to the data collection as well as Professor Ann Langley for her advice related to the methodology. We gratefully acknowledge the financial support of the HEC Montréal Foundation and MITACS (Grant IT08044).

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Chapter 3
Drivers, barriers, and performance outcomes of sustainable packaging: A systematic literature review

Chapter information

An article based on this chapter has been accepted for publication in the British Food Journal. Afif, K., Rebolledo, C., & Roy, J. (in press). Drivers, barriers, and performance outcomes of sustainable packaging: A systematic literature review. *British Food Journal*. A preliminary version of this article was presented at the 12th *Rencontres Internationales de la Recherche en Logistique et Supply Chain Management* (RIRL-SCM), May 22-23, 2018, Paris, France.

Abstract

This paper presents a comprehensive overview of the cross disciplinary literature on the drivers, barriers, and performance outcomes of sustainable packaging to understand the current state of research in this field and identify research opportunities. A systematic review is conducted within no time limit. We applied the *Methodi Ordinatio* methodology that resulted in retaining 48 relevant and high impact articles published in 26 journals with various scopes. Seven key drivers are identified and defined: the integrative and collaborative supply chain, environmental capabilities and resources, market-based instruments, cost reduction, consumer pressure, competitive advantage, and regulatory pressure. Three main barriers are identified and defined: cost/benefit ambiguity, additional costs, and complex trade-offs between packaging requirements. The review shows that the drivers and barriers to packaging sustainability are contingent to firm size. Sustainable packaging positively affects the environmental, social, and economic performance; however, its operational performance requires a proactive and integrated supply chain. Our results highlight the importance of integrated packaging decisions at three different levels to improve packaging sustainability: vertical and horizontal integration, upstream and downstream integration, and product-packaging integration. We developed research propositions and provided insightful directions for future research. Most studies focus on specific drivers, barriers, and outcomes of sustainable packaging, while this paper brings them together to build a comprehensive framework. The latter provides a deeper understanding of the factors that incentivize or deter firms from pursuing sustainable packaging and its performance outcomes.

Keywords Sustainable Packaging, Drivers, Barriers, Performance outcomes, Systematic literature review.

3.1. Introduction

Packaging is increasingly associated with waste production that accounts for about 30% to 35% of the municipal waste in industrialized countries and about 15% to 20% in developing countries (Wiesmeth, 2018). Large amounts of packaging are produced every year with the intention of use and throw away, which has raised concerns about environmental pollution (Wohner *et al.*, 2019). Governments, businesses, and academic communities recognize nowadays the key role of packaging sustainability (e.g. Singh *et al.*, 2021; Petkoska *et al.*, 2021).

Besides its environmental effect, sustainable packaging (SP) may positively influence business performance (e.g. Yusuf *et al.*, 2017). The greatest motivation to the pursuit of SP seems to be the economic gains, which co-generate environmental gains (Gustavo *et al.*, 2018). However, there are important barriers that discourage companies from implementing SP. Recent studies underline the effect of negative consumer attitudes due to the economic, social, and environmental pressures of sustainable behaviors, greenwashing perceptions, and confusion in sustainability efforts for packaging (e.g. Boz et al., 2020). Moreover, SP design can be challenging and costly because it has to protect the environment while fulfilling its integral functions, i.e. protecting, preserving, communicating, allowing efficient logistics, and differentiating the product (e.g. Singh *et al.*, 2021; Wohner *et al.*, 2019). The associated SP decision-making process is also complex because it involves multiple stakeholders with various and sometimes conflicting requirements (e.g., Niero *et al.*, 2017). This imposes potential challenges to managers and requires performing complex multi-criteria analyses. Therefore, many authors highlighted the importance of achieving an optimal balance between logistics, marketing, and environmental packaging decision criteria (e.g. Singh *et al.*, 2021).

The drivers, barriers, and performance outcomes of SP have received significant attention in the extant literature. Previous research has especially focused on specific SP drivers (e.g. Verghese and Lewis, 2007), barriers (e.g. Prendergast and Pitt, 1996), and performance outcomes (e.g. Zailani *et al.*, 2012). However, a literature overview that captures a comprehensive picture of these influencing factors and their research streams has not been provided so far. Yet, having an aggregated view of all these factors would support SP decisions by providing a complete overview of the key aspects of improving packaging sustainability (e.g. White *et al.*, 2015). Meherishi *et al.* (2019) conducted a systematic literature review of studies published over 2000–2018 to understand general SP trends in supply chain management. The authors focused on how SP is aligned to circular economy concepts by reviewing supply chain structures. Nevertheless, they did not review the drivers, barriers, and performance outcomes of SP. Moreover, the authors focus on papers published in the field of supply chain and logistics. However, SP decision is interdisciplinary, which implies a deeper investigation of packaging studies to

encompass broader economic, social, and environmental dimensions (e.g., Gustavo *et al.*, 2018).

To address this research gap and complement the study of Meherishi et al. (2019), this paper conducts a systematic review within no time limit of the extensive body of SP literature. The following research question has guided our review:

RQ. What are the drivers, barriers, and potential performance outcomes of SP?

Our main purpose is to develop a comprehensive categorization of SP drivers, barriers, and outcomes to understand, structure and create a longitudinal overview of these topics and provide directions for future research. Based on the sustainable design framework for the assessment of packaging sustainability (Colwill et al., 2012), we considered leading academic journals covering the environmental, technical, logistical, commercial, manufacturing, legislative, and social dimensions of packaging.

This paper contributes to the literature in three important ways. First, we developed a novel comprehensive framework that provides an aggregated view of previous research on three important SP topics (i.e. drivers, barriers, and performance outcomes). We adopt a broader perspective than prior academic work based on a rigorous review method. The latter represents the full spectrum of high-quality research on SP and creates robust and reproducible results. Second, the complexity of SP decision-making process entails integrative and collaborative approaches. We highlight the importance of adopting an integrated approach at three levels: vertical and horizontal integration, upstream and downstream integration, and product-packaging integration. Third, we provide insightful directions for future research to explore missing knowledge and help decision makers with responsibility for environmental packaging strategy to better comprehend the body of SP.

The remainder of this paper is structured as follows. Section 2 describes the methodology. Section 3 presents the results in view of our RQ, research propositions, and the comprehensive framework. Section 4 discusses the major findings and elaborates research recommendations. Section 5 concludes the review.

3.2. Methodology

This article is a systematic literature review (SLR) aiming to identify, assess, and synthesize the relevant literature on SP. To ensure a rigorous, replicable, and transparent examination and synthesis of relevant SP research, our review followed the guidelines on conducting SLRs outlined by Seuring and Gold (2012), built upon a structured five-stage process, namely (1) formulating the research question, (2) carrying out a rigorous search for studies, (3) selecting relevant studies to be included in the review, (4) conducting a

descriptive evaluation, and (5) performing the thematic content analysis. This approach has been practiced by several SLR studies in the field of sustainability (e.g. Rotimi *et al.*, 2021). Step (1) has been exposed in the previous section. Steps (2) to (5) are presented in the following sections.

3.2.1. Identifying articles

In this stage, Seuring and Gold (2012) recommend delimiting the material that will be analyzed. Hence, it is important to theoretically define and justify the inclusion criteria of papers. This rule-driven search procedure helps generate valid and reliable findings (Durach *et al.*, 2017). The following are the criteria used to build our bibliographic portfolio.

Temporal scope
We decided to search articles within no time limit to ensure covering a larger body of relevant literature (e.g., Shah *et al.*, 2021). As the search has been performed during 2020, the upper time limit is December 2019, i.e. the last complete year.

Database selection
ProQuest's ABI/INFORM Collection has been used for the study. It is the most comprehensive and diverse Proquest business database that allows access to three databases: ABI/INFORM Dateline, ABI/INFORM Global, and ABI/INFORM Trade & Industry. Moreover, it encompasses a broad array of key journals from the world's most important scholarly publishers such as Emerald Insight, Elsevier's ScienceDirect, Springer, Palgrave Macmillan, and Blackwell Publishing. This database has been used by previous systematic reviews in the field of sustainability (e.g. Meixell and Luoma, 2015; Touboulic and Walker, 2015).

Targeted fields of interest
Given the multifunctional and interdisciplinary nature of packaging, we focused on journals covering fields that contribute to research on the environmental, technical, logistical, commercial, manufacturing, legislative and social requirements that are considered in the sustainable design framework (Colwill *et al.*, 2012).

Language and type of targeted publication
For practical reasons linked to the coding process applied to analyze studies, we focused on journals written in English following Seuring and Gold (2012). To ensure an acceptable level of quality of the content, the search was also limited to peer-reviewed scientific articles (Burgess *et al.*, 2006). As our main objectives are to map academic research and propose avenues for future research, we did not include practitioner journals, gray literature, textbooks, conference proceedings, working papers, and reports. These

search criteria have been adopted by earlier systematic reviews (e.g. Seuring and Gold, 2012; Touboulic and Walker, 2015).

Database search strategy

Several combinations of keywords were used, of which only those that yielded positive results are shown in Table 3.1. As researchers have used different terms when studying sustainable packaging, we used the cross-referencing method as recommended by Durach *et al.* (2017) to locate the broadest array of articles. The keywords of relevant articles were checked to identify other keywords that would help locate additional articles. The keyword search continued until a saturation point was reached, with no new articles identified.

Table 3.1. Study selection process

Keywords Search options Limit to English peer-reviewed academic publications Limit to scholarly journals Publication date: All dates until December 2019	**Initial results (without selection)**	**Limited results (initial selection)** Inclusion of publications in all fields contributing to research on the environmental, social, economic, marketing, ethical, and operational dimensions of sustainable packaging. Exclusion of anonymous articles Exclusion of duplicates	**Selected results (final selection)** Assess the relevance of articles by reading their abstracts
'green packaging' OR 'ecological packaging' OR 'sustainable packaging' OR 'environmental packaging' OR 'environmentally friendly packaging' OR 'eco-friendly packaging'	175	82	41
('environmental' OR 'sustainable' OR 'ecological' OR 'environmentally friendly' OR 'eco-friendly packaging') AND 'packaging' AND ('supply chain' OR 'value chain')	113	53	29
'packaging' AND ('value chain' OR 'supply chain')	93	35	9
('environmental' OR 'sustainable' OR 'ecological' OR 'environmentally friendly' OR 'eco-friendly') AND 'packaging' AND ('incentives' OR 'drivers' OR 'influencing factors' OR 'determinants' OR 'implementation factors' OR 'success factors')	54	26	17
('environmental' OR 'sustainable' OR 'ecological' OR 'environmentally friendly' OR 'eco-friendly') AND 'packaging' AND ('trade-offs' OR 'challenges' OR 'barriers' OR 'drawbacks' OR 'limitations')	47	19	12

(‘environmental’ OR ‘sustainable’ OR ‘ecological’ OR ‘environmentally friendly’ OR ‘eco-friendly’) AND ‘packaging’ AND (‘outcomes’ OR ‘opportunities’ OR ‘benefits’ OR ‘performance outcomes’)	29	17	10
‘sustainable supply chain’ AND (‘packaging’ OR ‘container’)	41	13	9
(‘green packaging’ OR ‘ecological packaging’ OR ‘sustainable packaging’ OR ‘environmental packaging’ OR ‘environmentally friendly packaging’ OR ‘eco-friendly packaging’) AND ‘decision-making’	9	7	4
‘producer responsibility’ AND ‘packaging’	53	15	5
Total of articles identified	614	267	131

Article selection process

This phase was carried out in three steps (see Table 3.1). The initial results of the keyword search were first identified. As there were many identified items that did not match our research, we refined the results of the first step using a title screening. Each time before selecting a paper, we consulted its keywords and subject terms to ensure that the paper really tied to our research objectives. All duplicate and anonymous items were excluded. From the 614 search results, 267 articles remained. Subsequently, an abstract screening was applied following Touboulic and Walker (2015). We read the abstracts of all remaining papers to assess whether the authors provide an answer to our research question and sub-questions. The articles found non-relevant were excluded. This process yielded a bibliographic database of 131 potentially relevant papers.

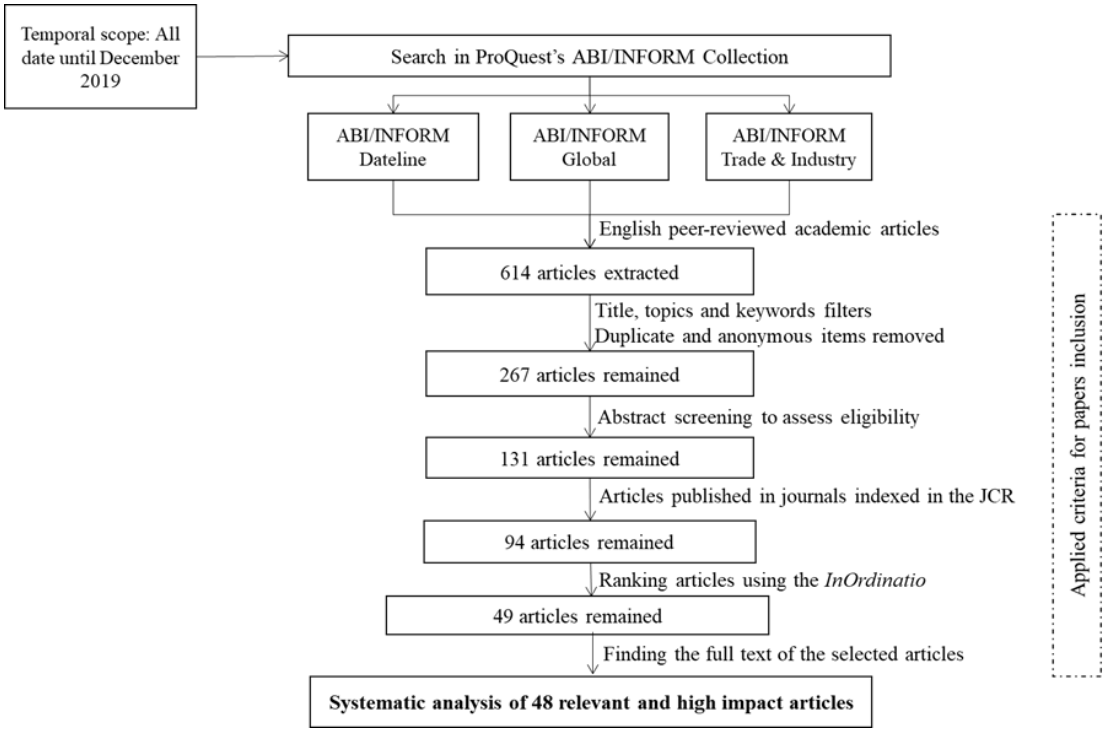
3.2.2. Selecting articles to be included in the review

To ensure the relevance of studies, Burgess *et al.* (2006) recommend carefully selecting the final sample of papers to be included in the review. Therefore, we applied the *Methodi Ordinatio* methodology proposed by Pagani *et al.* (2015) to rank the peer-reviewed articles according to their scientific relevance. This method is based on the calculation of an index called the *InOrdinatio* (1). The latter involves three variables: the impact factor (IF), the number of times the paper has been cited (Ci), and the year in which the paper was published (PublishYear). The *InOrdinatio* equation (1) also accounts for the year in which the research was developed (ResearchYear), and a weighting factor varying from 1 to 10 to be assigned by the researcher (α). Since we searched articles within no time limit, we chose a weighting factor of 5, because it would provide a balance of time. This approach allows identifying the most relevant and high-impact studies conducted on the study’s topic (Pagani *et al.*, 2015).

$$InOrdinatio = \left(\frac{\text{IF}}{1000}\right) + \alpha * [10 - (\text{ResearchYear} - \text{PublishYear})] + (\text{Ci}) \quad (\mathbf{1})$$

For the IF, we chose the Thomson Reuters Journal Citation Report (JCR) which is the most recognized journal report for evaluating journals using quantifiable, statistical information based on citation data. We began by identifying the journals in which the 131 selected articles were published. Of the 73 journals covering various fields, we identified those indexed in the JCR (46 journals), and kept the papers published in those journals. From the 131 papers, we retained 94 papers published in 46 journals indexed in the JCR. The JCR impact factors (2018) of these journals range from 8.500 to 0.466. For the Ci, we used Google Scholar (Pagani *et al.*, 2015). We retrieved the research year directly from the articles. Figure 3.1 complements Table 3.1 by presenting a descriptive summary of the literature review process adopted.

Figure 3.1. Summary of literature review steps



With all these data at hand, we applied the equation (1) to the set of 94 papers. Then we sorted them according to their scientific relevance: "the higher the *InOrdinatio* value is, the more relevant the paper is for the portfolio" (Pagani *et al.*, 2015: 2121). The articles with an *InOrdinatio* value equal or greater than 75 were identified as the most relevant and high-impact studies conducted on the study's topic within no time limit. This approach yielded a final database of 49 relevant articles. The next step is to retrieve the complete version of the selected articles. The full text of Wills (1990) was not found.

Therefore, 48 articles remained (Appendix 1) and are brought for in-depth analysis. Table 3.2 shows the distribution of those articles in each journal.

Table 3.2. Overview of selected articles in each journal

Journal	No. of articles	Authors
International Journal of Physical Distribution & Logistics Management	8	[24]; [37]; [17]; [1]; [7]; [16]; [27]; [22][2]
British Food Journal	4	[38]; [8]; [35]; [29]
International Journal of Production Economics	4	[9]; [5]; [3]; [18]
The International Journal of Life Cycle Assessment	4	[12]; [19]; [32]; [39]
Journal of Industrial Ecology	3	[36]; [33]; [34]
International Journal of Consumer Studies	2	[6]; [23]
International Journal of Production Research	2	[10]; [47]
Journal of Business Ethics	2	[46]; [15]
Journal of Environmental Planning and Management	2	[40]; [45]
California Management Review	1	[26]
Canadian Public Policy	1	[42]
Environmental Management	1	[14]
European Journal of Innovation Management	1	[21]
Growth and Change	1	[31]
International Journal of Operations & Production Management	1	[41]
International Journal of Retail & Distribution Management	1	[25]
Journal of Business Logistics	1	[13]
Journal of Environmental Economics and Management	1	[4]
Journal of Polymers and the Environment	1	[44]
Marketing Intelligence & Planning	1	[11]
National Tax Journal	1	[28]
Organization & Environment	1	[43]
Production Planning & Control	1	[48]
Supply Chain Management: An International Journal	1	[20]
Waste Management & Research	1	[30]
Journal of Consumer Policy	1	[2]

3.2.3. The coding process adopted for the selected studies

The papers selected in the previous stage were downloaded and collected in the reference management software Endnote (Wichor *et al.*, 2016). To conduct the content analysis, we

[2] The reference numbers correspond to the articles in Appendix 1.

adopted a two-phase coding process guided by Touboulic and Walker (2015). First, the research team defined preliminary coding categories (predefined codes) to answer the research question. Each article has been read by the first author and relevant segments (e.g. main findings) have been highlighted in the text by adding labels. The model exemplified out in Table 1 has been used to extract and categorize relevant information from each article. The labels inserted in the text helped categorizing and assigning the original segments to their appropriate code. Then, we moved from detailed original segments to structural dimensions by predefined code and by article (Seuring and Gold, 2012). The codes and the coding itself were verified by the two other authors to validate that the dimensions are assigned to their appropriate codes. This enhances the reliability of coding allocation. Second, after two rounds of coding, we cross-analyzed the dimensions extracted for each predefined code and for each article. This stage started with a rigorous reading of the dimensions highlighted in each code. Then a hierarchy was drawn up in an iterative way with sub-codes assigned to each main code. For example, "consumer pressure" was identified as a sub-code of the code "drivers." Relevant dimensions were grouped, categorized, and synthesized by sub-codes. The subsequent section presents the results for these codes and sub-codes.

Table 3.3. Model of data extraction table for the 48 studies included in the study

Author (year)	Journal	Industry	Units of analysis	Type	Theory	Sustainable packaging definition	Research method	Main findings	Codification
Fernie and Hart (2001)	BFJ	Food retail industry	Legislator-retailer Primary and secondary packaging	Empirical (Qualitative approach)	n/a	n/a	Multiple case study (n=10)	Legislation is perceived by many firms as an opportunity to reduce waste, optimize packaging and reduce costs.	e.g. regulatory pressure
Prendergast and Pitt (1996)	IJPDLM	Food and kindred products; beverages; tobacco products; pharmaceutical; games and toys	Manufacturers Primary packaging	Empirical (Quantitative approach)	n/a	p.63	Survey (n= 600)	e.g. significant relationships between firm size and the perception of trade-offs	e.g. complex trade-offs
Verghese and Lewis (2007)	IJPR	Industrial goods	Supply chain Tertiary packaging	Empirical (Qualitative approach)	n/a	p.4387	Multiple case study (n=9) and life cycle assessment (LCA) method	e.g. sustainable packaging requires a collaborative approach to ensure that costs are reduced for the whole supply chain.	e.g. collaborative supply chain
Zailani et al. (2012)	IJPE	Electronic equipment; industrial goods; food and beverage industries	Manufacturers Level of packaging not specified	Empirical (Quantitative approach)	Transaction cost theory	p.333	Survey (n= 400)	e.g. Sustainable packaging has a positive effect on environmental, economic, and social outcomes.	e.g. performance outcomes

3.3. Descriptive results

As suggested by Seuring and Gold (2012), we began with a descriptive evaluation of the selected articles assessing the papers for their source, publication date, research method, unit of analysis, industry, and country to understand the trends relating to our research topic.

Analysis by source and publication date

The 48 papers are spread over twenty-six journals with various scopes, which confirms the interdisciplinarity of packaging (e.g. Vernuccio *et al.*, 2010). The foremost journals that published relevant and high impact articles on our research topic, are the *International Journal of Physical Distribution and Logistics Management*, followed by the *Journal of Consumer Policy*, the *International Journal of Production Economics*, and the *Journal of the Environmental Economics and Management*. The number of publications has evolved over time since 1989, the year when the first relevant study has been found through the ranking method adopted. Since then, the number of studies published each year has fluctuated, and has tended to increase particularly in recent years. This illustrates that the environmental impact of packaging has been studied for more than thirty years, but the scientific interest in packaging sustainability has grown significantly in the last decade.

Analysis by research method

The studies adopt qualitative (22), quantitative (13), and mixed (13) approaches (Table 3.4). We observe a predominance of empirical studies (43) and the most used research methods are case studies (17), surveys (16), life cycle assessment (6), and simulation (4). The remaining studies (5) are conceptual and use the literature review method.

Table 3.4. Research methods of the selected studies

Research method		**Number of articles**	**Authors**
Survey	Quantitative	6	[7]; [31]; [9]; [6]; [27]; [3]
	Qualitative	4	[17]; [44]; [29]; [25]
	Mixed approach	5	[42]; [15]; [11]; [23]; [48]
Case study	Multiple case studies	11	[28]; [40]; [38]; [16]; [10]; [36]; [43]; [8]; [21]; [18]; [45]
	Single case study	7	[46]; [1]; [2]; [26]; [33]; [22]; [47]
Life cycle assessment (LCA)		5	[12]; [19]; [39]; [14]; [34]
Literature review		4	[24]; [37]; [20]; [30]
Simulation		3	[4]; [13]; [35]
Literature review and content analysis		1	[5]
Survey and simulation		1	[41]
LCA and simulation		1	[32]

Analysis by units of analysis

The selected articles differ in terms of supply chain actors studied (Table 3.5). Four main perspectives were identified. First, the supply chain perspective is explicitly studied in the largest number of articles (18). Some of these studies view the supply chain from a holistic perspective, while others study interactions within the supply chain. Second, the perspective of a single supply chain actor is studied in 13 articles that primarily focus on consumers or manufacturers, the two central actors in sustainable packaging decisions. Third, the dyadic perspective is found in 9 articles, which study interactions between consumers and manufacturers, the latter and legislator, and between retailers and legislator. Fourth, the perspective of three supply chain actors is adopted in 8 articles. The studied triads include suppliers, manufacturers, distributors, retailers, consumers, legislator, waste collector, and packaging professionals. Moreover, the selected articles differ in terms of the type of packaging studied. Most studies (23) address sustainable packaging without specifying which level of the packaging system is studied. The remaining studies focus on primary (10), tertiary (7), and secondary packaging (3). Few studies (5) explore the packaging system (i.e. primary, secondary, and tertiary packaging).

Table 3.5. Units of analysis studied in the selected articles

Unit of analysis		**Number of articles**	**Articles**
Single supply chain actor	End-consumers	5	[2]; [6]; [23]; [29]; [25]
	Manufacturers	8	[1]; [7]; [31]; [5]; [43]; [21]; [3]; [30]
Dyads	Manufacturers – consumers	3	[24]; [11]; [13]
	Legislator - Manufacturers	5	[17]; [28]; [40]; [36]; [45]
	Legislator - retailers	1	[38]
Triads	Manufacturers - distributor – retailer	1	[48]
	Legislator -manufacturers – waste collector	1	[33]
	Suppliers - manufacturers – consumers	1	[9]
	Legislator -manufacturers – consumers	2	[42]; [4]
	Manufacturers - retailers – consumers	2	[46]; [44]
	Packaging professionals - manufacturers - consumers	1	[15]
Supply chain	Holistic view of the supply chain	11	[16]; [26]; [10]; [20]; [27]; [8]; [35]; [18]; [22]; [47]; [41
	Interactions within the supply chain	7	[37]; [12]; [19]; [32]; [39]; [14]; [34]

Analysis by industry and country

The analysis by industry reveals that most studies included in this review (22 studies) are related to the food and beverage, which is considered a major source of packaging waste. Therefore, this industry tends to dominate the debate on packaging sustainability, which is in line with previous studies (e.g. Manzini et al., 2014). Scientific interest on packaging sustainability extends to other industries such as electrical and electronic equipment,

industrial goods, and waste management. Some survey-based studies are multi-sectorial (Table 3.6).

Table 3.6. Industries studied in the selected articles

Industry	Number of articles	Authors
Food	16	[46]; [31]; [2]; [38]; [9]; [16]; [6]; [8]; [12]; [19]; [39]; [35]; [18]; [33]; [29]; [41]
Beverage	6	[31]; [42]; [2]; [32]; [14]; [34]
Packaging industry	6	[28]; [40]; [36]; [44]; [43]; [30]
Electrical and electronic equipment	3	[26]; [36]; [33]
Industrial goods	2	[11]; [10]
Waste management industry	2	[4]; [45]
Automobile	1	[47]
Healthcare	1	[27]
Multi-industry (more than two industries)	5	[17]; [7]; [5]; [3]; [48]
Unspecified	6	[37]; [24]; [15]; [33]; [23]; [25]

Regarding the geographical focus, Europe has the most high-impact publications on this study's theme (28 studies) with respectively UK, Italy, Germany, Spain, and Sweden at the top of the list. It is followed by North America (10 studies) with US and Canada standing out, and Africa (2 studies). Some empirical studies have an international scope by covering more than three developed countries (3 studies). These results suggest that the scientific interest in environmental issues is growing more quickly in developed countries than in developing ones. Some empirical studies have an international scope by covering more than three developed countries (Kivimaa, 2008; Vernuccio *et al.,* 2010; Ferreira *et al.,* 2017).

3.4. Thematic analysis results

3.4.1. The evolving definition of sustainable packaging

The concept of SP is referred to in different ways in the literature (Table 3.7). The definitions formulated by authors reveal four perspectives: environmental, social, economic, and operational. Earlier definitions focus primarily on the environmental perspective, which emphasizes the importance of optimizing packaging design and maximizing its use to reduce negative environmental externalities (e.g. Livingstone *et al.*, 1994; Kroon *et al.*, 1995; Prendergast and Pitt, 1996). This fulfills external societal

outcomes stemming from increasing public awareness and sustainable consumer demand (Labatt, 1997). The recent definitions integrate the environmental, social, economic, and operational perspectives (e.g. Jahre et al., 2004; White et al., 2015; Yusuf et al., 2017). According to Verghese and Lewis (2007), SP goes beyond recovering, recycling, or reusing. It provides a competitive advantage and positively affects the value perceived by consumers (Rokka and Uusitalo, 2008; Scott and Vigar-Ellis, 2014). The resources and waste reduction derived from SP implies an overall cost reduction from an economic point of view (Zailani *et al.*, 2012). To achieve the lowest ecological footprint, SP should combine eco-efficiency and eco-effectiveness principles (Niero *et al.*, 2017). It must be effective by maximizing the environmental performance while meeting functional requirements; efficient by increasing value while optimally using materials; cyclic by using renewable and recyclable materials; beneficial and safe by not compromising the environment and user's safety and health (Magnier and Crié, 2015).

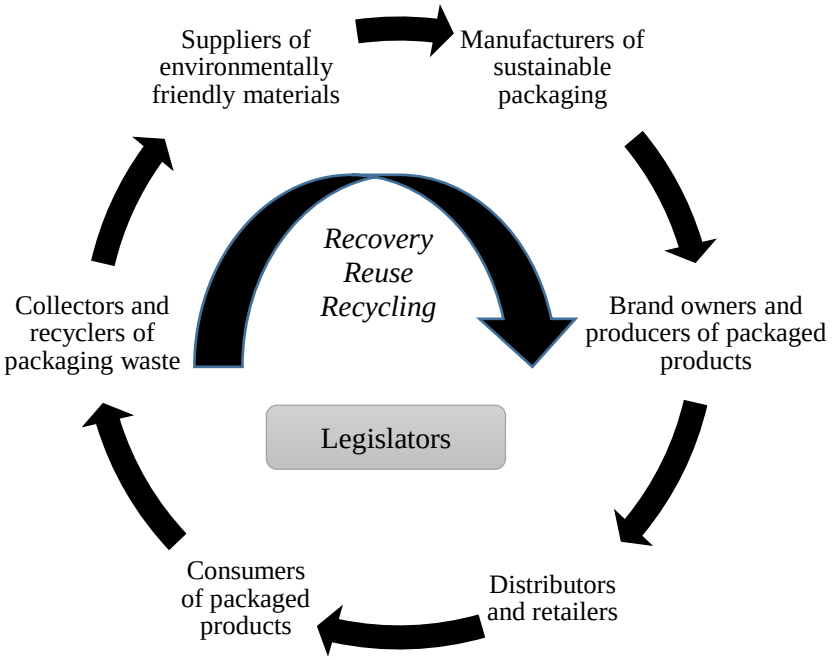
Table 3.7. The evolving definition of SP

Article	Definition
Livingstone et al. (1994: 17)	"Environmentally friendly packaging" implies (1) a reduction at source of packaging by using fewer resources and creating less waste; (2) reuse or refilling; (3) recycling.
Kroon et al. (1995: 57)	"Returnable container" is used a certain number of times in the same form during its lifetime, which implies less harm to the environment than one-way packaging.
Prendergast and Pitt (1996: 63)	"Environmentally friendly packaging" conforms to environmental requirements through package reduction, recycling, or reuse.
Labatt (1997: 68)	"Environmental packaging" implies reducing material and energy inputs and maximizing reuse and recycling.
Jahre et al. (2004: 124)	"Environmental packaging" is based on material and energy efficiency in production, use, and disposal. This requires trade-offs between marketing, logistics, and environmental functions.
Verghese and Lewis (2007: 4387)	"Sustainable packaging" is made of materials that reduce the environmental impacts of packaging in supply chains.
Ciliberti et al. (2008: 92)	"Sustainable packaging" contains and protects products across the supply chain. It is made up of materials that are recycled and does not compromise human health and ecosystems.
García-Arca et al. (2014: 330)	"Sustainable packaging logistics" is the process of designing, implementing, and controlling the integrated packaging, product, and supply chains to prepare goods for safe, efficient, and effective handling, transport, distribution, storage, retailing, consumption, recovery, and reuse. It maximizes social and consumer value, sales, and profit from a sustainable perspective.
White et al. (2015: 6551)	"Inter-organizational green packaging" reduces packaging and maximizing its material reuse and recycling. This requires trade-offs between operational and environmental requirements.
Yusuf et al. (2017: 633)	"Returnable packaging" reduces the environmental impact via waste reduction while reducing operational costs. This refers to a change in attitude toward the environment for the purpose of environmental sustainability and to achieve business performance.

Niero et al. (2017: 742, 746, 749)	"Sustainable packaging" combines two main principles": "eco-efficiency" which is based on "maximizing value while minimizing resource use and pollution", and "eco-effectiveness" which is based on "maximizing the benefits to ecological and economical systems"; to achieve a "Continuous Loop Packaging Systems".

More recent studies expand on the concept acknowledging the key importance of integrating packaging decisions with the whole supply chain. For instance, Colwill *et al.* (2012) propose a "Holistic Integrated Sustainable Design (HISD)" framework where they underscore the importance of a holistic and integrated packaging eco-design to achieve the greatest sustainable return. Likewise, White *et al.* (2015) introduce the concept of "inter-organizational green packaging" that ensures packaging is meeting the conflicting requirements arising from the firm and its stakeholders. Niero *et al.* (2017) also emphasize the importance of integration in their "continuous loop packaging system" definition which is based on collaborative relationships among stakeholders during the packaging decision process. Figure 3.2 illustrates the multiple intermediaries in the closed and continuous supply chain of SP.

Figure 3.2. The supply chain of sustainable packaging



Source: Adapted from Matthews (2004), Verghese and Lewis (2007), Accorsi *et al.* (2014)

3.4.2. Sustainable packaging drivers

The thematic analysis allows identifying relevant SP drivers. Table 3.8 presents a description of these drivers and the theoretical approaches adopted. The integrative and

collaborative supply chain is the predominant driver in the literature (13 papers), followed by environmental capabilities (11 papers), market-based instruments (9 papers), cost reduction (6 papers), consumer pressure (6 papers), competitive advantage (6 papers), and regulatory pressure (5 papers).

Integrative and collaborative supply chain

The authors studied this driver based on generic theoretical frameworks such as sustainable supply chain management and integrated eco-design frameworks. Dyllick (1989) provides qualitative evidence from a case study that the development of a collective marketing strategy including consumers, retailers and packaging producers increases the chances of moving toward more SP practices. Verghese and Lewis (2007) also established that adopting a cooperative supply chain approach ensures designing effective packaging that meets all important requirements. In this sense, Kumar *et al.* (2008) noticed inefficient packaging designs due to a lack of coordination between manufacturers, retailers, and consumers during the purchasing decision-making process. Involving relevant stakeholders in earlier stages of the decision process leads to a significant reduction of environmental and operational costs for the whole supply chain. In fact, there are complex trade-offs between logistics, marketing, and environmental packaging functions (Jahre and Hatteland 2004). An integrated eco-design of packaging helps considering the interrelationships between multiple decision-making criteria that influence the packaging practices (García-Arca and Prado Prado, 2008; Colwill *et al.*, 2012). Similarly, García-Arca *et al.* (2014) examine the "sustainable packaging logistics" - which is based on an integrated approach - has increased the flexibility of the firm to develop economically, socially, and environmentally viable packaging practices. However, this approach depends on the ability of the firm to objectively evaluate the packaging requirements of all relevant stakeholders. In this sense, White et al. (2015) examine the decision criteria weights of an inter-organizational packaging design to determine the most important influencing factors. The operational concerns, most notably cost and quality, remain the most influential factors. Therefore, Niero *et al.* (2017) recommend maintaining collaborative relationships among upstream and downstream supply chain stakeholders during SP decision process. This ensures a fair distribution of packaging costs and benefits between suppliers, manufacturers, retailers, consumers, and recyclers. All the above arguments suggest that an integrative and cooperative supply chain allows the firm to objectively align the stakeholders' requirements, which in turn yield to the pursuit of more effective and efficient product packaging. Based on the foregoing, the following research proposition is formulated:

Proposition 1. *Integrating packaging decisions with the whole supply chain allows balancing the divergent operational, economic, marketing, and environmental requirements of stakeholders, which leads to the pursuit of more SP*.

Environmental capabilities and resources

Labatt (1997) and Kivima (2008) addressed this driver from the perspective of the innovation and the organizational coupling/decoupling theories. These theories are used to understand the firms' response to environmental issues as they present varying patterns under pressure for change. Kivima (2008) provided qualitative evidence from four product development experiences that integrating environmental considerations into product development is considered as a major driving force to generate packaging environmental innovations. The environmental expertise, environmental training, and intentional development of environmental innovations are the most important environmental capabilities. Moreover, having a dedicated technology, logistics, waste management, and customer relationships are the prioritized capabilities needed to implement efficient and effective packaging (Niero *et al.*, 2017). The management attitude and customer relationships are, surprisingly, the least important sources of influence to engage in SP practices for industrial and consumer manufacturers (Kassaye, 2001). Moreover, many authors emphasized the importance of technical resources such as life cycle assessments to analyze the environmental impact of packaging practices across the supply chain (e.g. Matthews, 2004; Büsser and Jungbluth, 2009; Humbert *et al.*, 2009; Dobon *et al.*, 2011; Pattara *et al.*, 2012; Manzini *et al.*, 2014). However, these resources are mostly limited to specialized users who provide tactical rather than strategic support to the SP decision-making process (Colwill *et al*, 2012). According to the innovation and the organizational coupling/decoupling theories, firms could have dissimilar packaging strategies because of the heterogeneity of their resources and capabilities. Each firm develops a unique portfolio of resources and capabilities in response to environmental concerns. The variation in firm responsiveness to these concerns depends on its size, product orientation, and the presence of an environmental affairs function (Labatt, 1997). Large firms show more proactive responses than medium and small firms. Besides, consumer-oriented firms with an environmental affairs function are more likely to show a proactive behavior to packaging-waste reduction than industrially oriented firms with any form of environmental function. Empirical support for these arguments is found in Kassaye (2001) who showed that firm size, type of products, and business nature have a significant moderating effect on SP. Based on the above, the following proposition is formulated:

Proposition 2. *Large and consumer-oriented firms with an environmental affairs function are more likely to develop environmental capabilities and resources enabling the pursuit of more SP; than small, medium, and industrially oriented firms with any form of environmental affairs function.*

Market-based instruments

Dewees and Hare (1998) addressed this driver from the economic theory perspective, which states that achieving an optimal reduction in packaging waste requires pricing the

negative externalities that remain after environmental regulations. Market-based environmental instruments such as packaging eco-taxes and subsidies to environmental designs can present firms with strong economic incentives to produce less packaging and increase recyclability (Fullerton and Wu, 1998; Dewees and Hare, 1998). According to the SLR, Extended Producer Responsibility (EPR) is one of the most important market-based measures that prolongs the firm responsibility for packaging waste across the supply chain. This is based on the "polluter pays" principle which implies that firms contribute financially to the EPR schemes (Rousso and Shah, 1994; Fernie and Hart, 2001; Roine and Chin-Yu, 2006; Mayers and Butler, 2013). Since the EPR policy is driven by weight, it provides a strong incentive to reduce packaging at the source (Dewees and Hare, 1998). In this respect, Ciliberti *et al.* (2008) established that the reduction at source is the second most important SP practice adopted by Italian firms. This suggests that firms are inclined to reconsider their packaging when they bear the financial burden of eliminating its waste. Nevertheless, Roine and Chin-Yu (2006) found a weak causality between Norwegian EPR and technological change and innovation for plastic packaging. The EPR has an indirect and no significant effect on institutional change and innovation, but it has a rather direct effect on downstream operations through increased recycling. The EPR policy implies that firms are forced to internalize costs that were previously externalized to society, but they can also reduce costs and avoid potential environmental sanctions or penalties. More specifically, the formal pressure gives rise to two forms of strategies. Firms could either bear these costs when they are lower than those generated by adopting a SP, or they implement this practice to avoid potential environmental sanctions, legal liabilities, or costs of non-compliance (Livingstone and Sparks, 1994; Chappin *et al.*, 2009). In such a context, the regulatory drivers may fail to achieve the required sustainability goals. According to the EPR framework, firms are inclined to adopt SP when they must bear sufficiently high disposal costs. Therefore, the following proposition is formulated:

Proposition 3*. Market-based instruments prompt decision-makers to choose more SP practices, particularly when the disposal costs that must be borne by the firm are higher than the environmental costs of non-compliance.*

Cost reduction

Bone and Corey (2000) relied on the ethical decision-making theory which holds that ethical sensitivity, personal values, perceived consequences, and industry norms are the main background factors that influence the "deontological" and "teleological" judgment of managers and hence their decision-making process. Ethical sensitivity refers to packaging decision-making outcomes that may impact consumers well-being or society. Personal values are important goals for managers that influence their perception when making ethical judgments on SP. The perceived consequences relate to positive and negative outcomes of SP, whereas industry norms indicate the extent to which SP is

perceived by brand managers as common practice within the marketplace. The SLR shows that ethical sensitivity and personal values are poorer predictors of brand managers behavior regarding SP. Brand managers rely more on pragmatic values than on moral values (Bone and Corey, 2000). This suggests that they prioritize economic wellbeing of the firm over environmental concerns. Similarly, Verghese and Lewis (2007) established that SP innovation is only adopted by industrial firms when it delivers economic benefit such as cost reductions and increased sales. Cost control is also the most important criterion for food purchasing agents (Pullman and Wikoff, 2017). Being predominately driven by a cost-reduction approach, the latter tend to be committed to reducing food and packaging waste. Nevertheless, Yusuf et al. (2017) established that the economic benefits have a moderate effect on the adoption of returnable packaging. Whereas Kassaye (2001) showed that the priority factors for engaging in SP vary depending on the firm's size. For smaller firms, the highest priority is given to cost considerations while this factor is ranked third for large firms. Based on a relative cost model, Mollenkopf *et al.* (2011) explain that the packaging choice decision depends on the relative influence and interactions between logistics decision factors. When the daily volume increases, returnable packaging becomes more economically viable and significantly reduce the operational costs. Similarly, White *et al.* (2015) determined the weight scores for the decision criteria of SP design. The primary issue of concern is the labor cost of packaging operations followed by packaging materials cost. Returnable packaging was preferred, predominantly due to its cost advantage, whereas its environmental benefit was of secondary importance. These findings suggest that even though firms address issues to which stakeholders are ethically sensitive, they tend to rely on pragmatic values during the packaging decision-making process. Therefore, the following proposition is formulated:

Proposition 4*. Drivers for SP are mostly cost-oriented. Economic and operational benefits such as cost reduction and increased sales would induce firm to embrace SP practices.*

Consumer pressure

The moral decision-making (Thogersen, 1999), the reasoned action and planned behaviour (Rokka and Uusitalo, 2008), and the consumer behavior (Magnier and Crié, 2015) theories were used to explain factors that affect the environmental decisions of consumers. The SLR shows that environmental concerns are increasingly important in consumer product choices. However, the behavioural intention of consumers is not consistent with their attitude towards sustainable products (e.g. Thogersen, 1999; Magnier and Crié, 2015; Fernqvist *et al.*, 2015). The planned behaviour theory states that attitude towards the behaviour, subjective norms, and perceived behavioural control are three major determinants that independently guide consumer behaviour.

First, the attitude towards the behaviour refers to the degree to which a consumer favourably or unfavourably evaluates the environmental dimension of packaging in their product choices. Based on a survey of 330 Finnish consumers, Rokka and Uusitalo (2008) analyzed the relative importance of SP when compared with other product attributes. The largest consumer segment favored environmentally labelled packaging as the most important criteria in their product choice. Nevertheless, Scott and Vigar-Ellis (2014) found that South African consumers exhibit limited knowledge of what SP is, how to differentiate it from conventional packaging, as well as its benefits. While some consumers have some knowledge of it, their behaviour reflects limited action of actual purchasing. According to the planned behaviour theory, different levels of personal factors or norms can prevent positive attitudes towards sustainable products from being translated into a buying action. Therefore, consumer personal norms determine the willingness to choose a SP, and hence induce firms to make the necessary design changes (Thogersen, 1999).

Second, the subjective norms refer to consumer perception of the social pressure to perform the behaviour regarding SP. Magnier and Crié (2015) structured consumers' perception of SP into perceived benefits and perceived sacrifices. The perceived benefits are either "private" or "pro-social". The private benefits include, first, health benefits since SP reduces the negative environmental externalities, which corresponds to the "critical value" (Vernuccio *et al.*, 2010). Second, the convenience of SP given its reduced volume (i.e.the "practical value"). Third, lowering the product price because of reduced size, volume, and packaging materials. Other perceived benefits are related to "emotional" and "social" values deriving from the perceived utility. The pro-social benefits refer to an altruistic behavior (i.e."ideal value"), because SP contributes to the well-being of individuals and the environment protection. While the perceived costs include the "loss of pleasure during the consumption experience," because SP can be less sophisticated compared to conventional packaging; the "aesthetic cost" as SP can be perceived as less attractive due to its simplicity and dark colors; and the "decrease in perceived quality" due to reduced packaging materials. According to the planned behaviour theory, the consumer perception of these benefits and sacrifices depends on the normative beliefs of the social environment, which determines the consumer buying behavior.

Third, the perceived behavioural control indicates whether the choice of SP is perceived by consumers as easy or difficult. Magnier and Crié (2015) established that SP does not only entail positive inferences, but also many costs such as higher product price. In this respect, Thogersen (1999) found that the perceived costs of choosing SP are low and do not capture the consumers' attention, thus allowing for environmental concern to enter their decision-making process. This suggests that ethically interested consumers are less likely to be influenced by the perceived costs, because they are highly concerned about sustainability. They rather base their decision on a reasoned process by evaluating the

products pros and cons, which guides their buying behaviour. This sends a direct signal to firms to pursue sustainable product packaging. Based on the above findings, we formulate the following proposition:

Proposition 5*. The importance of the environmental attribute in consumer product choice, personal norms, perceived benefits and sacrifices, and sustainability concerns would prompt firms to pursue more SP practices.*

Competitive advantage

This driver was studied from the natural resource-based view perspective (Yusuf *et al.*, 2017), which holds that SP is a valuable organisational resource that would allow achieving a sustainable competitive advantage. It enables firms to optimize its distribution activities without harming the environment. However, Robertson (1990) stressed the importance of balancing packaging integrity with environmental pressures to achieve this competitive advantage, particularly for food products. In this respect, Prendergast and Pitt (1996) proved that there is no negative relationship between the environmental function of a sales packaging, its aesthetic and functional properties, and its ability to handle and protect the product through the distribution chain. This suggests that a SP is not less effective than a conventional packaging, hence, it offers a competitive advantage (García-Arca *et al.*, 2014). Rundh (2009) also provided evidence from five case studies that packaging strengthens the brand name and image; thus, it contributes to achieving a competitive advantage for consumer products. Furthermore, acquiring a competitive advantage was posing the highest source of influence to embrace SP for consumer goods manufacturers (Kassaye, 2001). However, Yusuf et al. (2017) showed that this competitive advantage has a negligible effect on the adoption of returnable transport packaging by the firm. These conflicting findings can be explained by the fact that sales packaging is more complex than transport packaging, as it must reconcile marketing, logistics and environmental requirements to achieve a competitive advantage (Prendergast and Pitt, 1996; Fernie and Hart, 2001). Based on the foregoing, we formulate the following proposition:

Proposition 6*. Acquiring a competitive advantage would incentivize the pursuit of sustainable sales packaging for consumer products rather than sustainable transport packaging for industrial product.*

Regulatory pressure

This driver was studied from the innovation (Labatt, 1997) and natural resource-based view (Yusuf *et al.*, 2017) theories. The SLR shows that government regulations incentivize firms to undertake packaging environmental practices. Firms mainly adjust their packaging buying behaviour to comply with regulations, avoid potential costs of non-compliance, and continue doing business in their field (Livingstone and Sparks,

1994). Legislation is perceived by many firms as an opportunity to reduce waste, optimize packaging and reduce costs, while others are unprepared for the complexities it creates (Fernie and Hart, 2001). Labatt (1997) found a positive relationship between government's policies and corporate environmental decisions regarding packaging-waste reduction, whereas Yusuf *et al.* (2017) established that government regulations have a negligible effect on the adoption of returnable packaging. In fact, firms' strategic choices are heterogeneous depending on how they respond to institutional pressures and according to their needs and the specificities of their field. Packaging laws could cause firms to embrace environmental practices that are considered appropriate and socially legitimate in the industry (Livingstone and Sparks, 1994; Fernie and Hart, 2001). However, firms must firstly be aware of, and understand government policies before they can set an appropriate environmental decision-making process (Labatt, 1997). However, the awareness of packaging laws is often more intense for larger firms, so they tend to set up a more proactive environmental approach than smaller firms (Livingstone and Sparks, 1994). The awareness of primary packaging legislation is also greater than that for transport packaging because the primary packaging decision is more complex than that of transport packaging (Fernie and Hart, 2001). Therefore, we formulate the following proposition:

Proposition 7*. The awareness of packaging waste regulations is more likely to induce large firms to pursue primary rather than transport SP.*

Table 3.8. Sustainable packaging drivers

Variable	Description	Theoretical approach	References
Integrative and collaborative supply chain	Integrate stakeholders' packaging requirements based on a collaborative approach. **Main constructs**: sustainable packaging logistics; inter-organizational packaging design; upstream and downstream collaboration; collective marketing strategy.	Generic theoretical frameworks	[10]; [14]; [16]; [18]; [20]; [21]; [22]; [26]; [27]; [34]; [44]; [46]; [47]
Environmental capabilities and resources	Organizational abilities and resources that enable firms to pursue sustainable packaging practices. **Main constructs**: Physical, human, organizational, technological, and technical resources; corporate environmental integration and innovation.	Theory on organizational coupling/decoupling Corporate social responsibility and innovation theory	[5]; [12]; [14]; [18]; [19]; [26]; [34]; [35]; [37]; [39]; [43]
Market-based instruments	Incentive-based instruments based on price and market mechanisms, such as eco-taxes for sustainable practices. **Main constructs**: Extended Producer Responsibility; market-price mechanisms; Packaging Waste Directive; The Green Dot.	Economic theory	[4]; [5]; [28]; [33]; [36]; [38]; [40]; [42]; [45]
Cost reduction	Refers to economic benefits resulting from sustainable packaging. **Main constructs**: Economic benefits; system cost; transportation cost; labor cost; disposal cost, recycling revenue.	Ethical decision-making theory	[10]; [11]; [13]; [15]; [41]; [47]
Consumer pressure	Consumer-level factors that affect business environmental decisions. **Main constructs**: consumers' buying attitudes and behaviors; consumers' willingness to purchase; consumers' responses to ecological cues; consumers' environmental knowledge, perceptions, and actions regarding sustainable packaging.	Moral decision-making, reasoned action, planned behaviour, and consumer behavior theories	[2]; [6]; [23]; [24]; [25]; [29]
Competitive advantage	Achieving a sustainable advantage through sustainable packaging practices. **Main constructs**: Sustainable competitive advantage; relative advantage; brand image; product quality and integrity; market share; competition.	Natural resource-based view theory	[7]; [11]; [22]; [23]; [24]; [48]
Regulatory pressure	Regulatory policies that drive firms' decisions regarding packaging sustainability. **Main constructs**: Government regulations; awareness of the packaging legislation; packaging waste management; packaging waste regulations.	Innovation theory Natural resource-based view theory	[4]; [17]; [31]; [38]; [48]

3.4.3. Sustainable packaging barriers

The thematic analysis identified relevant potential barriers to sustainable packaging. Table 3.9 presents a description of these barriers and the theoretical approaches adopted.

Complex trade-offs between packaging requirements

Balancing packaging integrity with environmental pressures implies highly complex trade-offs (Robertson, 1990). Besides its environmental function, packaging must meet other important functions, e.g. containment and protection. The firm should develop attractive and environmentally packaging, yet still practical to protect and promote the product. There are potential trade-offs between environmental, logistical, and marketing packaging requirements (Prendergast and Pitt, 1996). Based on the case study of a food supply chain, Jahre *et al.* (2004) noticed the difficulty to develop packaging that perfectly fits the product without reconciling its environmental, logistical, and marketing roles. Through 186 case studies of packaging design, Vernuccio *et al.* (2010) also proved the complex multidimensional nature of packaging given that three functions tend to influence packaging decision, namely marketing, logistics, and ethics. The simultaneous integration among these dimensions appears in only one third of the cases studied, while the integration of marketing and ethics was the most common combination. Besides, the packaging decision-making process requires inputs not only from logistics, marketing, and environment departments in the firm, but most likely from external stakeholders (Colwill *et al.*, 2012). It remains also difficult to objectively weigh different packaging requirements on the same scale (García-Arca *et al.*, 2014; White *et al.*, 2015). The above findings underscore the complex trade-offs arising from the multidimensional and multifunctional nature of sustainable packaging decisions. However, large firms with important financial resources are less likely to see these trade-offs than small firms with financial constraints (Kassaye, 2001). This suggests that large firm are more likely to show a proactive environmental behavior because of their advanced capabilities allowing them to adequately conduct this multi-criteria decision (Kumar *et al.*, 2008). Based on the foregoing, we formulate the following proposition:

Proposition 8*. The complex multi-criteria analysis for the environmental, logistical, and marketing packaging requirements is more likely to posit as a barrier to the pursuit of SP for small firms with financial constraints than for large firms with financial resources.*

Cost/Benefit ambiguity and additional costs

Gray and Guthrie (1990) underscored the organizational dilemma between profit seeking and environmental considerations. In fact, firms do not have clear evidence of economic benefits of sustainable packaging since they are unable to predetermine its impact on profit, thus they are more likely reluctant to make significant investments. Besides, the premium cost that consumers would pay for an ecological design of packaging remains

unclear (Livingstone and Sparks, 1994; Vernuccio *et al.*, 2010). Kassaye (2001) showed that one sixth of the 290 firms surveyed were uncertain about the commercial benefits of their sustainable packaging and were unable to estimate its impact on their performance. Another layer of complexity is added with the uncertainty surrounding the overall distribution chain costs of sustainable packaging so that the benefit of any change can be measured (Verghese and Lewis, 2007). Mollenkopf *et al.* (2011) established that the overall supply chain cost impact of such decision remains unclear. White *et al.* (2015) also recognized that sustainable packaging benefits are difficult to measure. Moreover, sustainable packaging may require dedicated equipment (Yusuf *et al.*, 2017), logistics investments (Mayers and Butler, 2013) and higher administration costs than those for conventional packaging (Kroon and Vrijens, 1995). In this respect, Verghese and Lewis (2007) showed that the investment in capital equipment is a major barrier to environmental innovation in industrial packaging. Fernie and Hart (2001) underscored other indirect costs associated with human and information technology resources. Therefore, the following proposition is formulated:

Proposition 9. *SP entails a complex cost-benefit analysis and higher costs than those required for conventional packaging, which may deter firms from pursuing SP*.

Table 3.9. Sustainable packaging barriers

Variable	Description	Theoretical approach	References
Cost/benefit ambiguity	Uncertainty surrounding sustainable packaging costs and benefits. **Main constructs**: impact on profit; supply chain cost impact	Generic theoretical frameworks	[17]; [11]; [10]; [13]; [21]; [37]; [47]
Complex trade-offs	Potential trade-offs between environmental, logistical, and marketing packaging functions. **Main constructs**: packaging functions; product integrity.		[7]; [11]; [16]; [21]; [22]; [24]; [47]
Additional costs	Investment required for adopting sustainable packaging. **Main constructs**: investment in capital equipment; human resource and information technology.	Natural resource-based view theory	[10]; [38]; [48]

3.4.4. Performance outcomes of sustainable packaging

The thematic analysis shows that sustainable packaging has economic, operational, environmental, and social performance outcomes (Zailani *et al.*, 2012; Yusuf et al., 2017). Table 3.10 presents a description of these outcomes. Yusuf *et al.* (2017) established that returnable packaging has a significant positive impact on business performance through enhancing sales turnover, quality of products, and lowering cost. Based on a survey of 400 manufacturing firms, Zailani *et al.* (2012) also found that sustainable packaging has

a direct positive effect on the environmental, economic, and social performance. The resources and waste reduction derived from sustainable packaging implies an overall cost reduction from an economic point of view. This reduction fulfills external societal outcomes stemming from increasing public awareness and consumer demand for sustainable performance (Labatt, 1997). However, Zailani *et al.* (2012) showed that sustainable packaging does not positively affect the operational performance. This contradicts the findings of García-Arca *et al.* (2014: 342) who examine the operational outcomes of "sustainable packaging logistics." The latter is based on "a proactive integration of both the efficiency and sustainability in supply chains." This resulted in a significant operational performance by decreasing both internal and external logistic costs. Most savings come from reduced transport and handling costs. The authors also proved the positive social and environmental outcomes through the reduction of food losses, resources consumption, and waste generation. The firm's competitiveness has been improved as well as that of its stakeholders. This proactive approach has led to an evolution in the way suppliers address packaging design and assess the impact of each alternative for the whole supply chain. The above findings lead us to formulate the following proposition:

> ***Proposition 10***. *SP positively affects the environmental, social, and economic performance; however, its operational performance requires proactive and integrated supply chain.*

Table 3.10. Performance outcomes of sustainable packaging

Variable	Description	Theoretical approach	References
Performance outcomes			
Economic performance	Economic returns resulting from implementing sustainable packaging. **Main measures**: sales turnover; market share; waste and disposal costs; resource management efficiency; net profit; internal rate of return.	Innovation, transaction cost, and natural resource-based view theory	[3]; [48]
Operational performance	Operational level consequences resulting from sustainable packaging practices. **Main measures**: manufacturing operating cost; supply/inventory turnover rate; ability to fulfill perfect order; response to unexpected demand variations; quality of service/products; labor cost; material cost; availability of packaging material.		[3]; [47]; [48]
Environmental performance	Effects of sustainable packaging practices on the natural environment inside and outside the firm. **Main measures**: compliance to environmental standards; consumption for hazardous/harmful/toxic materials;		[3]; [47]

	energy consumption; generation of waste material; re-use; recycling; recovery of materials.		
Social performance	Social level consequences resulting from sustainable packaging practices. **Main measures**: packaging waste reduction; brand image; improvement in stakeholders' relations; product image; customer loyalty and satisfaction; competitive advantage; innovation; damage free; easy to unpack.		[3]; [22]; [31]; [47]; [48]

3.5. Discussion

Based on the systematic analysis of 48 papers identified through the SLR, we developed the comprehensive framework in Figure 2. The latter summarizes the existing knowledge and provides a deeper understanding of the factors that incentivize or deter firms from pursuing a SP as well as its potential performance outcomes. This section discusses the major findings in the view of our RQ, leading us to recommend future research.

First, our results show that the drivers and barriers to packaging sustainability are contingent to firm size. Large firms show more proactive environmental responses and are mainly influenced by customer pressure. They are better positioned to make more and better choices of SP due to their size, awareness of regulations and consumer preferences, and infrastructure to develop environmental capabilities and resources. Whereas smaller firms do not consider packaging as a major issue and are mainly influenced by cost considerations. They are less aware of legislation because of they do not have dedicated environmental functions that would keep them well informed. Besides, there is a relationship between firm size and the perception of trade-offs between packaging functions. Nevertheless, Yusuf et al. (2017) did not confirm this effect, suggesting that all firms face the same level of challenges. These conflicting findings suggest that further investigation should be done to clarify how SP decisions vary depending on the firm size.

Second, among the most important SP drivers, our results emphasize the importance of integrated packaging decisions at three different levels.

- **A vertical and horizontal integration** (e.g., Colwill *et al.*, 2012). To develop an optimal packaging that meets all stakeholders' requirements, SP decisions can no longer be made either by manufacturers alone or even with their direct suppliers. Firms should involve relevant stakeholders in its packaging decision-making process. The latter requires inputs not only from firms cross-functional teams, but also from different supply chain stakeholders, e.g. suppliers, retailers, and end consumers.

- **An upstream and downstream integration** (e.g., Niero et al., 2017). SP decision involves numerous stakeholders with various and sometimes conflicting interests. The priority afforded to environmental issues varies from one stakeholder to another. Hence, an integrated approach both at the upstream level, between actors involved from raw material extraction to products end-consumption, and at the downstream level between actors involved from the point where packaging becomes waste to its disposing, recycling, or reusing stages, helps considering the trade-offs between multiple packaging decision factors. This would ensure a fair distribution of packaging costs and benefits between suppliers, manufacturers, distributors, retailers, consumers, waste collectors, and recyclers.

- **A product-packaging integration** (e.g., Pattara *et al.*, 2012). An integrated approach between the packaging system and the packaged product seems to be the most effective in reducing the ecological footprint of product packaging. This approach is particularly critical for packaging in the food industry, which is characterized by high and consistent packaging flows due to the large variety of commodities. An integrated approach helps avoid over-optimization of primary packaging at the expense of secondary and tertiary ones. This ensures product quality and integrity across the distribution chain and reduces waste during logistics operations.

These integrated approaches help improving packaging sustainability and provide a competitive advantage to the firm. Further empirical investigation should be done to better clarify the costs and benefits arising from these approaches.

Third, our results emphasize the importance of collaboration between stakeholders to implement SP practices. This approach helps balance their competing requirements. The stakeholder theory offers relevant lenses to understand the role and power of each stakeholder. Future studies could rely on the Salience Model perspective to categorize stakeholders in terms of power, legitimacy, and urgency. The power is the ability to induce stakeholders to adopt SP. The legitimacy refers to which extent SP is perceived as an appropriate practice by stakeholders. The urgency indicates the time expected by stakeholders to respond to their requests. For instance, according to the Salience Model, the regulator is a definitive stakeholder who holds the power, legitimacy, and urgency attributes and has a high level of salience, while the consumer is an expectant stakeholder with a moderate level of salience and embraces power and legitimacy. Hence, this classification would provide insights into how managers can tailor their supply chain to enhance their packaging sustainability.

Fourth, regarding the outcomes, SP positively affects the environmental, social, and economic performance of the firm. However, the results for operational performance are conflicting. Some authors highlight that SP does not positively affect the operational performance, whereas others suggest the importance of adopting a proactive and integrated approach to achieve positive operational outcome. Hence, further empirical research needs to be done to better clarify the operational implications of SP in different organizational contexts and for different packaging system levels.

Fifth, the regulator plays a substantial role in driving SP decisions of firms. Packaging waste regulations and non-compliance costs are considered among the most important regulatory drivers to adopt a SP. Yet, firms have a way to avoid environmental sanctions when they are lower than those generated by adopting SP. In such a context, the regulatory drivers may fail to achieve the required sustainability goals. Therefore, further research needs to be done to investigate what incentive schemes are more appropriate to influence nonconforming stakeholders depending on their role and power in the supply chain.

Sixth, our results show that the scientific interest in packaging environmental issues is growing more quickly in developed countries (e.g. Europe, North America). Further empirical investigations need to be conducted to explore to which extent the drivers, barriers, and performance outcomes of SP vary according to cultural differences between countries. A cross-cultural analysis would provide insight into the contextual conditions that are favorable to SP practices as well as the consumers purchase intentions (e.g., Ferraris *et al.*, 2019).

Figure 3.3. Comprehensive framework

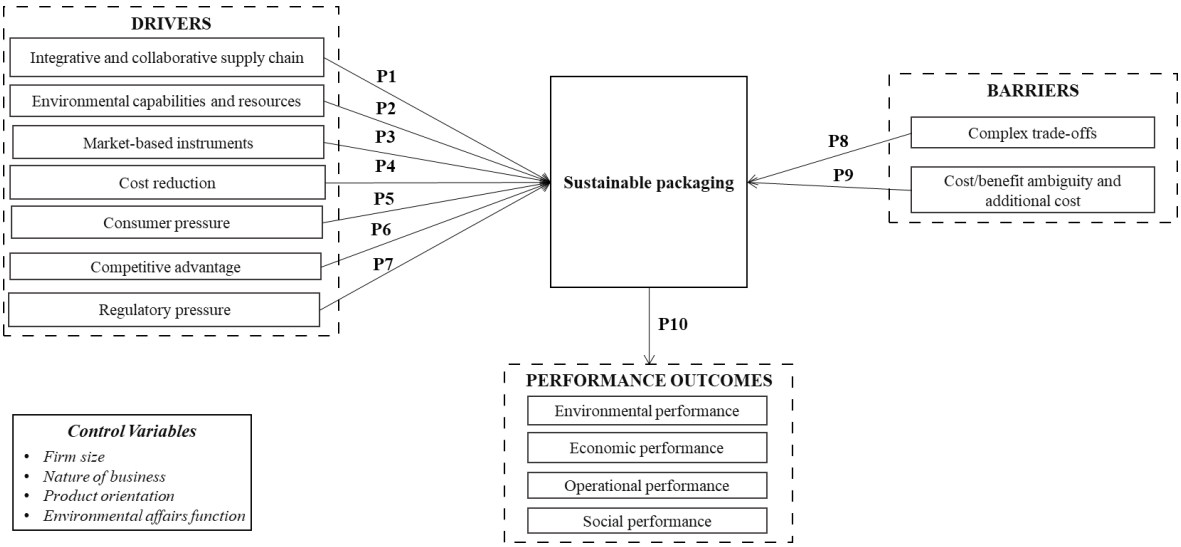


Table 3.11. Control variables

Variable	Description	References
Firm size	Small, medium-sized, or large firms. **Main measures**: number of employees; annual turnover; sales revenue.	[7]; [17]; [31]; [11]; [48]
Nature of business	Firm operating in manufacturing or non-manufacturing business. **Measures**: categorical variable	[11]
Product orientation	Type of product, namely consumer or industrial products. **Measures**: categorical variable	[31]; [11]
Environmental affairs function	Presence of a public affairs function within firms to oversee specific social and environmental issues. **Measures**: categorical variable	[31]

3.6. Conclusion

Waste production is a major issue that leads companies to reflect more on the environmental impact of their packaging. However, many managers see this as a threat to their efficiency because of the complexities surrounding SP decisions. To help addressing this issue, this research makes several theoretical contributions. We conducted a methodologically rigorous review of relevant SP research to support a better understanding of the scientific progress in that important research field. We developed a

novel comprehensive framework that provides an aggregated view of previous research on SP drivers, barriers, and performance outcomes. This framework complements and enriches that of Meherishi *et al.* (2019) to accelerate the transition towards a circular economy for SP. This framework pinpoints relevant factors that should be considered by researchers to advance the SP research field. We also developed research propositions and provide insightful directions for future research.

Considering the complex, multifunctional, and interdisciplinary nature of packaging decisions, two important guidelines can be provided for decision makers. First, to develop SP that meet the requirement of all stakeholders, ensure product quality and integrity, and prevent waste production, firms should adopt integrated approaches at three levels: vertical and horizontal; upstream and downstream; and product-packaging integration. Second, packaging decisions need to consider a broader set of decision criteria from different perspectives (e.g. consumer, regulator). Hence, the comprehensive framework would help decision makers to better comprehend the influencing factors that should be considered simultaneously to take the right actions in improving SP practices.

This research has two main limitations. First, ABI/INFORM Collection was used for the articles search, which implies that studies published in other databases are not included in our review. Second, we used the JCR and Google Scholar to apply the *Methodi Ordinatio* methodology. The selection of articles included in the review could be different by using other information sources. However, the rigor adopted in the SLR process helps remedy these limitations. The relevant and high-impact studies analyzed cover contributions which, to our knowledge, reflect the research advances in SP.

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Appendix 1. Final set of articles included in the review

Article reference number	Authors (Year)	InOrdinatio
1	Kroon and Vrijens (1995)	628,01
2	Thogersen (1999)	415,00
3	Zailani *et al. (*2012)	414,00
4	Fullerton and Wu (1998)	409,00
5	Ciliberti *et al.* (2008)	375,00
6	Rokka and Uusitalo *(*2008)	368,00

7	Prendergast and Pitt (1996)	361,01
8	Rundh (2009)	305,00
9	Gonzalez-Torre *et al.* (2004)	290,00
10	Verghese and Lewis (2007)	204,00
11	Kassaye (2001)	204,00
12	Humbert *et al. (*2009)	176,00
13	Mollenkopf et *al. (*2011)	176,00
14	Pattara *et al. (*2012)	161,00
15	Bone and Corey (2000)	157,00
16	Jahre *et al. (*2004)	156,01
17	Livingstone and Sparks (1994)	154,01
18	Accorsi *et al.* (2014)	146,00
19	Büsser and Jungbluth (2009)	137,00
20	García-Arca and Prado Prado (2008)	120,00
21	Vernuccio *et al.* (2010)	117,00
22	García-Arca *et al.* (2014)	113,01
23	Scott and Vigar-Ellis (2014)	113,00
24	Robertson (1990)	112,01
25	Magnier and Crié (2015)	108,00
26	Matthews (2004)	106,01
27	Kumar *et al.* (2008)	103,01
28	Rousso and Shah (1994)	103,00
29	Fernqvist *et al.* (2015)	102,00
30	Rujnic-Sokele and Pilipovic (2017)	98,00
31	Labatt (1997)	97,00
32	Romero-Hernández *et al.* (2009)	95,00
33	Mayers and Butler (2013)	92,00
34	Niero et al. (2017)	88,00
35	Manzini *et al.* (2014)	87,00
36	Roine and Chin-Yu (2006)	86,00
37	Gray and Guthrie (1990)	84,01
38	Fernie and Hart (2001)	84,00
39	Dobon *et al.* (2011)	83,00
40	Bailey (1999)	81,00
41	Pullman and Wikoff (2017)	79,00
42	Dewees and Hare (1998)	78,00
43	Kivimaa (2008)	77,01
44	Colwill *et al. (*2012)	77,00
45	Ferreira *et al.* (2017)	77,00
46	Dyllick (1989)	76,00
47	White *et al. (*2015)	76,00
48	Yusuf *et al.* (2017)	75,00

Chapter 4
Evaluating the effectiveness of the weight-based packaging tax on the reduction at source of product packaging: The case of food manufacturers and retailers

Chapter information

A preliminary version of an article based on this chapter was presented at the 26th European Operations Management Association Conference, June 15-19, 2019, Helsinki, Finland. An improved version was published in the proceedings of the 51st Decision Sciences Institute Conference, November 21-23, 2020, San Francisco, USA.

Abstract

This project examines the effect of the packaging tax policy on food manufacturers' and retailers' decision to produce less packaging at the source. We analyze a longitudinal data set for the packaging quantities generated from 2005 to 2017 in the province of Quebec (Canada). We estimate two fixed effect models, then we triangulate our results with qualitative evidence from in-depth interviews and a focus group with key stakeholders. We show that the reduction effect of the packaging tax is sensitive to the targeted packaging particularities. Manufacturers and retailers are willing to bear high tax fees for food packaging when it has important operational, environmental, and technical benefits. Hence, policymakers should not expect that only increasing taxes will always produce the expected reduction effect for all packaging, because other important decision-making criteria come into play when choosing the food packaging. However, varying taxes according to packaging material recyclability is found to be effective. Indeed, since the packaging tax is charged on a weight basis, decision makers are inclined to seize the opportunity of reducing their costs by substituting high-taxed materials (i.e. environment-damaging and heavy packaging) with low-taxed materials (i.e. environmentally friendly and lightweight packaging). The local availability of packaging materials would shape this substitution elasticity, hence applying the "material levies" suggested by previous studies might be an ineffective approach to achieve the expected reduction at source. The absence of a regulatory framework combined with high-priced recycled materials, technical difficulties, and availability issues, lead manufacturers to choose virgin materials while retailers are predisposed to pay a high price to benefit from the recycled content branding. Practical recommendations are proposed to enhance the effectiveness of the packaging tax.

4.1. Introduction

Packaging is increasingly seen as a major issue for today's societies. It represents a significant waste stream that accounts for about 30% to 35% of the municipal waste in industrialized countries and about 15% to 20% in developing countries (Tencati et al. 2016; Wiesmeth, 2018). The closure of the Chinese and the Indian waste management markets, which were the main buyers of recyclable materials, turns out to be very challenging for most countries (Éco Entreprises Québec, 2020). Many thousands of tons of material bales are likely to accumulate in sorting centers, which triggers a multitude of environmental, operational, and economic issues. In the province of Quebec, this situation causes an increase in the operating costs of sorting centers as well as a drop in the selling prices of packaging materials (Éco Entreprises Québec, 2020: 3). The multiple challenges imposed by packaging waste generation lead academic communities, businesses, and governments to reflect on the environmental impact of packaging (e.g. Molina-Besch et al., 2018; Heidbreder et al., 2019; Friedrich, 2020).

Several studies emphasize the responsibility of manufacturers to take appropriate measures to manage the negative impacts of product packaging at the post-consumption stage (e.g. Fullerton and Wu, 1998; Wiesmeth et al., 2018; Heidbreder et al., 2019). According to the Waste Management Hierarchy (Directive 94/62/EC), the reduction at source remains the best alternative to manage packaging waste. Dewees and Hare (1998) examined the regulation of packaging waste in Canada and show that 88% of reduction in waste in the province of Ontario (Canada) was reached by source reduction of product packaging. To encourage firms to undertake such environmental practice, governments in most developed countries launched upstream incentive-based instruments, such as packaging taxes. The latter could be a powerful agent to discourage environment-damaging packaging practices (Porter et al., 1995; Sharma, 2000), because they present firms with strong incentives to make optimal packaging choices regarding volume, weight, and materials (e.g. Fullerton and Wu, 1998; Mayers and Butler, 2013). However, Chappin et al. (2009) were cautious about the idea that such instruments always lead to the desired change in firms' environmental practices, because they present firms with the following dilemma: either decision makers adopt green practices to avoid potential costs related to environmental sanctions, or they bear these costs when they are lower than those incurred by adopting green practices. This implies that firms might be strongly inclined to avoid costs deriving from environmental taxes. Hence, policymakers have emphasized the urgent need to resolve problems connected with the reduction at source of packaging and to promote it more effectively (Yamaguchi and Takeuchi, 2016).

Previous studies have explored the effectiveness of the environmental taxes on packaging practices in different contexts, but with disputed results. Some studies show that the packaging tax is effective to reduce the quantity of packaging at the source (Dewees and

Hare, 1998; Cela and Kaneko, 2011), while other studies establish that it tends to be ineffective for inducing manufacturers to produce less packaging (Palmer et al., 1997; Røine and Lee, 2006; Cela and Kaneko, 2013). Whereas other studies demonstrate that the packaging tax would be more effective when it varies according to product recyclability (Calcott and Walls, 2000), and when tax rates are high enough (Friedrich, 2020). Otherwise, this instrument has two major effects, namely a reduction and a substitution effect (Fullerton and Kinnaman, 1995; Palmer and Walls, 1999), which implies an overall decrease in packaging waste (Rouw and Worrell, 2011). However, few studies examined both the reduction and the substitution effects of the packaging tax (Palmer and Walls, 1999; Cela and Kaneko, 2011; Dace et al., 2014) by separating the packaging tax-related effect from the market-related effect associated with pure price variations of virgin and recycled packaging materials (Cela and Kaneko, 201; Cela and Kaneko, 2013; Dace et al., 2014). Furthermore, the above-mentioned studies focus mainly on manufacturers. Very often the role of retailers is neglected in the context of packaging regulatory instruments such as taxes (Friedrich, 2020). Yet, retailers also generate a significant amount of packaging on the market. Besides, their significant decision-making power allows them to demand more sustainable packaging from their suppliers (Friedrich, 2020; Afif et al., 2020). Therefore, this paper intends to bridge the above-mentioned research gaps by analyzing at a panel level the effectiveness of the packaging tax policy (i.e. the reduction and the substitution effects) on the reduction at source of packaging for manufacturers and retailers.

This study focuses on two single-use packaging, the Polyethylene Terephtalate (PET) plastic bottles and the clear glass packaging. We focus exclusively on the food sector because food packaging is one of the most relevant waste sources that present an urgent need for reduction at source (Williams and Wikström, 2011; Molina-Besch et al., 2018). We examine the relationships of interest using a longitudinal dataset for the packaging quantities generated by food manufacturers and retailers. After estimating two fixed effect models, we triangulate our statistical results with qualitative evidence from in-depth interviews and a focus group with key stakeholders. Our findings have several theoretical and policy implications with respect to the reduction and the substitution effects of the packaging tax as well as the packaging material price effects on the decisions of manufacturers and retailers to produce less packaging at the source.

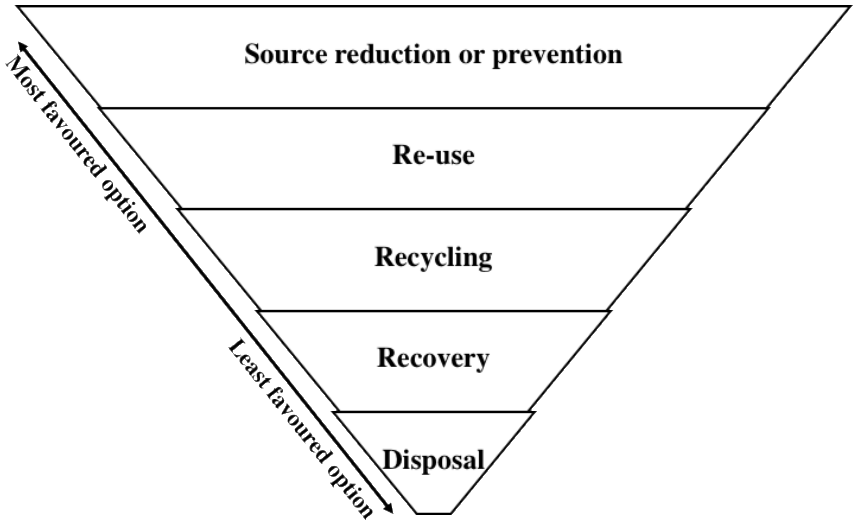
This chapter is structured as follows. The theoretical background and research hypotheses are first outlined. Subsequent section describes the methods and research design. Then, the results of the empirical models and the qualitative evidence are presented and discussed in the following section. The last section presents the theoretical contributions, the managerial and policymakers' implications, the research limitations, and the implications for future research.

4.2. Literature review

4.2.1. The reduction at source of product packaging

Reduction at source of product packaging is implemented through two main approaches: package "downsizing" and package "eco-compatibility". According to Vernuccio et al. (2010), "package eco-compatibility" minimizes the environmental impact of packaging materials by reducing their quantity and variety, while ensuring that an optimal combination is used to guarantee the effectiveness of the packaging/product pairs across the supply chain. According to Çakır and Balagtas (2014), "package downsizing" or "package lightweighting" (Tencati et al., 2016) optimizes packaging size, volume, and weight. The importance of these practices stems from the "Waste Management Hierarchy" (Figure 4.1) that specifies the order of priority of each waste management option. The preferred alternative is prevention or source reduction by using less packaging materials in manufacturing and in product designs (Article 1 of the Directive 94/62/EC; Bartl, 2014). These practices are important because they are introduced before materials, packaging, and products become waste (Bartl, 2014). They provide more efficient physical distribution of products (i.e. transportation, handling, storage, recovery, re-use, or disposal) due to volume/weight efficiency, overpackage elimination, and systematic reduction of upstream waste sources. Considering that source reduction of packaging materials is seen as the best solution to manage packaging waste, several studies pointed out the need to investigate the factors that induce firms to adopt such green practice (e.g. Bartl, 2014; Çakir and Balagtas, 2014, Afif *et al.*, in press).

Figure 4.1. Waste Management Hierarchy



Adapted from Canadian Council of Ministers of the Environment (2014)

4.2.2. The Extended Producer Responsibility (EPR)

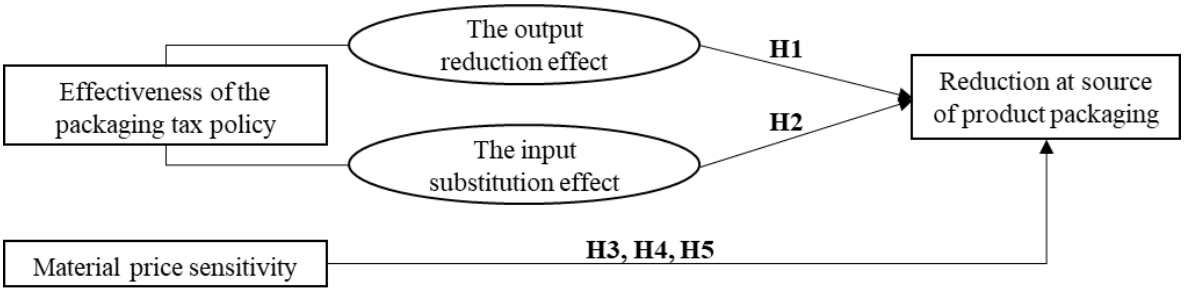
Extended producer responsibility (EPR) is a policy approach in which a producer's responsibility, physical and/or financial, for a product is extended to the post-consumer stage of a product's life cycle. This measure is based on the "polluter pays" principle, which implies that producers contribute financially to the waste management. Applied to packaging, EPR shifts responsibility upstream in the packaging life cycle to the producer (i.e.brand owners, first importers or manufacturers) and away from municipalities and general taxpayers. EPR presents firms with strong incentives to make optimal packaging choices regarding volume, weight, and materials (Fullerton and Wu, 1998; Dewees and Hare, 1998; Mayers and Butler, 2013). The EPR policy aims not only at relieving municipalities from some of the financial burden of waste management, but most importantly it aims at incentivizing the packaging producers to reduce resources, use more secondary (i.e. recycled) materials rather than primary (i.e. virgin) ones, and undertake product design to diminish packaging waste (OECD, 2001).

In the case of manufacturers, Mayers and Butler (2013) and Ferreira et al. (2017) maintained that the costly financial contribution to the EPR schemes forces manufacturers to reconsider their packaging, giving rise to a "voluntary producer responsibility". This suggests that the EPR policy induces manufacturers to optimize their product packaging to reduce costs and avoid penalties (Røine and Lee, 2006). However, in the case of retailers, Friedrich (2020) and Heidbreder et al. (2019) have noticed that the voluntary retailers' commitments are less likely to occur without applying important and binding regulatory economic incentives. This occurs most importantly when the packaging changes required are associated with additional costs for retailers. Therefore, the EPR policy implies that both manufacturers and retailers are forced to internalize costs that were previously externalized to society, but they also have a way to reduce costs and avoid potential environmental sanctions or penalties. More specifically, the formal pressure imposed on manufacturers and retailers would give rise to two forms of strategies. They could either bear these costs when they are lower than those generated by reducing their product packaging, or they would implement this practice to avoid potential environmental sanctions, legal liabilities, or costs of non-compliance (Livingstone and Sparks, 1994; Chappin et al., 2009). In other words, reducing product packaging at the source becomes a more attractive practice when the total disposal costs (i.e. financial contribution to the EPR scheme) that must be borne by manufacturers and retailers are high enough.

The packaging tax is one of the most important EPR-based policy instruments (e.g. Fullerton and Wu, 1998; Dewees and Hare, 1998; OECD, 2001). Fullerton and Kinnaman (1995) suggest that the "first-best" solution to decrease the overall amount of waste

disposal can be achieved by the "waste-end taxes". The latter combine both source reduction incentives and recycling incentives in a single instrument. It combines more specifically "an output reduction effect" which is a preventive effect through reducing waste at the source, and "an input substitution effect" which encourages replacing environment-damaging materials with environmentally friendly ones (Fullerton and Kinnaman, 1995; Palmer and Walls, 1999). Therefore, this study explores the effectiveness of the packaging tax (i.e. the reduction and the substitution effects) in reducing at source the product packaging. Figure 2 presents our conceptual framework. The following subsections explain the relationships between the variables of interest and present our research hypotheses. Table 1 presents a summary of relevant empirical studies.

Figure 4.2. Conceptual framework



4.2.3. The output reduction effect of the packaging tax policy

The packaging tax represents a price-based policy that provides major economic incentives for producers to carry out less environment-damaging packaging practices (Fullerton and Kinnaman, 1995; Fullerton and Wu, 1998; Dewees and Hare, 1998; Mayers and Butler, 2013). The packaging tax rates vary across the packaging materials based on their life cycle impacts. In other words, a packaging tax reflects the environmental harm associated with the manufacture of packaging materials as well as the social costs of their ultimate disposal. Applied in the form of weight basis charges, the packaging tax aims at encouraging manufacturers to choose more environmentally friendly packaging materials (e.g. Dewees and Hare, 1998; Roine and Chin-Yu, 2006; Dace et al., 2014).

The causality between the packaging tax and the reduction at source of packaging has been explored in previous studies for different packaging materials. Based on an economic analysis of packaging waste reduction at source in Ontario (Canada), Dewees and Hare (1998) establish the effectiveness of the taxes applied on the plastic and glass packaging materials. They show that it provides an important economic incentive which significantly impacts manufacturers' choices for packaging materials. Given that the packaging tax policy is driven by the packaging weight rather than product volume, the authors noticed

that it induces manufacturers to reduce their packaging weight at the source. Similarly, Dace et al. (2014) explore the effect of the packaging tax applied on plastic packaging and show that it is an effective instrument to increase packaging material efficiency (i.e. expressed in terms of packaging materials amount per product unit). The authors demonstrate that the packaging tax ensures a reduction in the total consumption of materials and hence the resulting waste generation. More specifically, the packaging tax helps counteract a "rebound effect", which is caused by an increased share of low-cost recycled materials which in turn increases the total consumption of packaging materials. This effect naturally goes against the principles of the EPR policy (Bernard, 2016). Therefore, Dace et al. (2014) argue that when the packaging tax is increased and combined with eco-design policies, it allows reaching a significant material efficiency as well as reducing waste generation. Similarly, Cela and Kaneko (2011) investigate the effectiveness of the environmental taxes applied on the paper and paperboard industrial packaging in the case of Denmark. They establish that environmental taxes are effective in reducing at source the quantity of paper and paperboard.

All the above results suggest that manufacturers are inclined to reconsider their packaging design when they bear the financial burden of eliminating its waste (Ferreira et al., 2017). Nevertheless, Roine and Chin-Yu (2006) found a weak causality between the Norwegian tax and technological change and innovation for plastic packaging. The financial contribution to the EPR schemes through packaging taxes was found to have an indirect and no significant effect on packaging change and innovation, but it has rather a direct effect on downstream operations through increased recycling. In other words, the authors notice a weak causality between the packaging taxes, on the one hand, and on the other hand, designing and producing packaging with less material so that the amount of waste downstream is reduced. Similarly, the packaging tax effect was found to be ineffective in the case of plastics packaging on the US market (Palmer et al., 1997) and the Danish market (Cela and Kaneko, 2013). Palmer and Walls (1999) show that the packaging tax alone provides few incentives for packaging redesign and suggest that it should be combined with related subsidies. The upstream combination tax/subsidy was found to be more effective in producing less output than the packaging tax alone. Besides, Friedrich (2020) conducted a choice-based experiment with 253 industrial decision makers from the German food and technics retail segment. Their results show that the packaging tax is only effective when it forces the retailers to invest in more environmentally friendly packaging alternatives rather than simply paying for the tax or even shifting this burden to the consumer in the form of higher products prices. Therefore, the author shows that the packaging tax rates must be high enough to prompt decision makers to choose more environmentally friendly packaging alternatives. According to the Extended Producer Responsibility (EPR) framework, firms are inclined to choose optimal packaging through the reduction at source practice when the total disposal costs that they must bear are

sufficiently high. Based on the foregoing, it is plausible to assume the following hypothesis:

> ***H1***. *The higher the packaging tax amount to be paid by manufacturers and retailers for packaging they generate on the market, the more they reduce their packaging at the source.*

4.2.4. The input substitution effect of the packaging tax policy

The taxes cause a substitution effect unless the demand for the taxed products is completely inelastic (Fullerton and Kinnaman, 1995; Rouw and Worrell, 2011). Since previous research has shown that the demand for packaging materials is price elastic (e.g. Cela and Kaneko, 2011; Rouw and Worrell, 2011; Dace et al., 2014), it is important to investigate the potential possibilities of substitution from one packaging material to another. Dace et al. (2014: 178) show that the packaging tax is effective when combined with increased substitution elasticity, which is "the willingness and/or ability of packaging producers to replace one material with another." The PET plastic bottles were found to be the most elastically demanded product packaging (Palmer et al., 1997). Besides, the authors suggest that source reduction policies tend to be more effective for materials that have higher demand elasticity. In this sense, Dewees and Hare (1998) find that the packaging tax tends to shift the choices of manufacturers from heavy glass materials toward lightweight packaging materials, especially plastic materials. Their findings suggest that the most significant source reduction in beverage containers waste disposal has been achieved by shifting from glass toward aluminum and plastic bottles including the PET plastic bottles, thereby reducing the weight of the containers. This market-driven change toward lighter materials that can be recycled more economically reduces the pressure on manufacturers to fund expensive recycling programs.

In the case of the retail industry, Friedrich (2020) shows that the packaging material weight was favored by most decisions makers as it represents the basis for packaging taxation. The amount of new and recycled or recyclable plastic material used is steadily higher in the food segment. For both food and technics retailers, switching from plastic packaging to biomaterials substitute materials depends on relevant government regulatory instruments (i.e.taxation) since retail industry incentives are too weak for voluntary commitments. Fernie and Hart (2001) argue that it is difficult to replace short-term benefits with long-term environmental objectives in the retail industry where cost is the main decision driver. In other words, the substitution from one material to another can hardly be achieved by retailers alone without economic incentives, because this substitution implies additional costs that are more likely to be passed on to the market in the form of increased product price for end consumers (Friedrich, 2020). Similarly, Heidbreder et al. (2019) highlight that turning away from fossil-based plastics is more

achieved by the mandatory regulatory and economic instruments (i.e. packaging taxes) than out of self-interest of retailers, mostly if such a change is associated with higher shifting costs. These instruments would be effective in reducing at source the fossil-based plastic use. In the same line, Friedrich (2020) noticed that the tax must be high enough for environment-damaging plastic packaging to make it difficult for retailers to pass the additional costs on consumer price, and most importantly to incentivize them to choose biobased materials that have more advantageous tax rates.

Otherwise, Calcott and Walls (2000) find that varying taxes according to the degree of product recyclability could be an efficient upstream instrument which sends signals to producers to reduce their packaging weight and make it easier and less costly to recycle. This upstream instrument provides important incentives to manufacturers for a more efficient "design for environment". This suggests that the substitution of packaging materials tends to be sensitive to the taxes applied on different packaging materials which in turn depend on their environmental impact. Nevertheless, Cela and Kaneko (2011) highlight that the mechanism of applying a weight basis charges (i.e. taxes) covering all packaging materials allows achieving an overall reduction of consumption for all packaging materials, which discourages any substitution repercussion. Their results report no possibilities of paper and paperboard substitution with packaging belonging to other materials. Based on the Extended Producer Responsibility (EPR) framework, increasing tax rates for environmentally harmful packaging materials make environmentally friendly materials alternatives attractive from an economic point of view, since both manufacturers and retailers would have financial savings on their contribution to the recycling schemes. Therefore, we propose to test the following hypothesis:

> ***H2.*** *An increase in the packaging tax rate for a given material induce manufacturers and retailers to replace it with another material with a more advantageous packaging tax rate.*

4.2.5. The material price sensitivity and the reduction at source of packaging

The price of packaging material is an important decision-making factor for raw materials sourcing (Accorsi et al., 2014). Several studies have demonstrated that decision makers are only willing to adopt environmental packaging alternatives when costs are appropriate (e.g. Arnaud, 2017). This stems from the fact that manufacturers are predominately driven by a cost-reduction approach (e.g. Thøgersen, 1999; Accorsi et al., 2014). Verghese and Lewis (2007) argue that environmental packaging alternatives are only adopted by firms when they deliver economic benefits such as an increased efficiency and cost reductions. Similarly, the reduction at source of product packaging seems to be very sensitive to the variations in packaging material prices. Cela and Kaneko (2011) show that demand for paper and paperboard packaging is negatively related to material price. In line with

material price sensitivity, Pal and Gander (2018) underline that using low-priced raw materials such as plastics in product's packaging is beneficial for manufacturers due to low costs and increased efficiency. If the packaging material prices are low, this could also be advantageous for the consumer through reduced purchase prices of products. This suggests that the manufacturer demand for plastic packaging materials is price elastic. Whereas Palmer et al. (1997) found that demand for plastic packaging was relatively price inelastic in the US market. Friedrich (2020) stresses that if the low-priced materials (i.e.plastics materials) are environmentally harmful, this will generate a "marginal production costs" as well as a "marginal damage costs". To reduce these negative environmental effects, either the producer costs must increase by raising the prices of materials deemed to be harmful, or the market demand must decrease by switching to a less environment-damaging packaging material. Based on the foregoing, we propose to test the following hypothesis:

> ***H3.*** *An increase in the packaging material price lead manufacturers and retailers to produce less packaging from that material at the source.*

Moreover, Cela and Kaneko (2011) underline the importance of differentiating the price elasticity for the virgin packaging from that of the recycled packaging. Palmer et al. (1997) show that the demand for recycled plastic packaging is price-inelastic, while the demand for both virgin and recycled glass packaging material is price-elastic in the US market. Besides, Cela and Kaneko (2013) suggest a price-inelastic demand for virgin plastic packaging materials in the Danish market. However, Dace et al. (2014) notice that demand for virgin and recycled plastics packaging materials is price elastic in the Republic of Latvia context. Overall, the research seems to be ambiguous. These results suggest that the price elasticity of virgin and recycled material seems to depend on the context and the packaging material. Pearce and Turner (1993) and Cela and Kaneko (2013) suggest applying "material levies" on the virgin and recycled packaging raw materials to better improve material eco-efficiency at the source. This implies increasing the purchasing price of virgin raw materials and decreasing that of recycled raw materials. Since the replacement of virgin materials with the recycled materials is among the priority environmental goals of policymakers, then increasing virgin material prices should be encouraged (Palmer and Walls, 1999). Under such circumstances, the producers demand would be satisfied with recycled rather than virgin packaging materials. This would stimulate the reduction at source of virgin packaging and thus decrease the subsequent waste generation. Moreover, Dace et al. (2014) stress that it is important to ensure the material prices do not decrease to counteract the "rebound effect" (i.e. increased share of low-cost materials), and hence ensure reducing the total consumption of materials. Based on the above, it is plausible to assume the following hypotheses:

***H4**. Manufacturers and retailers generate less packaging from virgin materials at the source when the price of these materials increases.*

***H5**. Manufacturers and retailers generate more packaging from recycled materials at the source when the price of these materials decreases.*

Table 4.1. Summary of relevant empirical studies

Study	Point of view	Type of packaging	Context	Method	Main findings/contributions		
					Packaging tax reduction effect	Packaging tax substitution effect	Material price sensitivity
Palmer et al., 1997	Manufacturers	Glass, plastics (including PET bottles), aluminum, paper, and steel packaging	United States	Simple partial equilibrium model	Ineffective (the deposit/refund instrument is found to be most effective for the reduction at source).	The PET bottles are the most elastically demanded packaging. Source reduction policies are more effective for materials with higher demand elasticity.	Price-inelastic demand for secondary plastic (i.e. recycled). Price-elastic demand for primary and secondary glass (i.e. virgin and recycled).
Dewees and Hare (1998)	Manufacturers	Plastic (PET), glass, steel, aluminum	Ontario (Canada)	Economic analysis	Effective	Substitution effect from glass to light-weight packaging (i.e. plastics and aluminum).	Sensitivity to material price variations.
Palmer and Walls (1999)	Manufacturers	Plastic, glass, aluminum, steel, and paper	United States	Economic analysis	Effective when combined with subsidy (i.e. the tax/subsidy provides innovative effects on product packaging redesign).	The upstream combination tax/subsidy provides incentives to substitute recycled inputs for virgin ones.	The subsidy for recycling encourages the use of recycled materials by reducing their cost relative to virgin materials
Calcott and Walls (2000)	Manufacturers	Not specified	United States	Economic analysis (the social optimum model)	Effective when taxes vary according to product recyclability, which spurs efficient “design for environment” (i.e. send signals upstream to producers).		
Røine and Lee (2006)	Manufacturers and importers	Plastic	Norway	Survey	Weak causality		
Cela and Kaneko (2011)	Importers	Paper and paperboard	Denmark	Panel data analysis (1994–2007)	Effective	No substitution effect	Price-elastic demand
Cela and Kaneko (2013)	Importers	Plastics packaging	Denmark	Panel data analysis (1994–2007)	Ineffective		Price-inelastic demand for virgin packaging materials
Dace et al. (2014)	Manufacturers	Plastics packaging	Republic of Latvia	System dynamics model (2011-2030)	Effective when combined with eco-design policies.	Effective when combined with increased substitution elasticity.	Price-elastic demand for virgin and recycled packaging materials

Friedrich (2020)	Retailers	Plastic packaging	Germany	Choice-based experiment with 253 industrial decision makers	Effective if tax rates are high enough to induce a change and prevent retailers from passing additional costs on to the product price.	Substitution from plastic to biobased packaging materials, but the shifting costs are more likely to be passed on to the market (i.e. higher product prices).	

4.3. Methodology and data description

4.3.1. Choice of the study area: The province of Quebec

The hypotheses under study are tested using data from the province of Quebec (Canada). The Quebec government has introduced incentive instruments such as packaging taxes to discourage environmentally harmful activities and to stimulate packaging environmental innovation. These incentives mainly involve cost internalization based on the "user-payer" or the "polluter-payer" principle to incentivize manufacturers to reduce the environmental impact of their product packaging (Sustainable Development Strategy, 2015–2020: 22). More specifically, the province of Quebec has applied product charges in the form of weight-based taxes on product packaging since 2005. The Quebec firms who generate an annual turnover of around 100 B$ are bound to pay this tax on all packaging materials they generate on the market. We focus specifically on food manufacturing and retail because the food sector is characterized by high and consistent packaging material flows (Accorsi et al., 2014). There is a large variety of commodities and therefore an increased consumption of packaging compared to other sectors. This has inevitably increased the production of waste and garbage from food packaging as well as the environmental impact of the food distribution chain (Williams and Wikström, 2011; Accorsi et al., 2014; Molina-Besch et al., 2018).

4.3.2. Data and sample characteristics

To test our hypotheses, we constructed a longitudinal database from different data sources. One important benefit of using a longitudinal dataset is that it allows a dynamic formulation of the problem to examine changes in the phenomenon of interest over multiple time periods (Wooldridge, 2010). We used an unbalanced longitudinal dataset from Éco Entreprises Québec (ÉEQ), a private and non-profit organization that "represents companies that place containers, packaging, and printed matter on the Quebec market in their responsibility to finance the costs of municipal curbside recycling services". Companies that put packaging on the Quebec market have the obligation to report the total quantity from each packaging material. They accordingly pay contributions to ÉEQ to finance the curbside recycling programs including packaging materials.

This study focuses on the quantities of single-use polyethylene terephthalate (PET) plastic bottles and clear glass packaging generated and declared each year by Quebec food manufacturers and retailers. This packaging is intended to be used only once (i.e. non-returnable). Based on discussions with ÉEQ specialists, this packaging is particularly relevant to explore. The PET plastic bottles are a widely used form of single-use plastics.

Their consumption has increased markedly over the last years in the food sector. Thus, extensive research efforts are devoted worldwide in recent years with the intention of reducing PET bottles waste as well as using PET resources more rationally (Zhang et al., 2020). The taxation applied on the quantities generated by firms from that material has increased in the last ten years. As for the glass packaging, it is energy-intensive, particularly during the production, transportation, and handling operations (e.g. Stefanini et al., 2020). Besides, this packaging presents major recycling challenges, which leads to a significant increase in its taxation since 2013. Therefore, this paper explores the effectiveness of the packaging taxes in reducing these two packaging materials.

The period considered is 2005-2017 which was determined by the availability of complete annual ÉEQ data. The year 2005 marks the creation and the accreditation of ÉEQ. Table 4.2 presents the number of firms available in the dataset for each sector and for each material. We classified the food subsectors according to the North American Industry Classification System (NAICS) to retrieve accurate statistical data from Statistics Canada. The data is unbalanced in that some firms are not observed during the entire period of interest (i.e. 2005-2017). In addition to the ÉEQ data, we used other longitudinal data from Statistics Canada, Official Gazette of Quebec, Recyc-Québec, the Federal Reserve Economic Data (FRED), the Plastics News and the Market Recycling databases. Table 3 presents the data generated from each of these sources.

Table 4.2. Sample characteristics

NAICS code	**Sector description**	**Number of firms available in the dataset**	
		PET plastic bottles	**Glass packaging**
311	Food manufacturing	101	95
445	Food stores (retail)	48	57

4.3.3. Unit of analysis

Given the strict measures for confidentiality of ÉEQ data, the names of firms in the database were hidden by ÉEQ and replaced with reference numbers. Considering that no firm-level information was available, the unit of analysis for this research is the firm embedded within its industry. Measuring the variables of interest at a more aggregate level enables linkages among firms within the same industry to be considered.

4.3.4. Description of variables and measures

The selection of variables and their measures were based on our literature review. The comments from the packaging experts interviewed helped ensure that the variable choices and the database manipulation were as appropriate as possible, which enhances the

internal validity of the study. Table 4.3 summarizes all the variables included in the model, their measures, and data sources.

4.3.4.1. Dependent variable

The reduction at source of packaging is our main variable of interest. To operationalize this variable, we constructed a material intensity measure which reflects the intensity of use of the PET and the clear glass materials for food manufacturers and retailers. According to the OECD (2008), the intensity of material use is an eco-intensity indicator reflecting the use of physical materials (i.e. input) per unit of value added (i.e. output). This indicator has been approximated using the PET plastic bottles quantities and the clear glass packaging quantities generated by each firm in each industry, divided by a normalization factor. The latter is the annual manufacturing sales for manufacturers (Eq. 1) and the annual retail sales for retailers (Eq. 2). The OECD (2008) recommends choosing appropriate input and output by considering the statistical coherence between the two. Thus, for the sake of accuracy, we use the manufacturing and retail sales as outputs rather than the GDP which is a broad economic indicator. The data on industrial sales are retrieved from Statistics Canada and follow the North American Industry Classification System (NAICS) Classification, as specified in Table 2. The subscripts *m, i, j, t*, represent respectively the packaging material (i.e. PET or glass), the firm, the industry, and the year.

$$\text{Intensity of material use by manufacturers} = \text{Qmijt}/(\text{Manufacturing sales}_{jt}) \quad \textbf{(1)}$$

$$\text{Intensity of material use by retailers} = \text{Qmijt}/(\text{Retail sales}_{jt}) \quad \textbf{(2)}$$

The material intensity ratio is the inverse of the eco-efficiency indicator. The lower the material intensity indicator, the more eco-efficient is the material use (Rouw and Worrell, 2011). This suggests creating more value while using fewer resources, hence creating less environmental impact (e.g. Rouw and Worrell, 2011; Dace et al., 2014). The OECD (2008:91) suggests that the intensity of material use indicator helps "model the improvement of material efficiency of relevant industrial sectors (e.g. manufacturing) and can be used to assess the environmental effectiveness and economic efficiency of potential policy measures (e.g. economic instruments)". It is therefore a valuable tool to monitor the intensity of consumption of materials and the subsequent waste generation (Dace et al., 2014). *Appendix 1.1 and Appendix 1.2* show the evolution of the intensity of material use of the PET plastic bottles and the clear glass materials over the period of interest (i.e. 2005-2017).

4.3.4.2. Independent variables

i. The amount of packaging tax borne by firms

Since the packaging tax is charged on a weight basis, it is supposed to decrease packaging demand and therefore decrease the amount of the packaging tax borne by manufacturers and retailers. This would be the signal that the tax instrument has been effective in changing the packaging material consumption (e.g. Cela and Kaneko, 2013). Therefore, our first explanatory variable is the contribution of food manufacturers and retailers to the compensation scheme. The total amount of a firm contribution to the compensation scheme depends on three variables. First, the types of materials used, and the quantities generated on the market from these materials. Second, the packaging tax rates which vary from one material to another and over time. *Appendix 1.3* shows how the packaging tax rates applied on the PET plastic bottles and the clear glass packaging have evolved over time from 2005 to 2017. Third, the share of costs borne by manufacturers and retailers to finance municipal recycling of packaging waste (i.e. selective collect). *Appendix 1.4* shows how the firms' share of these recycling costs has evolved over time. For example, from 2005 to 2009, 50% of these costs were financed by firms through the packaging tax revenues and the remaining 50% were financed by municipalities. Since 2013, these costs are exclusively financed by the packaging tax revenues to incentivize firms to enhance the environmental impact of their product packaging. Therefore, the relevant explanatory variable retained is the annual packaging tax paid according to the packaging quantity generated multiplied by the proportion of costs borne by firms each year. In other words, the packaging tax rate and the share of recycling costs financed by firms affect the material intensity indicator through its effect on the quantities of packaging generated on the market. Based on the above, our explanatory variable is approximated using Eq. (3). The subscripts *m, i, j, t*, are respectively the packaging materials, the firm, the industry, and the year.

$$\text{Tax amount}_{mijt} = Q_{mijt} * \text{Tax}_{mt} * \text{Recyc Share}_{t} \quad \textbf{(3)}$$

ii. The variable of substitution between packaging materials

As mentioned before, previous studies suggest that some materials substitute for one another. An increased tax on one material (e.g. glass) increases demand for another material with more advantageous tax rates (e.g. plastic) (e.g. Palmer et al., 1997; Dewees and Hare, 1998; Rouw and Worrell, 2011; Dace et al., 2014). Therefore, we carried out a graphic analysis for the tax rates evolution of different packaging materials. This allows identifying the materials whose tax rates have significantly increased over years. We

noticed that the polystyrene plastic, the HDPE[3] plastic, the clear and the colored glass[4] materials display a significant increase in the tax rates over years (i.e. 2005-2017). Remember that a significant increase in the tax rates implies that the material imposes recycling problems (i.e.environment-damaging materials) (e.g. Calcott and Walls, 2000; Rouw and Worrell, 2011; Dace et al., 2014). Thus, we expect that the market demand for these packaging materials would decrease by switching to less environment-damaging materials.

On the one hand, the polystyrene presents multiple recycling problems in Quebec (e.g. high treatment costs in sorting centers). It is currently the only type of plastic which does not appear in the Charter of recyclable materials for the selective collect. Thus, Quebec firms who generate this material on the market pay a higher contribution for the curbside recycling than that paid for other packaging materials (Recyc-Québec, 2015). This leads us to conclude that the polystyrene is an environment-damaging material which is interesting to explore. Whereas the PET plastic is characterized by a high and steadily increasing recycling rate. It is therefore a less environment-damaging material than the polystyrene. Therefore, we will examine the potential substitution between these two materials. On the other hand, Dewees and Hare (1998) suggest a potential substitution from heavy glass materials toward lightweight PET plastic bottles. Besides, the life cycle analysis of Stefanini et al. (2020) reveal that the PET plastic bottles have lower environmental impact than the glass packaging material. Thus, we will examine the potential substitution between these two materials. It should be mentioned that this represents a theoretical valuation, because these materials can be used for different product packaging.

We model the potential substitution between the above-mentioned materials following the methodology suggested by Dace et al. (2014). First, we calculate the average taxation of these materials using Eq. (4) and Eq. (5). The parameter ε is the substitution elasticity (Dace et al., 2014). The larger the absolute value of ε, the more significantly the materials demand responds to a change in the tax rates of that material relative to the average taxation ($Tax_{average}$). More specifically:

- When $\varepsilon = 0$, the average taxation is equal to arithmetic mean of the tax rates of the two alternative materials.
- When $\varepsilon > 0$, the average taxation is lower than the mean value. Reducing the average taxation increases when we substitute a high-taxed material (i.e.

[3] The HDPE was not included in our model following the interviews with packaging experts. This plastic material has characteristics that make it not comparable to the materials under investigation in this study.

[4] The colored glass packaging was not included in our model following the interviews with packaging experts. The clear glass and the colored glass do not have the same properties. Besides, the single-use clear glass packaging is the most used in the food industry.

environment-damaging / heavy packaging material) with a low-taxed (i.e. environmentally friendly /lightweight packaging material).

- When substituting an environment-damaging material with a less environment-damaging material, the suggested value for ε is 2.5. Hence, we retain this value to model the potential substitution between the above-mentioned materials.

$$Tax_{average}\ (Polystyrene\_PET) = \frac{(Tax_{PET}^{(1-\varepsilon)} + Tax_{Polystyrene}^{(1-\varepsilon)})^{(1/(1-\varepsilon))}}{2} \quad \textbf{(4)}$$

$$Tax_{average}\ (Glass\_PET) = \frac{(Tax_{PET}^{(1-\varepsilon)} + Tax_{Glass}^{(1-\varepsilon)})^{(1/(1-\varepsilon))}}{2} \quad \textbf{(5)}$$

Then, we calculate the tax rates ratios of materials (i.e. Poystyrene, PET, and clear glass), divided by the average taxation ($Tax_{average}$). The interpretation of these ratios is as follows. For example, an increase in the glass tax compared to the average taxation (i.e. Eq.4), is expected to increase the demand for the PET plastic bottles.

iii. The material price variable

We model this explanatory variable using three relevant indicators. First, the plastic raw material prices using the producer price index (PPI) for plastic and for glass materials. The data are retrieved from the Federal Reserve Economic Data (FRED). As shown in *Appendix 1.5*, the producer price index (PPI) for the plastic and the glass raw materials have fluctuated over the 2005-2017 period. Second, we distinguish between the virgin and the recycled material prices. For the recycled PET material price, we retain the price market index (PMI). This index designates the average price for recycled materials on the market. It is calculated by the recycling specialists based on data collected each month on the price of materials that are sold by sorting centers. It consists of a price per ton for each material. The data on the price market index (PMI) are retrieved from Recyc-Québec. It should be noted that the PMI for glass material is not available since 2013. Therefore, we retrieve data for the recycled glass material price from the Recycling Markets database for the Quebec region (*Appendix 1.6*). Regarding the historical pricing of virgin PET plastic bottles, data are retrieved from the Plastics News database (*Appendix 1.7*). Whereas data on the pricing of virgin glass material was not available, which may be due to the major challenges facing the glass industry in Quebec. We were not able to use reliable proxies for this variable. For the sake of accuracy, we retain the average producer price and the recycled price of the clear glass material.

4.3.4.3. Control variables

We controlled for the unobserved factors (heterogeneity) in each industry by including dummy variables for industries. We also controlled for industry size and competitiveness

using the annual industry GDP at basic prices, which has been widely used in prior literature as a reliable proxy for this variable.

Table 4.3. Summary of variables, measures, and data sources

Variables	Proxy Measurement		Abbreviation	Units	Data sources
Dependent variable	The intensity of use of material *m* by firm *i* in industry *j* at time *t*	$Q_{ijt}/Sales_{jt}$	IMU_{ijt}	Kg/$	Éco Entreprises Québec; Statistics Canada
Independent variables	The annual packaging tax amount paid according to firms' share of recycling costs (%) at time *t*, and according to the packaging quantity generated on the market by firm *i* in industry *j* at time *t*.	Q_{mijt}* Tax_{mt}* Recyc Share $_t$	$QTax_{mijt}$	$	Official Gazette of Quebec; Éco Entreprises Québec
	Producer price index (PPI) for plastic and glass raw materials at time *t*.	PPI_{mt}	PPI_{mt}	$/kg	Federal Reserve Economic Data
	Price of recycled PET plastic bottles (price market index) at time *t*.	RMP_{mt}	RMP_{mt}	$/kg	Recyc-Québec
	Price of recycled glass at time *t*.				The Recycling Markets database
	Price of virgin PET plastic bottles at time *t*	VMP_{mt}	VMPmt	$/kg	The Plastics News database
	The substitution between packaging materials based on their taxes: • Substitution from environment-damaging to environmentally friendly material • Substitution from heavy to lightweight packaging material	$Subs_{mt}$	$Subs_{mt}$	%	Official Gazette of Quebec
Control variable	Gross Domestic Product (GDP) at basic prices by industry.	GDP_{jt}	GDP_{jt}	K $	Statistics Canada

4.3.5. Empirical model for the econometric analysis

We specified a dynamic regression model (Eq. 6 and Eq. 7) to capture the dynamic effects. A model is said to be dynamic when lagged value of the dependent variable is included as one of the independent variables. Dynamic panel-data models use current and past information. An important benefit of estimating a lagged dependent variable (LDV) model is to capture the convergence of the material intensity indicator across firms, industries, and over time (Keele and Kelly, 2006; Bonin, 2020). For example, we can predict that current packaging material intensity of a given firm at time *t* is influenced by the packaging tax applied at time *t*. The previous value of the packaging material intensity at time *t-1* would help explain the current value of the variable at time t. Keele and Kelly (2006) have demonstrated that lagged dependent variable (LDV) models produce correct

inferences. Therefore, we included the lagged IMU variable as an independent variable in our model. The parameter θ reflects the unpredictable nature of the relationship (unobserved factors). The subscripts *i, j, t,* represent respectively the firm, the industry, and the year. ε is the error term, ci represents time invariant industry specific effect and ŋt is the industry invariant time specific effect. We estimate two empirical models. The first model in Eq. (6) includes the producer price index, which is the average material price paid by firms. Then we distinguish between the virgin and the recycled materials prices effects in the second model in Eq. (7). We included in both models the quadratic terms to capture the effect of high packaging tax rates on the intensity of use of materials. All variables were transformed into natural logarithms. The reason for log transforming our data is to help prevent a few observations from being extremely influential. We used more specifically the monotonic transformation ln (1+x) to avoid negative values in the dataset since some are under 1. An advantage of this transformation is that it simplifies the model and makes patterns in the data easier to interpret.

$$IMU_{mijt} = \theta IMU_{ij,t-1} + \alpha_1 Qtax_{mijt.} + \alpha_2 Qtax^2_{mijt.} + \alpha_3 PPI_{mt} + \alpha_4 Subs_{mt} + \alpha_5 GDP_{jt} + c_i + \eta_t + \varepsilon_{ijt} \quad \textbf{(6)}$$

$$IMU_{mijt} = \theta IMU_{ij,t-1} + \alpha_1 Qtax_{mijt.} + \alpha_2 Qtax^2_{mijt.} + \alpha_3 RMP_{mt} + \alpha_4 VMP_{mt} + \alpha_5 Subs_{mt} + \alpha_6 GDP_{jt} + c_i + \eta_t + \varepsilon_{ijt} \quad \textbf{(7)}$$

4.3.6. Supplementary interviews for interpretation of quantitative results

To develop a deeper understanding of our statistical results and add further insights into the hypothesized relationships, we conducted supplementary in-depth interviews with key informants. Conducting a quantitative analysis and adding qualitative data thereafter is an approach that has been adopted in previous studies. For example, Wang et al. (2018) conducted supplementary interviews to facilitate the interpretation of their statistical results. In social sciences, the qualitative research method is used for confirmatory, exploratory, or interventional purposes. When the authors make quantitative and then qualitative analyzes, the latter aims to confirm the hypotheses that are already validated by the quantitative analyzes. This approach is part of the confirmatory research and the positivist paradigm (i.e. explanation). The objective is to verify hypotheses, validate or interpret quantitative data with a view to their generalization (Guba and Lincoln, 1994). Therefore, we conducted 8 semi-structured interviews (Table 4.4) and a focus group with key stakeholders. We used distinct interview guides including questions around the relevant dimensions of our hypothesized relationships.

Table 4.4. Collection of qualitative data from key respondents

Key respondents	**Method**	**Number of respondents**
Representatives from Éco Entreprises Québec	Semi-structured interview	4
Experts in packaging eco-design	Semi-structured interview	2
Expert in plastics packaging waste management	Semi-structured interview	1
Project manager in residual materials management, and senior consultant in material recyclability and market development.	Semi-structured interview	1

4.3.7. The focus group procedure

The focus group consists of four representatives from Recyc-Québec, which is the organization in charge of recovering and recycling packaging waste in the province of Quebec. These respondents occupy different positions (i.e. senior and middle management) in Recyc-Québec, which stimulated relevant discussions. The focus group was conducted using a schedule based on three topics, namely the reduction and the substitution effects of the packaging tax and the material price sensitivity. For each topic, the results were first presented. Then, a round table discussion was initiated in which participants were invited to comment on the results and discuss the topic. The same procedure was applied for all topics. Discussions lasted one hour and were audio-recorded and transcribed. The participants' arguments are reported in the results section.

4.4. Empirical results

4.4.1. Fixed and random effects estimation for the full sample

We analyzed our panel data using Stata 14.1. The descriptive statistics are reported in *Appendix 2*. Longitudinal regression models were employed to estimate relationships between variables longitudinally. The first concern in a panel data analysis is to choose a valid model (Wooldridge, 2010). To choose the most appropriate model that yields consistent and efficient estimates, we estimated both fixed and random effects models for the full sample. Then, we conducted the Hausman specification test to decide whether to use the fixed or the random effects model. The Hausman specification test yields a p-value to be lower than 0.05 (i.e. significant), suggesting that the fixed effects model represents a valid model for the packaging materials under investigation (see *Appendix 2*). This means that the fixed effects estimates are more consistent and efficient than the random effects estimates (Hausman, 1978). Tables 4.5 and 4.6 present the fixed effects estimation results for the two empirical models specified in Eq. 7 and Eq. 8.

4.4.2. Qualitative data analysis

The interviews were first transcribed in French and then translated into English. Then, we coded transcripts using the qualitative software (Atlas.ti). Our coding procedure is based on strict use of predetermined codes based on theoretical constructs (Miles and Huberman, 1994). First, we retain preliminary codes which are the themes from the literature. These preliminary codes are the output reduction effect of materials, the input substitution effect (i.e. from environment-damaging to environmentally friendly packaging material and from heavy to lightweight packaging material), and the material price sensitivity (i.e. recycled and virgin material price sensitivity). We created these codes for the PET plastic bottles and for the glass packaging to catalogue key concepts while preserving the context in which they occur, and hence facilitate the subsequent analysis (Miles and Huberman, 1994). Second, we read the transcripts and coded the segments using the above-mentioned preliminary codes. These segments represent our first-order codes that are assigned to their appropriate preliminary codes. This means that data for each theme from the literature are consolidated (Miles and Huberman, 1994). Third, we read rigorously these data to create relevant second-order codes (themes). Fourth, we used the "data structure approach" to generate aggregate dimensions by moving from detailed original elements to more synthetic elements (Corley and Gioia, 2004). Tables 4.7, 4.8, and 4.9 report the qualitative data analysis. Only some coded quotations are reported in these tables to highlight salient aspects. Other detailed quotes and statements from respondents are added in our description and interpretation of the empirical models results.

Table 4.5. Fixed effects estimation (empirical model 1)

Model (1)	**Single-use PET plastics bottles**		**Single-use clear glass packaging**	
Variables	**Manufacturers**	**Retailers**	**Manufacturers**	**Retailers**
lag1	0.362***	0.217*	0.427***	0.366***
	(0.076)	(0.118)	(0.106)	(0.126)
Qtax	-0.011***	-0.042***	0.009***	0.052**
	(0.003)	(0.014)	(0.003)	(0.022)
Qtax_square	0.001***	0.006***	-0.001***	-0.008***
	(0.000)	(0.002)	(0.000)	(0.003)
PPI	-0.175***	-1.715*	-2.770***	-5.210**
	(0.063)	(0.865)	(0.819)	(6.034)
GDP	-0.082***	-0.010**	-0.055*	-0.019**
	(0.027)	(0.005)	(0.031)	(0.008)
Polystyrene_PET	0.005*	0.061**		
	(0.002)	(0.028)		
Clear glass_PET	-0.004	-0.149		
	(0.010)	(0.072)		
PET_Clear Glass			0.005	-0.014*
			(0.001)	(0.008)
Constant	1.441***	0.541**	0.844*	1.276**
	(0.456)	(0.247)	(0.472)	(0.492)
Observations	547	294	804	353
R-squared	0.548	0.447	0.443	0.563
Year effect	Yes	Yes	Yes	Yes
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Table 4.6. Fixed effects estimation (empirical model 2)

Model (2)	Single-use PET plastics bottles		Single-use clear glass packaging	
Variables	**Manufacturers**	**Retailers**	**Manufacturers**	**Retailers**
lag1	0.365***	0.238*	0.278***	-0.093***
	(0.075)	(0.127)	(0.076)	(0.026)
Qtax	-0.010***	-0.036***	0.033*	0.192***
	(0.003)	(0.012)	(0.018)	(0.061)
Qtax_square	0.001***	0.005***	-0.004**	-0.029***
	(0.000)	(0.001)	(0.002)	(0.008)
RMP	-0.014*	0.108*	0.075**	-1.914**
	(0.008)	(0.066)	(0.036)	(0.574)
VMP	-0.015**	-0.164*		
	(0.006)	(0.085)		
GDP	-0.096***	-0.010*	-0.068	-0.033**
	(0.027)	(0.005)	(0.104)	(0.013)
Polystyerene_PET	0.003	0.087**		
	(0.002)	(0.042)		
Clear Glass_PET	-0.006	-0.105		
	(0.005)	(0.049)		
PET_Clear Glass			-0.009**	-0.075**
			(0.003)	(0.025)
Constant	1.704***	0.758**	1.779**	8.061***
	(0.466)	(0.363)	(2.129)	(2.698)
Observations	547	294	804	353
R-squared	0.547	0.425	0.447	0.553
Year effect	Yes	Yes	Yes	Yes
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

4.4.3. Fixed effects estimation for food manufacturers and retailers and qualitative evidence

4.4.3.1. The output reduction effect of the packaging tax policy

Hypothesis 1 was not supported as shown by the consistent results for the packaging tax amount variable. The findings reveal a non-linear relationship between taxation and the intensity of use of both packaging materials under investigation. For the PET plastic

bottles, the coefficients for the linear and squared terms are statistically significant with a negative and a positive sign, respectively. This suggests a U-shaped effect of taxation on the intensity of use of the PET plastic bottles. This means that taxation at first decreases the quantities of PET generated in the market, then it increases after a certain level of taxation is reached. Whereas for the clear glass packaging, the coefficients for the linear and the squared terms are statistically significant with a positive and negative sign, respectively. This implies an inverted U-shaped effect of taxation on the intensity of use of the glass packaging, which means that taxation at first increases the quantities of glass generated, then it decreases after a certain level of taxation is reached. In other words, despite a significant increase in the packaging tax rates, the quantity of the single-use PET plastic bottles generated in the market tends to increase, which in turn increases the intensity of use of this material. Inversely, high packaging tax rates cause the demand for the single-use clear glass packaging to decrease, which leads to a decrease in the intensity of use of this material. Table 4.7 reports on the qualitative data analysis that helps to better understand these findings.

According to the key respondents interviewed, the inverted U-shaped effect of taxation on the intensity of use of the glass packaging is an expected result. The advisor in taxation and business intelligence at ÉEQ explains that "when a packaging material presents major challenges in terms of recycling, this leads to a significant increase in the tax applied on the quantities generated by firms from that material". This has been applied to glass packaging material since 2013, because of "the crisis of the glass recycling industry that has led to the closure of several glassworks in North America. Hence, the glass material was no more available on the market" (Director of operations at Recyc-Québec). The director of eco-design and circular economy at ÉEQ explains that "this forced many firms to explore other replacement alternatives. Due to limited local glass supply, firms buy this material from external suppliers located in Asia or Europe, which is restrictive for firms who prefer local material sourcing." In sum, these results suggest that after a high level of taxation is reached due to the recycling crisis, the quantities of glass packaging generated on the market decreased significantly, giving rise to an inverted U-shaped relationship (i.e. between taxation and the intensity of use of this packaging). The advisor in eco-design and circular economy at ÉEQ adds that "glass containers are energy-intensive, breakable, and heavy weight". Given that the packaging tax is charged on a weight basis, these properties cause an important increase in costs due to expensive financial contributions to the compensation scheme. These properties also imply high transportation costs for firms. Consequently, the use of glass packaging as a short-life and single-use packaging is no longer an attractive packaging alternative. Therefore, "reducing its weight is the first-choice alternative for both manufacturers and retailers" (Advisor in taxation and business intelligence). The director of eco-design and circular economy at ÉEQ explains that "either firms make significant eco-design efforts to lighten

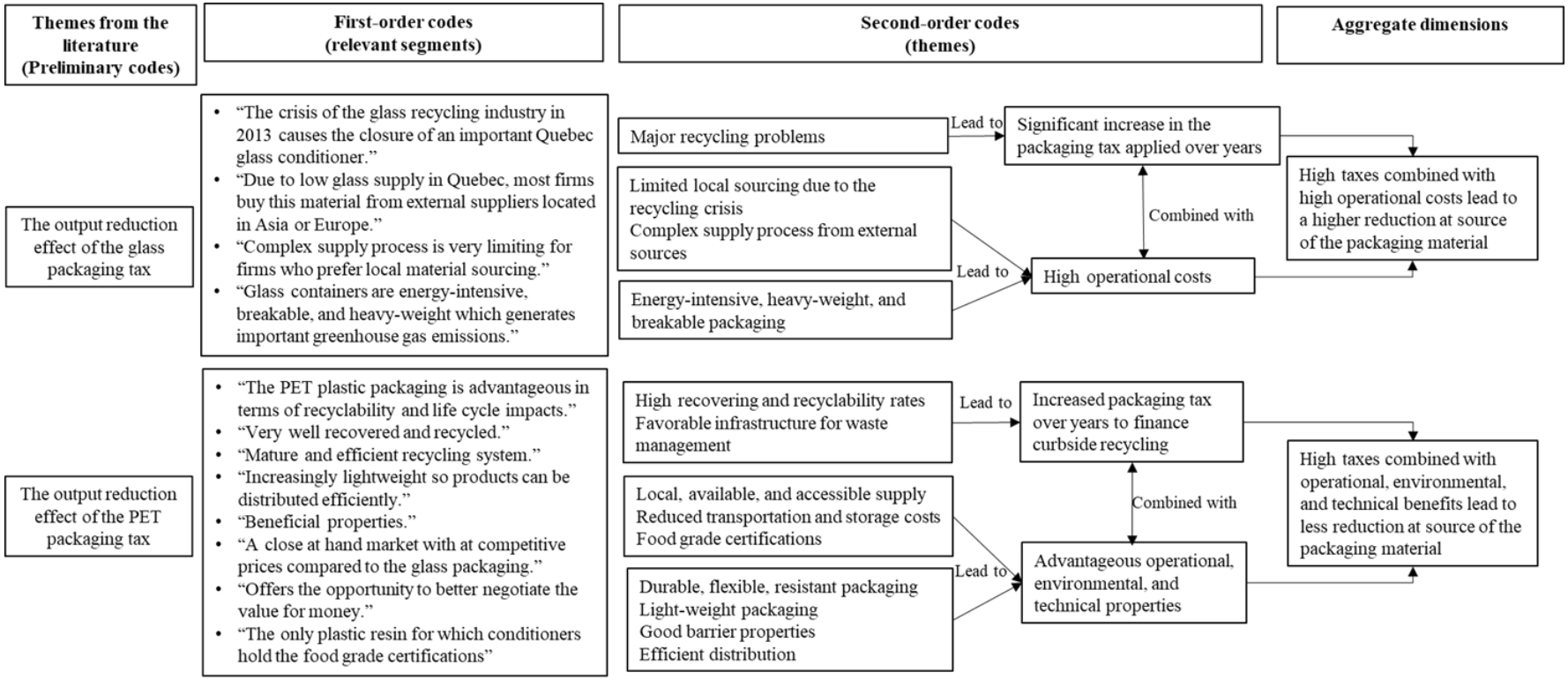
their glass packaging, or they migrate completely toward a less expensive packaging." In sum, all the qualitative evidence suggests that the intensity of use of clear glass packaging is sensitive to high taxation combined with high operational costs arising from the limited local supply and from the properties of this packaging material.

Unlike the clear glass packaging, the PET plastic bottles generated by food manufacturers and retailers do not appear to be sensitive to the packaging tax. The qualitative evidence helps to elucidate this counterintuitive result. According to the director of eco-design and circular economy at ÉEQ, this result is consistent, because "the PET plastic has beneficial properties such as high-pressure resistance, good barrier properties, and high transparency. It is the only plastic resin for which conditioners hold 'food grade certifications' in Canada, which means that the recycled PET plastic can be brought into contact with food in complete safety. Therefore, food manufacturers and retailers use this resin without any technical problems." Moreover, interviewees echoed that "in recent years the use of the PET plastic bottles is a trend that has been noticed in the case of primary packaging in the food industry" (Advisor in taxation and business intelligence). The advisor in eco-design and circular economy clarifies that this is related to "numerous operational and environmental considerations throughout the distribution chain." From an operational point of view, "the PET plastic packaging has several benefits related to reduced transportation and storage costs." From an environmental point of view, "the PET plastic is advantageous in terms of recyclability and life cycle impacts." The director of eco-design and circular economy at ÉEQ added that "the PET plastic bottles are increasingly lightweight so products can be distributed efficiently while reducing fuel requirements and greenhouse gas emissions through the distribution chain." This suggests that both food manufacturers and retailers tend to prioritize other decision criteria than the packaging taxes when choosing the type and the quantity of their product packaging. This statement has been confirmed by the vice president of operations performance at Recyc-Québec. The CEO advisor at Recyc-Québec also stresses that "packaging decisions of manufacturers and retailers are significatively impacted by other important factors such as general consumer trends, material prices, and fluctuating oil rates". The expert in plastic packaging waste management adds that "there is also an infrastructure concern. The PET plastic is well recovered and recycled, which facilitates its treatment in sorting centers. Hence, the recycled resin is available and accessible for Quebec firms, which causes the demand for this material to increase." This suggests that the PET plastic bottles have a favorable waste management infrastructure, which increases its value on the market.

In sum, the above findings lead us to conclude that the reduction effect of the packaging tax tends to be sensitive to the particularities and characteristics of the targeted packaging materials. Considering that the packaging tax is charged on a weight basis, high packaging

tax rates combined with operational, environmental, and technical benefits lead to a lower reduction at source of the packaging material. Whereas high packaging tax rates combined with high operational costs lead to a higher reduction at source of the packaging material.

Table 4.7. Qualitative data analysis for the output reduction effect



4.4.3.2. The input substitution effect of the packaging tax policy

Hypothesis 2 was supported for both food manufacturers and retailers and for all materials. The empirical results show that an increase in the polystyrene tax compared to the average taxation (i.e. between the polystyrene and the PET plastic bottles), increases the intensity of use of the PET plastic bottles for both food manufacturers and retailers. Besides, an increase in the PET tax compared to the average taxation (i.e. between the clear glass and the PET plastic bottles), causes the intensity of use of the PET plastic bottles to increase for food retailers[5]. These results suggest a substitution effect between packaging materials based on their taxation, which in turn depends on their environmental impacts. Table 4.8 reports on the qualitative data analysis that helps developing a deeper understanding of these findings.

The expert in the plastic packaging waste management confirms the substitution from the polystyrene to the PET plastic. For instance, "many food products in the grocery store were packaged in polystyrene, now most of them are packaged in PET containers". The expert explains that "the polystyrene material has a very low recycling rate. Thus, its taxation has excessively increased over years to deter companies from generating this material on the market." Similarly, the project manager in residual materials management affirms that "although the polystyrene is easy to handle and process, its recycling is expensive. The director of eco-design and circular economy emphasizes that "the recycling problems imposed by the Polystyrene in the Quebec context make the PET material an interesting replacement alternative especially in the food industry." These respondents stress that despite the required costs to implement such substitution (e.g. equipment changes), both food manufacturers and retailers have gradually migrated to the PET packaging especially because of the cost savings opportunities in terms of the financial contribution to the recycling schemes.

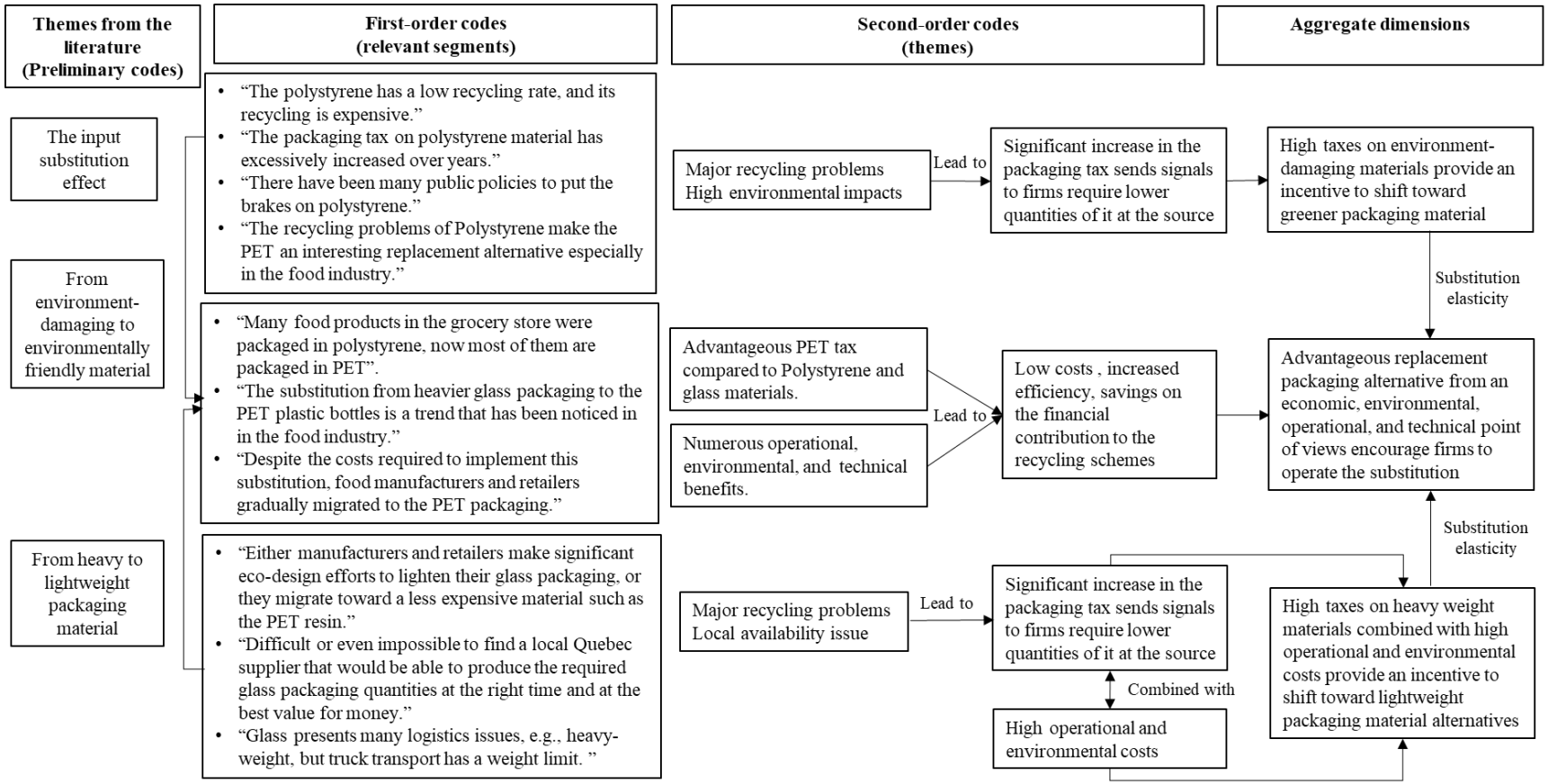
The potential substitution from the clear glass packaging to the PET plastic has been confirmed by all respondents. The interviewees echoed that in recent years "the substitution from heavier packaging material, namely glass to PET plastic bottles is a trend that has been noticed in the food industry" (Advisor in taxation and business intelligence at ÉEQ). While many food products such as ketchup and mayonnaise were packaged in glass containers, they are now packaged in PET plastic bottles. This substitution could be explained by two main factors. First, there is an issue of availability

[5] The robustness check of our result with the Arellano-Bond dynamic estimator (see *Appendix 4*) exhibits a potential substitution from clear glass to PET plastic bottles in food manufacturing as well (i.e.the variable of interest is statistically significant and negatively signed).

of the glass material. According to the director of operations at Recyc-Québec, “the clear glass is not available through the curbside recycling”, which leads decision makers to explore other packaging alternatives. As mentioned previously, the local glass supply is limited, which implies a complex supply process from external sources. Second, the glass packaging presents many logistics issues. The project manager in residual materials management exemplifies that “a glass pickle jar weighs 150g, while a PET jar weighs 15 g, so the latter weighs 10 times less. To carry pickles packed in glass, more trucks are needed than to carry the same products packed in PET packaging.” The respondent highpoints also “the number of units that are manufactured with one kilogram of each type of these materials. For example, 100 units of PET containers for mayonnaise are produced using one kilogram of the PET material, versus only 10 units of glass containers are produced using one kilogram of the glass material.” Conversely, the PET plastic bottles present multiple operational, environmental, and technical benefits. The director of eco-design and circular economy at ÉEQ clarifies that “the PET plastic supply is a close at hand market with very competitive prices compared to glass packaging.” Hence, food manufacturers and retailers have enough local suppliers to negotiate the best value for money unlike the glass packaging market. The advisor in taxation and business intelligence at ÉEQ adds that the PET plastic resin is characterized by “durability, flexibility, and high recyclability.” These are some important factors favoring the PET plastic bottles over the glass containers.

In sum, the above findings suggest that high taxes on environment-damaging and heavy weight packaging combined with high operational and environmental costs provide an incentive to manufacturers and retailers to shift toward lightweight packaging. Advantageous replacement packaging alternative from an economic, environmental, operational, and technical point of view encourage firms to operate this substitution. The latter allows potential savings on the financial contribution to the recycling schemes, an overall decrease in costs, and an increase in efficiency.

Table 4.8. Qualitative data analysis for the input substitution effect



4.4.3.3. The material price sensitivity

Hypothesis 3 was supported for both food manufacturers and retailers. The producer price index for plastic raw material was found to have a negative and statistically significant impact on the intensity of use of the PET and glass packaging. This suggests that an increase in the average price of plastic and glass raw material causes the quantity of PET plastic bottles and glass containers generated by manufacturers in the market to decrease. The director of eco-design and circular economy at ÉEQ explains this result by the peculiarities of the food industry, where "there are many everyday consumer products and therefore an increased consumption of packaging, consequently, the food profit margins are not high enough." Therefore, food manufacturers and retailers are sensitive to the variations of raw material price. However, the producer price index is an average price paid by businesses; thus, it does not distinguish between the virgin and recycled materials prices. Table 4.9 reports on the qualitative data analysis that helps explain the results for material price sensitivity.

Hypothesis 4 was supported. The PET virgin material price variable displays a statistically significant and negative impact on the intensity of use of this packaging for both food manufacturers and retailers. Whereas Hypothesis 5 was not supported. The recycled PET material has a negative and significant effect only for manufacturers. The recycled glass material has a negative and significant effect only for retailers. These results suggest that manufacturers are sensitive to both virgin and recycled PET prices. Whereas retailers are sensitive to the virgin PET price and to the recycled glass price. Interestingly, the recycled PET price has a positive and statistically significant effect on the intensity of use of PET plastic bottles by retailers, and the recycled glass has a positive and statistically significant effect on the intensity of use of glass by manufacturers. The qualitative evidence helps to better understand these results.

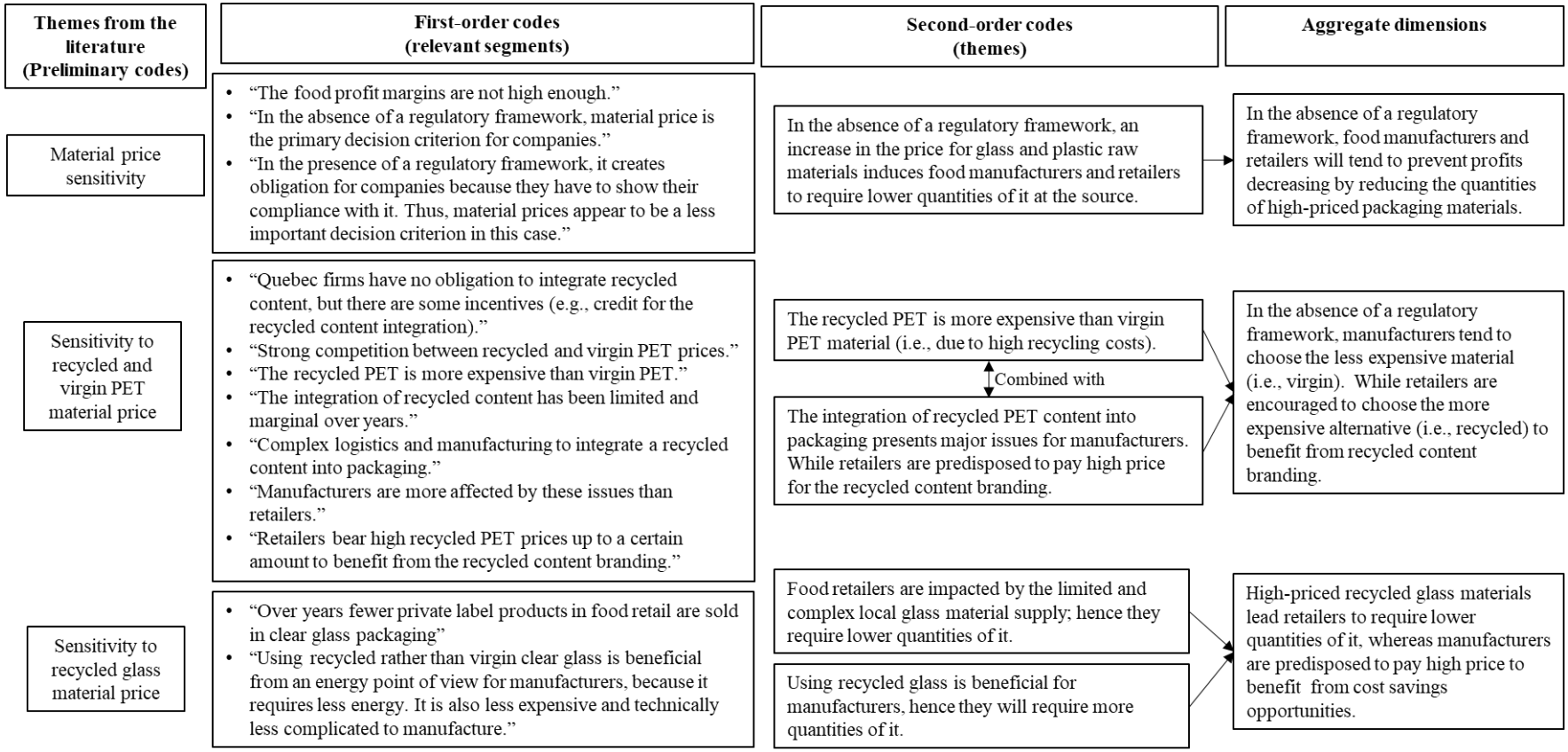
For the PET plastic bottles results, the director of eco-design and circular economy at ÉEQ highlights that "there is a strong competition between the recycled and the virgin PET prices." The expert in packaging waste management clarifies that "the recycled PET production requires extra efforts and costs compared to the virgin one, because it must be decontaminated, transported, collected, and sorted. That is why the price of recycled material is often more expensive than virgin material. The compensation scheme contributes to financing this system, but it is not always enough to bridge the price difference between these two materials."

Interestingly, despite an increase in the price of recycled PET plastic bottles, the intensity of use of this material tends to increase for food retailers, whereas it decreases for food manufacturers. In other words, an increase in the recycled PET price seems to have less impact on retailers than manufacturers. The project manager in residual materials

management explains this result. On the one hand, there are several logistics and manufacturing challenges associated with integrating a recycled content into packaging. 'Retailers are not affected by these issues. They place their orders with the manufacturer who must manage the production challenges (e.g. the properties of recycled PET are different from virgin one, the PET plastic loses its mechanical properties).' On the other hand, "food retailers are predisposed to bear high recycled PET prices to benefit from the recycled content branding." However, the project manager in residual materials management stresses that "the recycled PET is still a relatively rare material. Its integration into packaging has been limited over years because it is either technically difficult or expensive. Therefore, manufacturers choose mostly virgin material." For example, some companies have first integrated the recycled content into their packaging, but they went back to virgin material due to large price difference. The respondent clarifies that 'the virgin material price is so competitive that even though the recycled material price decreases, the latter still imply significant logistics costs (e.g. production)'. In the same line of thought, the expert in packaging waste management added that "in the absence of regulations, the material price is the primary decision-making factor for companies. While in the presence of a regulatory framework, companies must show their compliance with it, thus, material price will be a less important decision criterion in this case. Between these two extremes, there are voluntary approaches by companies who have sustainable development strategies, eco-design and responsible sourcing objectives." In Quebec, "manufacturers and retailers have no obligation to integrate the recycled content into their packaging, but there are only some incentives, such as the credit for the recycled content integration" which is a discount on the financial contribution to the compensation scheme (the expert in packaging eco-design).

Regarding the glass packaging results, retailers appear to be sensitive to the recycled glass price, whereas manufacturers are not. The project manager in residual materials management explains that "the use of recycled rather than virgin clear glass is beneficial from an energy point of view for manufacturers, because it requires less energy. For each ton of recycled clear glass, manufacturers save half a ton of greenhouse gas emissions compared to virgin material." Besides, "technically, recycled clear glass is less complicated to use and less expensive." However, the interviews stress the low local glass material supply. The only local glass conditioner is a big player who accepts large volume orders, which is restrictive for companies. Hence, in food retailing, the project manager in residual materials management highlights that "fewer private label products are sold in clear glass packaging". This statement was also confirmed by the expert in packaging eco-design. In sum, high-priced recycled glass materials lead food retailers to require lower quantities of it, whereas manufacturers are predisposed to pay high price to benefit from savings costs opportunities.

Table 4.9. Qualitative data analysis for the material price sensitivity



4.4.4. Robustness checks (validation of the model)

To establish the robustness of our statistical findings, we performed tests for endogeneity problems. In fact, including a lagged value of the dependent variable in our model may cause an endogeneity problem (Keele and Kelly, 2006). Therefore, we used the Arellano–Bond estimator "*xtabond*" which is the most common linear dynamic panel-data estimator. Using this estimator would help establish the robustness of our findings. The results from the Arellano-Bond dynamic estimation for the PET plastic bottles and the clear glass packaging (see *Appendix 4*) confirm that the lagged dependent variable (LDV) model has produced correct inferences. The ensuing results and significance levels proved robust. One exception involved the potential substitution effect between the clear glass and the PET plastic bottles. While the fixed effect model shows a statistically significant effect of this variable only for retailers, the Arellano-Bond dynamic estimator exhibits a potential substitution from clear glass to PET plastic bottles for food manufacturers as well. Moreover, the potential substitution effect between the polystyrene and the PET plastic bottles is statistically significant in model (1) of the fixed effect estimation, whereas it shows no statistically significant effect in model (2) of the fixed effect estimation. The Arellano-Bond dynamic estimator confirms the statistically significant effect of this variable. We also performed robustness checks by using the Ordinary Least Square (OLS) model (see *Appendix 5*). We seek to show that the relationships of interest are robust to different econometric approaches. It is true that the OLS method might be biased and inconsistent because of the unobserved firm-specific and time-specific heterogeneities. A fixed effects estimator relaxes this assumption by allowing for common time-invariant factors within a subsector (Wooldridge, 2010). In other words, the OLS is not the most efficient estimator in the context of panel data. However, it might be useful to check the effect of the independent variables (i.e.the signs of the relationships of interest) (Wooldridge, 2010). The ensuing results proved robust. The signs of the relationships of interest are the same as those estimated by the fixed effect models.

4.5. Discussion

The results for the output reduction effect and the input substitution effect of the packaging tax policy, and the material price sensitivity are respectively discussed in this section.

4.5.1. The output reduction effect of the packaging tax policy

The results for the reduction effect of the packaging tax are similar for both food manufacturers and retailers. The latter seems to display the same behavior, at least in the case of the packaging materials under investigation. Our empirical findings reveal a non-linear relationship between the packaging tax and the intensity of use of these materials.

There is a U-shaped relationship between these two variables for the PET plastic bottles, and an inverted U-shaped relationship for the clear glass material. These findings demonstrate that increasing the packaging taxes does not always allow a decrease in the intensity of material consumption. For the PET plastic bottles, high tax rates do not cause the intensity of use of this material to decrease. Despite a significant increase in this packaging tax over years, the quantity of the PET plastic bottles generated in the market tends to increase. This result is consistent with Zhang and Buongiorno (1998) and Cela and Kaneko (2013) who suggest that the plastic packaging is "a luxury commodity" where demand is not significantly affected by the pricing system variations. Previous studies have examined the packaging taxes effect in the case of plastic packaging, and it was also found to be ineffective in the US, Norway, and Denmark markets (Palmer et al., 1997; Roine and Chin-Yu, 2006; Cela and Kaneko, 2013). Moreover, our findings show that high tax rates for the clear glass material appear to produce the desired outcome. After a high level of taxation is reached, it tends to decrease the quantities generated on the market. This result complements that of Dewees and Hare (1998) who show that the packaging tax is effective in reducing the glass packaging at the source in the province of Ontario (Canada), but the authors claim a linear relationship between these variables, which is not consistent with our findings.

These findings lead us to conclude that increasing the packaging tax for the PET material would tend to be ineffective since it does not produce the desired reduction effect, while it turns out to be effective for the clear glass packaging when a given level of tax is reached. This is consistent with Chappin et al. (2009) who were cautious about the idea that the incentive-based instruments always lead to the desired outcomes. Using single-use glass packaging is no longer an advantageous alternative due to its costly financial contribution to the EPR schemes, its complex supply as well as its high operational costs (e.g. heavy weight, energy-intensive). Conversely, packaging decision makers are incentivized to adopt the PET plastic bottles because of its advantageous operational (e.g. lightweight), environmental (e.g. recyclability), and technical (e.g. pressure resistance) properties. Therefore, the packaging tax tends to be a relatively less important criterion for businesses when it comes to choosing the quantities of their packaging materials, because other important and relevant decision-making criteria come into play. These findings add further insights to complement the statements of previous studies on the EPR policy who suggest that reducing product packaging at the source becomes a more attractive practice when the financial contribution to the EPR scheme is high enough (e.g. Livingstone and Sparks, 1994; Mayers and Butler, 2013**).** Therefore, policymakers should not expect that increasing packaging taxes will always produce the expected reduction outcome for all packaging materials. This consideration should be kept in close attention when policymakers adjust the taxation rates. As suggested by Palmer et al. (1997), taxes

would be likely to raise revenue for the recycling schemes rather than changing the firm's behavior or significantly influence the demand for packaging materials.

4.5.2. The input substitution effect of the packaging tax policy

Our empirical findings suggest a substitution effect between packaging materials based on their packaging taxes, namely a potential substitution between the polystyrene and the PET plastic bottles and between the clear glass packaging and the PET plastic bottles for both food manufacturers and retailers. These results have also been confirmed by the key respondents interviewed. This is also consistent with Fullerton and Kinnaman (1995) and Palmer and Walls (1999) who suggest that the packaging tax causes a potential substitution effect. However, these findings contradict those of Cela and Kaneko (2011) who advocate that applying packaging taxes on all packaging materials yields to an overall reduction of the use of materials without any substitution repercussion.

In Quebec, the tax rates applied on the polystyrene and the glass materials have been significantly raised over the years to deter firms from generating these materials on the market. Applying high tax rates aims to limit the use of packaging materials that disrupts the recycling systems. This makes the PET plastic material an interesting replacement alternative from an economic point of view, because it provides potential cost savings in terms of the financial contribution to the recycling schemes. It is also advantageous from an operational and an environmental point of view. The PET plastic material has a more advantageous packaging tax than the other materials since it has a mature and efficient recycling system. These results are consistent with Calcott and Walls (2000) who demonstrate that varying taxes according to the product recyclability is an efficient upstream instrument, which sends signals to producers to reduce their packaging weight and make it easier and less costly to recycle.

The high taxes applied on environment-damaging packaging materials causes the intensity of use of environmentally friendly materials to increase, because they have not only an advantageous taxation (i.e. economically beneficial), but they are also advantageous from an environmental, operational, and technical point of view. Therefore, it can be assumed that increasing packaging taxes for environment-damaging packaging materials might have a considerable incentive effect regarding the choice of a more environmentally friendly replacement alternative. Moreover, since the packaging tax policy is charged on a weight basis, it tends to shift both manufacturers and retailers toward light-weight packaging materials away from heavy packaging materials (Dewees and Hare, 1998; Heidbreder et al., 2019; Friedrich, 2020). In sum, packaging decision makers are strongly inclined to reduce their packaging costs by switching from high-taxed materials (i.e. environment-damaging / heavy weight packaging material) toward low-taxed materials (i.e. environmentally friendly /lightweight packaging material) that are

also advantageous from an economic, environmental, operational, and technical point of view. Furthermore, the availability and the local accessibility of packaging materials are important criteria that would shape the substitution elasticity between packaging materials. These findings complement the statements of previous studies regarding the substitution elasticity between packaging materials (Palmer et al., 1997; Dace et al., 2014).

4.5.3. The material price sensitivity and the reduction at source of packaging

Our empirical findings reveal that an increase in the average producer price for packaging raw materials induces manufacturers and retailers to require lower quantities of it. This is consistent with previous studies that suggest that the reduction at source of packaging is sensitive to material price variations (e.g. Dewees and Hare, 1998; Rouw and Worrell, 2011). For the PET plastic bottles, our findings are consistent with Palmer et al. (1997) who show that the PET bottles are the most elastically demanded packaging. For the glass packaging, the reduction at source of glass packaging is price-elastic (e.g. Palmer et al., 1997; Dewees and Hare, 1998). Considering that profit margins in the food industry are not high enough, because of high and consistent packaging material flows (i.e. increased consumption of packaging due to large volume and variety of commodities), it can be assumed that decision makers tend to prevent profits from decreasing under higher prices of packaging raw materials unless they can be passed to end consumers through increased prices for packaged products (Fernie and Hart, 2001; Friedrich, 2020).

However, the producer price index does not distinguish between the virgin and the recycled material prices. Yet, it is of paramount importance to differentiate these prices effects (e.g. Cela and Kaneko, 2011; Dace et al., 2014). Our empirical findings reveal that food manufacturers are sensitive to both virgin and recycled PET prices. Whereas food retailers are only sensitive to the virgin PET and recycled glass prices. These findings add further empirical evidence on the price elasticity of the primary and secondary plastic packaging materials for manufacturers, and the price elasticity of primary plastic and secondary glass materials for retailers. Our findings are consistent with Dace et al. (2014) who show that demand for virgin and recycled packaging materials tends to be price elastic in the Republic of Latvia, as well as Palmer et al. (1997) who establish the price-elastic demand for recycled glass material in the United States. However, our findings go contrary to Cela and Kaneko (2013) who find that demand for virgin plastic materials is price inelastic in Denmark. Interestingly, our qualitative evidence high point that the recycled PET material price often tends to be more expensive than the virgin PET due to its high recycling costs. Considering that decision makers are predominately driven by a cost-reduction approach regarding the choice of their packaging materials (e.g. Accorsi et al., 2014), they are strongly inclined to choose the less expensive packaging alternative (i.e. virgin materials), unless other upstream incentive-based instruments encourage them

to choose the more expensive alternative (i.e.recycled materials) (Palmer and Walls, 1999; Heidbreder et al., 2019).

In this line of thought, our findings reveal that an increase in the recycled PET price has less impact on food retailers than on manufacturers. Retailers are predisposed to pay a high price to benefit from the recycled content branding. This is consistent with Friedrich (2020) who find that the amount of recycled or recyclable plastic material used is steadily higher in the food retail segment. These findings suggest that the "credit for the integration of recycled content into product packaging" appears to be an effective upstream incentive-based instrument for food retailers. However, it seems to be ineffective and/or not sufficient for food manufacturers, because the latter face complex technical challenges for the integration of recycled content into packaging. Therefore, it can be assumed that the absence of a regulatory framework combined with high-priced recycled materials, lead most likely food manufacturers to choose virgin material which is less expensive and technically less complicated. The packaging material price would be a less important criterion for decision makers in the presence of restrictive regulations since they must exhibit their compliance with it. This would induce a change in the purchased quantity of virgin packaging materials by stimulating their source reduction. Pearce and Turner (1993) and Cela and Kaneko (2013) recommend applying "material levies" on packaging raw materials to better improve material efficiency at the source. Reducing the quantity of virgin materials and increasing that of recycled materials at the source would decrease the packaging waste afterwards. Similarly, Dace et al. (2014) recommend increasing the virgin material price to decrease its demand and encourage its replacement with recycled materials. However, our qualitative findings show that the integration of recycled materials into packaging is still limited because it is either technically difficult, not available, or expensive. Besides, an overproduction of virgin material has been noticed, which causes its prices to decrease. Therefore, the "material levies" suggested by the above-mentioned authors must be implemented by ensuring the availability, the local accessibility of recycled materials at more competitive prices, and addressing the technical challenges faced by manufacturers.

Moreover, our findings reveal that the sensitivity to the price of recycled materials depends on the particularities of the targeted packaging materials. More specifically, food manufacturers are sensitive to the recycled PET price whereas they are not sensitive to recycled glass price. This goes contrary to Palmer et al. (1997) who suggest a price-inelastic demand for recycled plastic material and a price-elastic demand of recycled glass material for manufacturers. Our qualitative findings demonstrate that using recycled rather than virgin clear glass is beneficial from an energy point of view for manufacturers, because it requires less energy, while using recycled PET is technically complicated due

to its complex manufacturing challenges. Therefore, these considerations should be kept in close attention by policymakers when setting up policies for recycled materials.

4.6. Conclusion

This study evaluates at a panel level the effectiveness of the weight-based packaging tax policy in decreasing the packaging materials generated on the market by food manufacturers and retailers. The analysis focuses on two single-use packaging, namely the PET plastic bottles and the clear glass packaging for the period from 2005 to 2017. We first estimated two fixed effects models. Then, for confirmatory purposes, we conducted supplementary in-depth interviews and a focus group. This helped triangulate the quantitative results with qualitative evidence to develop a deeper understanding and add further insights into our hypothesized relationships. This section presents the theoretical, the managerial and policymakers' implications, the research limitations, and the implications for future research.

4.6.1. Theoretical implications

The theoretical contributions of this research are fivefold. First, we contribute to the existing literature by showing that the incentive effect of the packaging tax is sensitive to the particularities and characteristics of the targeted packaging materials. Packaging decision makers are willing to bear high tax fees for a packaging material when it presents significant operational, environmental, and technical benefits. These are important factors that could shape the influence of the packaging tax policy regarding the food packaging choice. Only increasing taxes might be an inadequate approach if the expected change in firms' practices for the targeted packaging materials are to be achieved. However, varying taxes according to packaging material recyclability is found to be effective.

Second, given that the packaging tax is an upstream incentive-based instrument that is charged on a weight basis, its increase would be more effective when combined with other eco-design policies or subsidies for recycling. A combined approach would incentivize firms to use less packaging materials at the source and engage in more environmentally friendly packaging alternatives rather than simply paying for the tax (Palmer and Walls, 1999; Cela and Kaneko, 2013; Dace et al., 2014; Heidbreder et al., 2019; Friedrich, 2020).

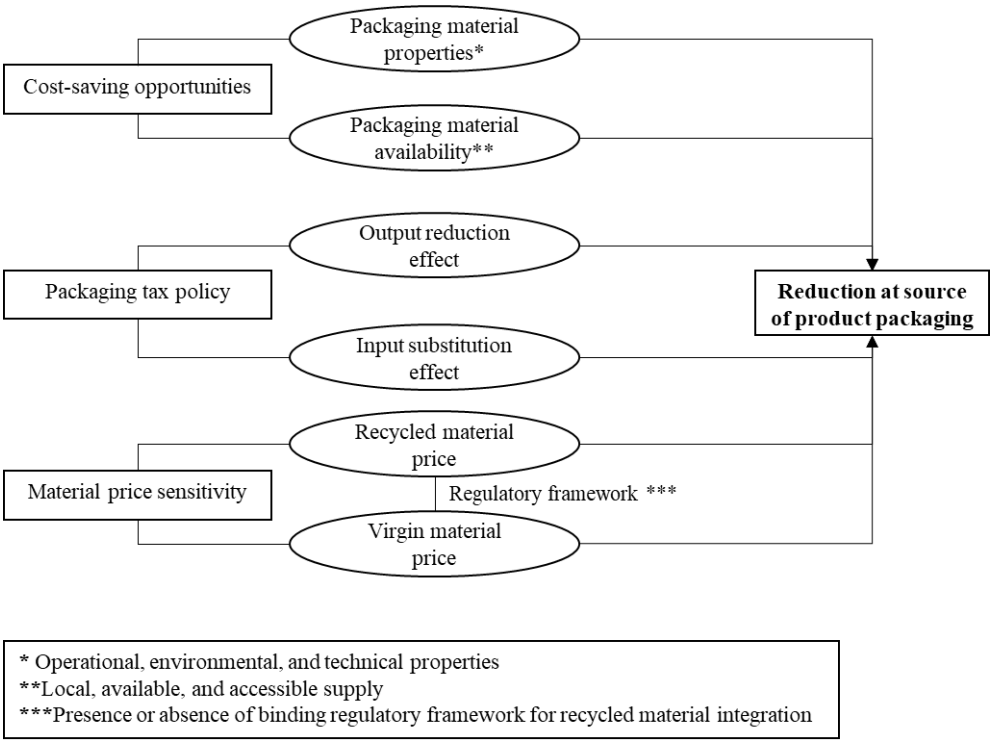
Third, our findings add further empirical quantitative and qualitative evidence on the substitution effect from one packaging material to another. This substitution tends to be not only sensitive to the taxes applied on packaging materials depending on the environmental harm they generate, but it is also sensitive to the environmental, operational, and technical benefits of the replacement alternative. The availability and the

local accessibility of packaging materials would shape the substitution elasticity between packaging materials.

Fourth, since the demand for packaging materials is price elastic (e.g. Dewees and Hare, 1998; Rouw and Worrell, 2011), we contribute to the existing literature by separating the material price and the packaging tax effects and by distinguishing virgin and recycled materials prices. The absence of a regulatory framework combined with high-priced recycled materials, technical difficulties, and availability issues, lead manufacturers to choose virgin materials while retailers are predisposed to pay a high price to benefit from the recycled content branding. Increasing the virgin material prices and decreasing that of recycled material might be an ineffective approach to improve packaging materials efficiency at the source. Therefore, the "material levies" suggested by previous studies should be implemented, while ensuring that recycled materials are locally available at more competitive prices than virgin materials.

Fifth, based on our main findings, a comprehensive framework (Figure 4.3) has been developed. The latter indicates the important variables that would affect the reduction at source practice. Besides the packaging tax effects, the cost-saving opportunities that arise from the properties and the local availability of packaging materials are important factors that lead packaging buyers to reduce their packaging at the source. Moreover, the material price sensitivity is an important variable, however, its effect will depend on the presence or the absence of a binding regulatory framework for the integration of recycled materials into product packaging. In fact, the absence of a regulatory framework combined with high-priced recycled materials, lead most likely packaging buyers to choose virgin material which is less expensive. The material price would be a less important criterion for buyers in the presence of restrictive regulations since they must exhibit their compliance with it.

Figure 4.3. Comprehensive framework



4.6.2. Managerial and policymakers' implications

The results of this research have four practical implications, namely improving the effectiveness of the packaging tax through alternative taxation policy, enhancing the integration of recycled materials into product packaging, developing decision support tools for packaging materials assessment, and promoting clear strategies on environmentally friendly versus environmentally harmful packaging materials. These contributions intend to decrease packaging waste generation and are relevant for both policymakers in regulatory institutions and packaging decision makers in organizations.

First, to improve the effectiveness of the packaging tax on the reduction at source of packaging, some alternative taxation policy could be useful, namely the eco-modulation strategy for the taxes applied on packaging materials (Institute for European Environmental Policy, 2017). There should be two ranges of the packaging tax rates applied on packaging integrating recycled content and packaging made from virgin materials. This strategy discourages the use of virgin materials and encourages the use of materials with mature and efficient recycling systems. This could present firms with a strong upstream incentive to incorporate recycled content into their packaging, and thereby reduce the subsequent packaging waste. Table 10 illustrates this strategy (see

Appendix 6). This strategy should be adapted according to packaging material recyclability and according to the peculiarities of each industry. For example, the use of recycled materials is strictly controlled in the food industry. Regulatory agencies first ensure the effectiveness of equipment to prevent food contamination.

Second, this research shows that the reduction at source by integrating recycled materials into product packaging is still very limited, because it is either technically difficult, not available, or expensive. Therefore, the "material levies" suggested by previous studies might be an ineffective approach if the expected reduction at source is to be achieved. It should be combined with measures favoring the local accessibility of recycled materials at competitive prices. This includes government mechanisms to better support the recycling industry. For instance, the experts in packaging eco-design interviewed recommend covering part of the costs required or provide subsidies when firms switch toward well recovered, sorted, and recycled packaging materials. Besides, developing a binding regulatory framework for recycled content integration would be encouraged when the availability of recycled materials will no longer be an issue. This should also be combined with training or personalized actions for businesses to help manage technical issues associated with recycled content integration.

Third, developing online decision support tools would provide packaging decision makers with the opportunity to conduct pre-diagnosis and assess the reduction and the substitution outcomes of different packaging materials. For example, if an environmentally friendly material is selected, the tool should indicate that it provides a "bonus" for the firm. Conversely, if an environment-damaging material is selected, the tool signals that it would cause a "malus" or a penalty for the firm. Moreover, it would be useful to develop indicators related to the quantitative performance of packaging materials (e.g. material circularity indicator, material recyclability indicator). This would allow analyzing how these indicators are related to the reduction and the substitution effects of the packaging tax. They might be incorporated into the online tools and would be useful for both policymakers and packaging decision makers. These indicators are not only useful to estimate the financial declaration of packaging generated on the market, but they also provide a more comprehensive decision support tool to choose efficient and effective packaging materials.

Fourth, to encourage the reduction at source practice, it is important to promote clear strategies on environmentally friendly versus environmentally harmful packaging materials. For instance, the interviews pointed out that many firms source glass packaging material from overseas (e.g. China). This packaging is produced using nuclear power or coal and thereafter they are shipped. Consequently, the production and the transport operations generate important greenhouse gas emissions. It is therefore important to bring such information to Quebec firms and put more emphasis on the life cycle of packaging

material rather than only focusing on end-of-life environmental impacts. For instance, in the United States, the EPR policy goals are widened to include environmental impacts throughout product life cycle (OECD, 2004).

4.6.3. Limitations

This research has three main limitations. First, due to confidentiality agreements, no firm-level information was available, which induces to a lack of granularity of data. Second, considering the issue of data availability of virgin glass historical pricing, we did not include this variable in our empirical model. For the sake of accuracy, we did not include any proxy for this variable. Third, the effects of incentive-based environmental instruments vary between and within countries with respect to how the regulatory institutions have implemented and communicated the policy (Heidbreder *et al.*, 2019). This effect is also sensitive to the particularities of the targeted packaging materials. Thus, the idiosyncratic nature of the packaging taxes policy limits the generalizability of our findings to other packaging materials, other industrial sectors, and other countries.

4.6.4. Implications for future research

We formulate four directions for future research, namely testing the comprehensive framework in Figure 3, examining the packaging tax effect when combined with other incentive-based instruments and considering firm-level variables, exploring the operational challenges of the glass packaging, and investigating the effect of the reduction at source of packaging on the firm performance outcomes.

First, this paper explores the effectiveness of the packaging taxes on the reduction at source of product packaging. Based on our findings, a comprehensive framework (Figure 3) has been developed. Besides the packaging tax effects, the latter encompasses other relevant variables. Future research could test this framework to provide more in-depth understanding of the factors influencing the production of less packaging at the source.

Second, we considered the decrease in quantities as a signal that the packaging tax has been effective in reducing packaging materials generated on the market. Further research needs to be done to explore the effect of such instrument when combined with other upstream incentive-based instruments, such as eco-design policies (Dace *et al.*, 2014), and subsidies for the use of recycled materials (Palmer and Walls, 1999). It would be useful to include relevant firm-level variables in the explanatory model, e.g. firm size, nature of business (Yusuf et al., 2017), product orientation, i.e. consumer or industrial products (Kassaye, 2001), and other intra-firm indicators, e.g. dummy variables for whether the firm has an environmental affairs function (Labatt, 1997) and whether the firm has benefited from training in packaging eco-design. This could provide more in-depth

understanding under what conditions the packaging tax policy generates the desired outcomes with regards to producing less packaging at the source, and hence reducing the subsequent packaging waste generation.

Third, since the packaging tax is charged on a weight basis, this paper shows that decision makers are inclined to reduce their costs by replacing heavy packaging with light-weight packaging. For instance, the glass packaging presents many operational issues particularly for firms who buy it from external sources due to limited local availability and complex supply process. Besides, this packaging is energy-intensive, breakable, and heavy weight. Therefore, there is an urgent need to empirically investigate the organizational decisions for this packaging material. Future research could investigate the operational challenges surrounding such packaging decisions. This is of particular interest for firms whose products can only be packaged in glass containers because of, for example, health considerations. This prevents the potential substitution from glass toward other replacement packaging materials.

Fourth, firms do not have clear evidence for the effects of reducing product packaging on their performance outcomes (e.g. Friedrich, 2020). Thus, it would be useful to investigate the effects of such practice on firm performance. Future research could shed light on its implications on the environmental, operational, economic, and social performance by using intra-firm indicators. This could give more insights into how managers can tailor their product packaging to enhance their performance. Previous studies used relevant measures for the performance outcomes of sustainable packaging practices (e.g. Zailani et *al.*, 2012; Yusuf *et al.*, 2017). For instance, the environmental performance measures include energy consumption, packaging material waste, and materials recovery. The operational performance measures consist of transportation cost, product return, labor and material cost, packaged product quality, and packaging material availability. The economic performance measures include waste and disposal cost, sales turnover, and net profit. Lastly, packaging waste reduction, product and brand image, damage free, and consumer satisfaction are relevant indicators for the social performance.

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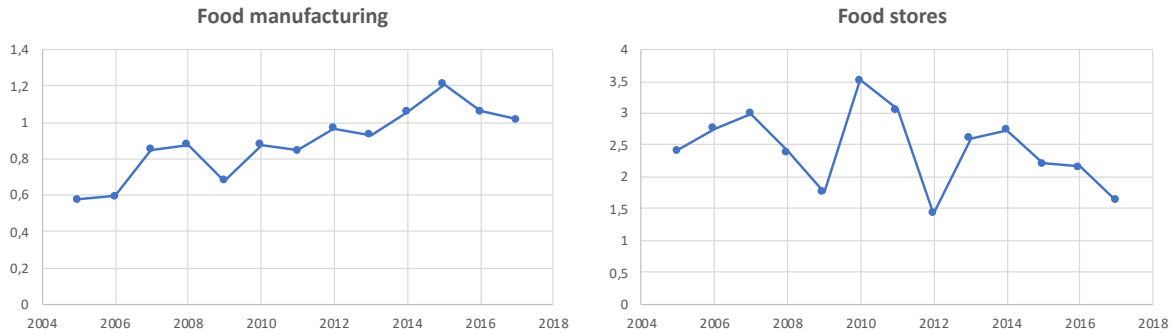
Appendices

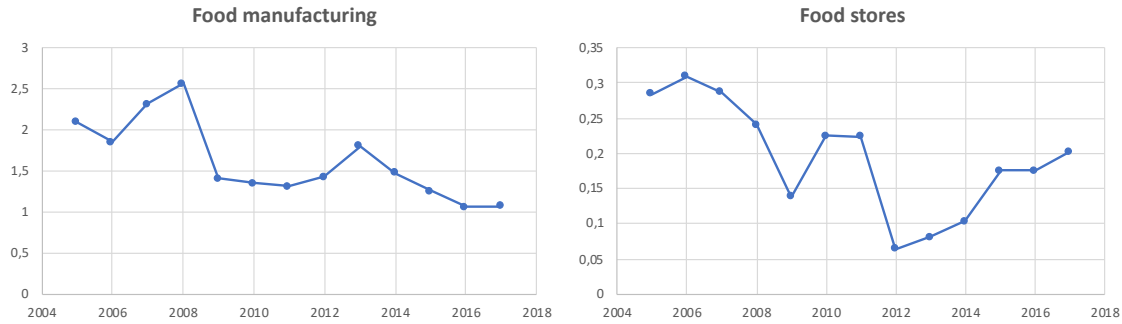
Appendix 1. Graphical description of variables

Appendix 1.1. The material intensity indicator for the PET plastic bottles



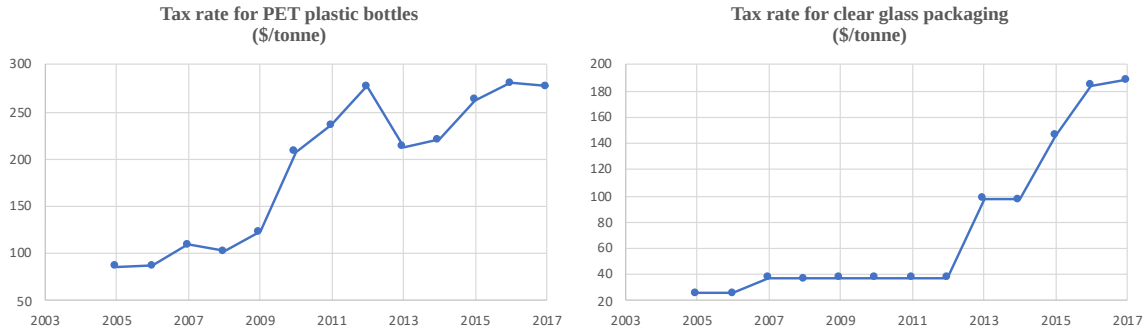
Source: Éco Entreprises Québec

Appendix 1.2. The material intensity indicator for the clear glass packaging



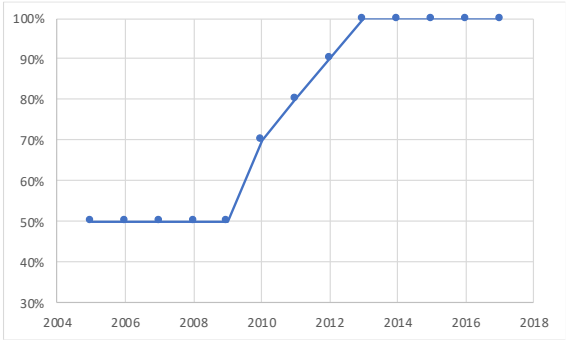
Source: Éco Entreprises Québec

Appendix 1.3. Packaging tax rate for the PET plastic bottles and clear glass packaging ($/tonne)



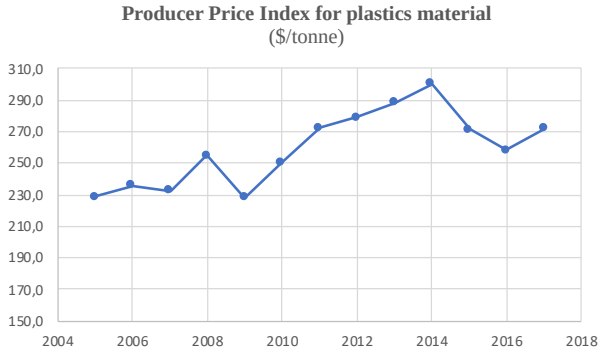
Source: Official Gazette of Quebec

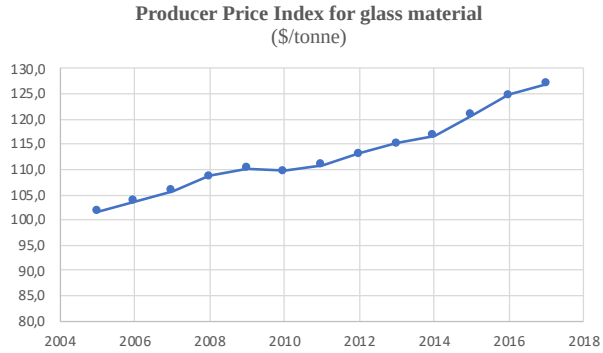
Appendix 1.4. Share of municipal curbside recycling costs (%)



Source: Éco Entreprises Québec

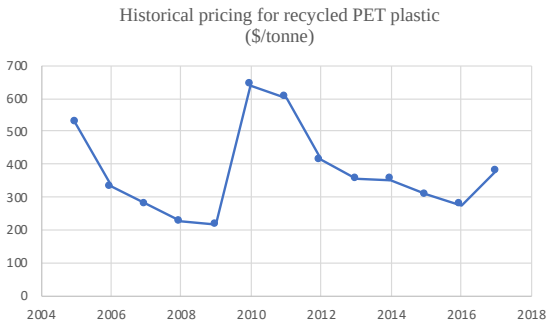
Appendix 1.5. Producer price index for the plastic and the glass raw materials

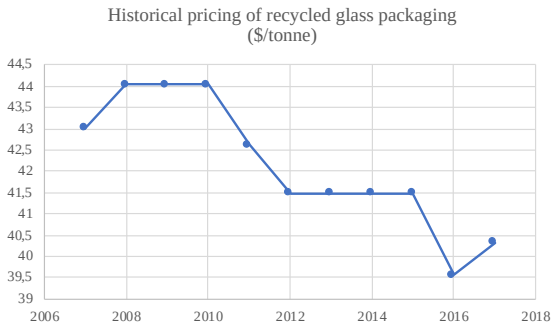




Source: The Federal Reserve Economic Data (FRED)

Appendix 1.6. Historical pricing for recycled PET plastic bottles and glass

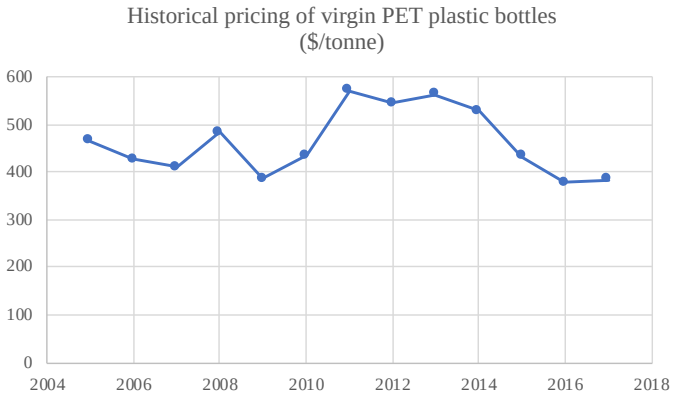




Source: Recyc-Québec

Source: The Recycling Markets database

Appendix 1.7. Historical pricing for the virgin PET plastic bottles (2005-2017)



Source: The Plastics News database

Appendix 2. Descriptive statistics of variables

Variables	Units	Mean	S.D.	Min	Max
PET plastic bottles model variables					
Annual packaging tax amount for food manufacturers	$	27 380,91	124 133,48	0,00	1 414 437,87
Annual packaging tax amount for food retailers	$	15 973,14	76 955,49	0,00	819 293,64
Producer price index for plastic	$/kg	0,2594	0,0227	0,2278	0,3005
Price of recycled PET plastic bottles	$/kg	0,3767	0,1353	0,217	0,64
Price of virgin plastic bottles ($/kg)	$/kg	0,462	0,0696	0,378	0,571
Packaging tax for PET plastic bottles	$/kg	0,183	0,0724	0,086	0,2803
Packaging tax for Polystyrene	$/kg	0,448	0,2449	0,119	0,789
Substitution from Polystyrene to PET *i.e.tax Polystyrene/Substitution elasticity between Polystyrene and PET*	%	1,7245	0,3599	1,1999	2,2018
Substitution from clear glass to PET *i.e.tax clear glass/Substitution elasticity between clear glass and PET*	%	0,7296	0,0632	0,6616	0,8477
Clear glass packaging model variables					
Annual packaging tax amount for food manufacturers	$	15 836,24	71 546,97	0,00	1 185 693,67
Annual packaging tax amount for food retailers	$	24 784,29	189 754,17	0,00	3 842 557,88
Producer price index for glass	$/kg	0,1129	0,0074	0,1016	0,1269
Price of recycled glass	$/kg	0,0421	0,0015	0,0395	0,044
Packaging tax for clear glass	$/kg	0,0759	0,0606	0,0255	0,1883
Substitution from clear glass to PET *i.e.tax PET/Substitution elasticity between clear glass and PET*	%	2,2602	0,8912	1,2462	3,6782
Food manufacturing GDP	K$	23 120 692	1 279 268	21 263 000	26 010 000
Food retail GDP	K$	10 622 091	8 462 219	1 766 000	18 534 000

Appendix 3. Results of the Hausman specification test

- **Hausman specification test for the PET plastic bottles**

```
. hausman fixed random
```

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lag1	.2610908	.7926981	-.5316073	.0274874
log_Qt	-.0141998	-.0077702	-.0064296	.0027226
log_Qt_squ~e	.0016135	.0008045	.000809	.0002098
log_IPM	.0215445	.0658072	-.0442627	.0073105
log_VMP	-.0414812	-.0528283	.0113472	.
log_GDP	-.003888	-.0065273	.0026393	.0019105
Polys_PET	.0149296	.025244	-.0103144	.
Glass_PET	-.0792184	-.0470902	-.0321282	.0085508

```
                b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      387.91
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

- **Hausman specification test for the glass packaging**

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lag1	.3939032	.791442	-.3975388	.0261352
log_Qt	3.97e-07	3.30e-07	6.70e-08	5.48e-08
log_Qt_squ~e	-1.87e-13	-5.20e-14	-1.35e-13	6.30e-14
log_PPI	-2.750675	-1.516864	-1.233811	.2695575
log_GDP	.0013702	-.0047678	.006138	.0027967
PET_Glass	.0003433	-.0019409	.0022841	.0004955

```
                b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      267.89
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Appendix 4. Robustness checks - Arellano–Bond estimator

Xtabond estimator	**Single-use PET plastics bottles**		**Single-use clear glass packaging**	
Variables	**Manufacturers**	**Retailers**	**Manufacturers**	**Retailers**
L.log_IMU	0.119**	0.201	0.132*	-0.151***
	(0.051)	(0.140)	(0.078)	(0.028)
Qtax	-0.012***	-0.040***	0.048**	0.220***
	(0.003)	(0.013)	(0.020)	(0.063)
Qtax_square	0.001***	0.005***	-0.005***	-0.033***
	(0.000)	(0.001)	(0.002)	(0.009)
RPM	-0.015*	0.112*	-0.031	-1.832***
	(0.009)	(0.064)	(0.034)	(0.525)
VMP	-0.014*	-0.147*		
	(0.007)	(0.076)		
GDP	-0.103***	-0.009**	-0.328**	-0.034***
	(0.035)	(0.005)	(0.161)	(0.012)
Polystyerene_PET	0.006**	0.088**		
	(0.003)	(0.041)		
Clear glass_PET	-0.004	-0.091		
	(0.006)	(0.042)		
PET_Clear Glass			-0.016***	-0.079***
			(0.005)	(0.028)
Constant	1.805***	0.708**	5.547**	7.119***
	(0.615)	(0.344)	(2.760)	(2.009)
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Appendix 5. Robustness checks - Ordinary least squares (OLS) model

- **OLS estimation for the glass packaging**

```
. regress log_EEI lag1 log_Qt log_Qt_square log_PPI log_GDP PET_Glass if group==1
```

Source	SS	df	MS	Number of obs =	804
				F(6, 797) =	663.23
Model	1.81788297	6	.302980495	Prob > F =	0.0000
Residual	.364087573	797	.000456823	R-squared =	0.8331
				Adj R-squared =	0.8319
Total	2.18197054	803	.002717273	Root MSE =	.02137

log_EEI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lag1	.6942628	.0188862	36.76	0.000	.6571904	.7313353
log_Qt	2.27e-07	2.27e-08	10.00	0.000	1.83e-07	2.72e-07
log_Qt_square	-1.26e-13	2.47e-14	-5.09	0.000	-1.74e-13	-7.71e-14
log_PPI	-.7744038	.3626126	-2.14	0.033	-1.486192	-.0626152
log_GDP	-.0065138	.0466323	-0.14	0.889	-.0980505	.0850229
PET_Glass	.0000353	.0008445	0.04	0.967	-.0016223	.001693
_cons	.1946508	.7560697	0.26	0.797	-1.289472	1.678774

```
. regress log_EEI lag1 log_Qt log_Qt_square log_PPI log_GDP PET_Glass if group==2
```

Source	SS	df	MS	Number of obs =	353
				F(6, 346) =	422.77
Model	36.539212	6	6.08986867	Prob > F =	0.0000
Residual	4.98406231	346	.014404804	R-squared =	0.8800
				Adj R-squared =	0.8779
Total	41.5232744	352	.117963848	Root MSE =	.12002

log_EEI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lag1	.6404096	.0264317	24.23	0.000	.5884226	.6923966
log_Qt	1.34e-06	1.13e-07	11.78	0.000	1.11e-06	1.56e-06
log_Qt_square	-2.84e-13	2.71e-14	-10.48	0.000	-3.37e-13	-2.31e-13
log_PPI	-6.935527	1.488088	-4.66	0.000	-9.862364	-4.008689
log_GDP	.013854	.0062752	2.21	0.028	.0015116	.0261964
PET_Glass	-.0014538	.0075769	-0.19	0.848	-.0163564	.0134488
_cons	.5561149	.1815868	3.06	0.002	.198962	.9132678

```
.
```

- **OLS estimation for the PET plastic bottles**

```
. regress log_EEI lag1 log_Qt log_Qt_square log_IPM log_VMP log_GDP Polys_PET Glass_PET if group==1
```

Source	SS	df	MS		
Model	.72306955	8	.090383694	Number of obs	= 547
Residual	.117528403	538	.000218454	F(8, 538)	= 413.74
				Prob > F	= 0.0000
Total	.840597953	546	.001539557	R-squared	= 0.8602
				Adj R-squared	= 0.8581
				Root MSE	= .01478

log_EEI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lag1	.6367142	.0308447	20.64	0.000	.5761235	.697305
log_Qt	-.006776	.000844	-8.03	0.000	-.0084341	-.005118
log_Qt_square	.0006802	.000065	10.46	0.000	.0005525	.0008079
log_IPM	-.0035996	.0119603	-0.30	0.764	-.0270943	.019895
log_VMP	-.0073977	.0058182	-1.27	0.204	-.0188269	.0040315
log_GDP	-.0353859	.0286323	-1.24	0.217	-.0916307	.020859
Polys_PET	.0015466	.00356	0.43	0.664	-.0054465	.0085397
Glass_PET	-.0102598	.0113776	-0.90	0.368	-.0326098	.0120901
_cons	.6458456	.482747	1.34	0.182	-.3024545	1.594146

```
. regress log_EEI lag1 log_Qt log_Qt_square log_IPM log_VMP log_GDP Polys_PET Glass_PET if group==2
```

Source	SS	df	MS		
Model	9.9993235	8	1.24991544	Number of obs	= 294
Residual	1.53190443	285	.005375103	F(8, 285)	= 232.54
				Prob > F	= 0.0000
Total	11.5312279	293	.039355727	R-squared	= 0.8672
				Adj R-squared	= 0.8634
				Root MSE	= .07332

log_EEI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lag1	.4429262	.0449688	9.85	0.000	.354413	.5314393
log_Qt	-.0380271	.0054227	-7.01	0.000	-.0487007	-.0273535
log_Qt_square	.0046408	.0004871	9.53	0.000	.003682	.0055996
log_IPM	.1504058	.069671	2.16	0.032	.0132707	.2875409
log_VMP	-.1865078	.0696721	-2.68	0.008	-.3236449	-.0493707
log_GDP	-.012669	.0077249	-1.64	0.102	-.0278742	.0025361
Polys_PET	.0908136	.030032	3.02	0.003	.0317009	.1499262
Glass_PET	-.2026826	.054527	-3.72	0.000	-.3100093	-.0953558
_cons	.9349951	.3863159	2.42	0.016	.1746008	1.695389

Appendix 6. Example of the eco-modulation strategy

Packaging material	Quantity generated on the market (kg)	Recycled content (%)	Virgin content (%)	Tax on recycled material ($/kg)	Tax on virgin material ($/kg)	Bonus/Malus
PET plastic bottles	Q1	100%	0%	A	X	Q1*A
	Q2	50%	50%	B	Y	Q2*B*0,5 + Q2*Y*0,5
	Q3	0%	100%	C	Z	Q2*Z

Note: The tax on recycled material is lower than that on virgin material. For example, integrating 100% of the recycled content in packaging provides a bonus on the financial contribution to the recycling program. Conversely, using only a virgin content entails paying a malus or a penalty. But this should be adjusted according to the material recyclability and the industry peculiarities.

Chapter 5
Conclusion

The research carried out in this thesis sheds new light on the organizational buying decision of packaging, and more particularly sustainable one. In fact, packaging implies a complex decision which remains very little explored in the current literature. The main objective of the thesis is to fill this gap by making relevant contributions in this direction. The thesis has the following research objectives: (1) explore the organizational buying behavior of packaging by investigating the buying center structure, the buying decision process, the influencing factors, and buying decision criteria (Chapter 2); (2) identify, assess, and synthesize the relevant literature on the drivers, barriers, and performance outcomes of sustainable packaging practices (Chapter 3); (3) examine the effectiveness of the packaging tax policy on the reduction at source of packaging (Chapter 4). To meet these research objectives, the thesis was structured into three research projects, including one conceptual and two empirical. Each of these projects presents its own conclusions and research perspectives which will not be repeated in detail in this chapter to limit redundancy. This chapter provides a concluding discussion, summarizes the main contributions and limitations of the thesis, and proposes some research perspectives.

5.1. General discussion and theoretical contributions

The thesis makes an important contribution to the emerging literature on organizational buying decisions of product packaging. Based on the main findings from the three research projects, we developed the comprehensive framework in Figure 5.1. Packaging for strategic products (i.e. high profit impact and high risk) requires an advanced level of customization, which in turn adds complexity to the buying centre structure and to the buying process. Multiple and sometimes conflicting decision-making criteria come also into play when choosing packaging for these products. Hence, the actions to improve packaging sustainability may differ between products categories. However, integrating sustainability as a decision criterion is more likely to be seen in large consumer-oriented firms. Given their size, awareness of regulations and consumer preferences, as well as their environmental capabilities and resources, large consumer-oriented firms can make more and better choices of sustainable packaging to achieve a competitive advantage and strengthen brand image. Whereas smaller firms do not consider packaging as a major issue and are mainly influenced by cost considerations. The costs associated with the implementation of sustainable packaging practices are significant for smaller firms with

fewer resources. This suggests that more dedicated incentives should be developed for these firms. Regulation can be the initial trigger to start thinking about new ways of acting so that either larger or smaller firms can embark in reducing packaging waste.

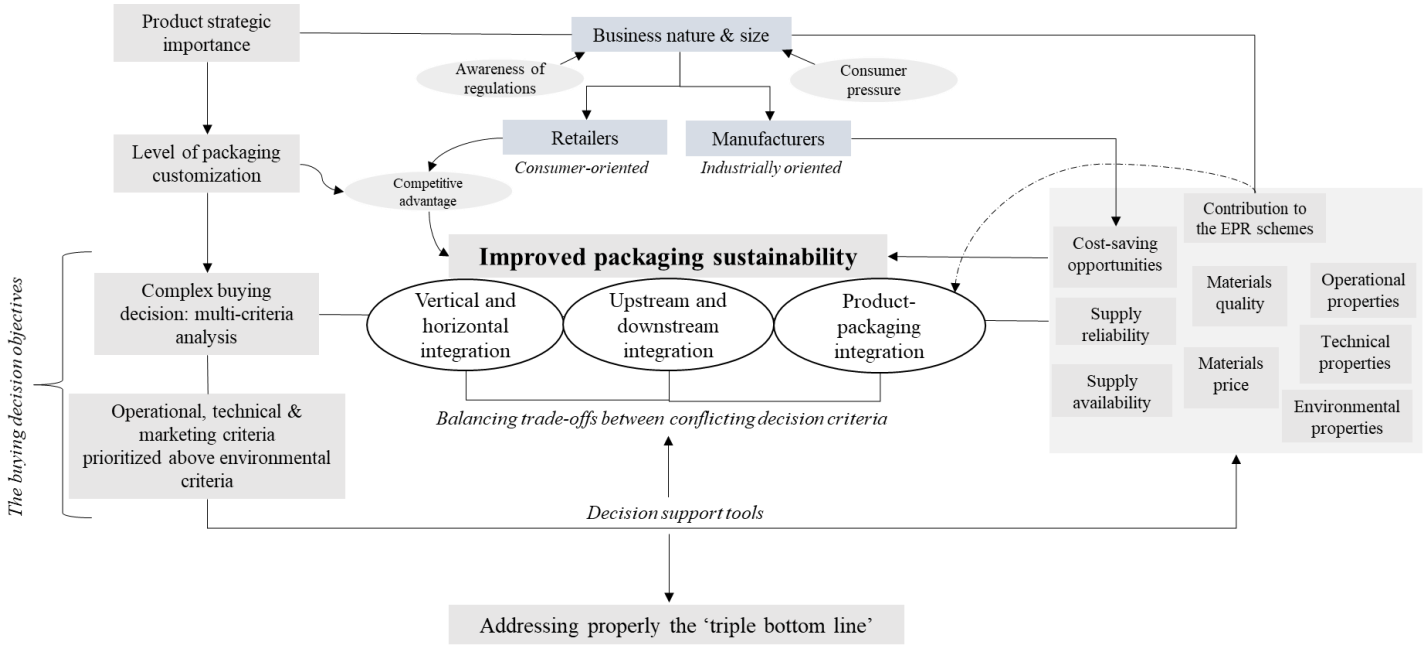
Once packaging buyers decide to improve their packaging sustainability, this requires a complex analysis between competing marketing, logistics, and environmental requirements. Another layer of complexity is added for food products because of their limited shelf life. The sensitivity of these products often leads packaging buyers to prioritize operational, technical, and marketing criteria above environmental criteria. Even though packaging buyers may try to choose eco-friendlier packaging materials for these products, they need to consider other important decision criteria such as their supply availability and reliability, their operational and technical properties as well as their cost and process quality. This enables reducing the overall cost impact of packaging and allows achieving a positive operational performance outcome. However, the decision criteria may be contradictory and are contingent to the supply chain actor. For instance, manufacturers aim to source low-priced packaging materials, while retailers are inclined to choose more expensive packaging materials to promote sales and acquire a sustainable competitive advantage.

To address these potential conflicts and improve packaging sustainability, integrated packaging decisions at three different levels are needed. First, a vertical and horizontal integration given that not only the cross-functional teams in the firm need to be involved, but also relevant supply chain stakeholders such as suppliers and end-consumers. Second, an integrated approach both at the upstream level, between actors involved from raw material extraction to products end-consumption, and at the downstream level between actors involved from the point where packaging becomes waste to its disposing, recycling, or reusing stages. This approach would provide a more accurate picture of the true trade-offs between packaging decision criteria. Third, a product-packaging integration, which is an effective approach to avoid over or underpackaging and ensure product quality and integrity throughout the distribution chain. An effective packaging tax policy would enable more integrated product-packaging. Since the tax is charged on a weight basis, packaging buyers are inclined to seize the opportunity of reducing their costs by using advantageous packaging materials from an operational, environmental, and technical point of view.

Using more comprehensive decision support methods and tools such as a lifecycle assessment (LCA) would help packaging buyers to balance the trade-offs between conflicting requirements and ensure that the decision taken is fulfilling all important buying decision criteria. This enables obtaining cost-efficient packaging with minimal environmental impact across the entire supply chain. In sum, the above-mentioned

approaches would ensure that packaging decisions are properly addressing the three mandates in the triple bottom line, namely the sustainable protection of the natural environment as well as the economic and the social viability of the decisions taken.

Figure 5.1. Comprehensive framework of the thesis



5.2. Managerial and public policies contributions

The empirical research carried out in this thesis focused on the food industry which is characterized by a high and consistent flow of packaging. It features a wide variety of products with different degrees of perishability and therefore an increased consumption of packaging. Several managerial and public policy implications stem from this work.

On the managerial level, three contributions result from this thesis. First, there are potentially divergent criteria that buyers must balance to achieve an optimal product-packaging combination. This entails a coordinated approach combining specialized skills of internal and external buying partners. However, the sensitivity of food products often leads packaging buyers to prioritize operational, technical, and marketing criteria above environmental criteria. Besides, the decision criteria are perceived differently by the buying centre members according to their positions. To help addressing this challenge, a multi-criteria analysis grid has been proposed to increase the buying decision efficiency while streamlining communication between the buying center partners. Second,

developing a sustainable packaging that meets all stakeholder's requirement, ensuring product quality and integrity, and preventing waste production, entails an integrated approach at three different levels: vertical and horizontal; upstream and downstream; and product-packaging integration. Third, packaging buyers are inclined to bear high taxation for packaging that is advantageous from an operational, environmental, and technical point of view. This provides packaging buyers with the opportunity to reduce the overall cost impact of packaging in the supply chain and throughout product life cycle.

On the public policy level, three recommendations have been proposed to strengthen the effectiveness of the packaging tax policy and thereby encourage packaging buyers to adopt sustainable packaging practices. First, varying taxes depending on the recyclability of packaging materials is proving to be an effective strategy. To this end, an alternative taxation policy (i.e. eco-modulation strategy) has been proposed to encourage the adoption of more environmentally friendly packaging materials. This strategy could present packaging buyers with a strong upstream incentive to incorporate recycled content into their packaging, and thereby reduce the subsequent packaging waste. Second, policymakers should promote clear strategies on environmentally friendly packaging materials. The development of a more restrictive regulatory framework for the integration of recycled content would be encouraged when the availability of recycled materials would no longer be an issue for firms. This regulatory framework should be combined with personalized training actions to support managers in overcoming the technical challenges related to the recycled content integration into product packaging. Third, the development of decision support tools would give managers the opportunity to assess and compare the effects of different packaging materials. In the same vein, it is interesting to develop quantitative indicators for the performance of these materials, such as circularity and recyclability indicators. This would promote more sustainable packaging practices by allowing packaging buyers to choose environmental materials and thereby benefit from favorable financial contribution to recycling schemes.

5.3. Methodological contributions

Methodologically, the thesis relied on a multi-method approach combining the richness and grounded understanding of qualitative research methods, the robustness and objectivity of quantitative research methods as well as a conceptual approach. Previous studies that have examined the effectiveness of the packaging tax have used mainly surveys, simulations, and economic analysis. Very few studies relied on longitudinal data (Cela and Kaneko, 2011; Cela and Kaneko, 2013). This thesis makes a significant contribution in this direction by relying on a mixed methodological approach combining the analysis of quantitative longitudinal as well as qualitative data. This approach allows

better interpreting and enriching the analysis of quantitative data and strengthens their potential for generalization (Guba and Lincoln, 1994).

5.4. Limitations

This thesis has three main limitations. First, the empirical research focuses on the behavioural buying decisions of larger firms. However, smaller firms with fewer resources were not investigated. Second, the *Methodi Ordinatio* methodology was applied to rank articles. This method focuses on studies that have more significant impact factor and citations. However, some relevant papers that are not freely available might be read and cited fewer times than papers whose access is free. This implies that the selection of articles included in the review could be different by using another methodology and other information sources. Third, the effect of packaging eco-taxes varies between and within countries with respect to how the regulatory institutions have implemented and communicated the policy. This limits the generalizability of our findings to other industrial sectors and other countries.

5.5. Research avenues

The work carried out within this thesis represents the beginning of a long journey and suggests interesting research perspectives. In addition to the potential avenues suggested in each of the research projects, three research avenues are proposed in this section.

First, regulations on packaging waste management and costs for non-compliance are among the most important incentives for adopting sustainable packaging practices. However, packaging buyers have a way to avoid environmental sanctions when they are lower than those generated by adopting these practices. In such a context, the regulatory incentives may fail to meet expected behavioural changes. Moreover, the complexity of regulations and the lack of awareness of packaging legislation could act as important barriers to the adoption of more sustainable packaging practices. Therefore, further empirical investigations should be done to explore which regulatory incentives are more effective to influence nonconforming stakeholders depending on their size, their role in the supply chain as well as product orientation and business nature (i.e. industrial or consumer-oriented firms).

Second, the business-to-consumer electronic commerce is experiencing rapid growth. Transactions through this channel have more than doubled year over year (Gao et al., 2020). The increased sensitivity of consumers to product quality and integrity brings an additional layer of complexity for packaging buyers (e.g. Rizou *et al.*, 2020; Liu *et al.*,

2020; Wang *et al.*, 2020). There are potentially conflicting trade-offs between environmental, logistics, and marketing attributes. Changes to one dimension can affect other dimensions and vice versa (Bernard, 2019), requiring packaging buyers to conduct a complex multicriteria analysis (García-Arca *et al.*, 2014; White *et al.*, 2015). Therefore, it is a major challenge to find a balance between delivering a product in optimal conditions of quality and safety in a lightweight, durable, and attractive packaging (Pålsson, 2018). In this context, some potential avenues of research remain to be explored. First, it is interesting to characterize the potential trade-offs made by packaging buyers between the marketing, logistical, and environmental packaging attributes and to identify those that would increase the consumer's willingness to pay for products purchased online. Second, the Association for Packaging and Processing Technologies (2018: 9) underlines that: "e-commerce packaging is a fundamentally different approach to packaging than standard retail packaging." It is therefore interesting to investigate whether the development of dedicated packaging solutions for the e-commerce channel is necessary to meet the growing challenges of sustainability. This would educate packaging buyers on best practices for e-commerce packaging that maintain the operations efficiency. An experimental approach could be mobilized. The use of experimental methodologies for product development with a decision-maker centered approach has been spreading for several years (Saulais *et al.*, 2017). The experience can place participants in a series of scenarios to choose from alternative product packaging with different combinations of attributes. For example, the experiment can present consumers with two food packaging scenarios: the first packaging can be ecological (e.g. the product/packaging ratio is optimal) but not attractive. While the second packaging can be attractive but not ecological (e.g. the product is over-packaged). This would help packaging buyers to better understand consumer preferences and willingness to pay for different combinations of packaging attributes.

Third, maintaining collaborative relationships in the supply chain would lead to the development of more sustainable packaging practices. Indeed, efficiency is one of the key principles of packaging sustainability. To respond to this principle, different circularity strategies are implemented at the upstream (e.g. packaging eco-design to eliminate waste generation at end-of-life) and at the downstream of supply chain (e.g. keeping packaging materials in circulation through recycling). These strategies involve the engagement of supply chain partners throughout packaging lifecycle, from conception to end of life. In this context, further empirical research needs to be conducted to explore the following questions: What are the mechanisms of collaboration in supply chain that would improve the circularity of packaging? What are the roles of supply chain actors in supporting the transition from a transactional to an interdependence mode? What incentives would accelerate this transition? Are the most effective incentives operational, economic, environmental, or social? A qualitative research methodology could be mobilized to answer these research questions.

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