Doctoral Dissertation

The Danish packaging taxation policy in the case of paper/paperboard and plastic packaging: effectiveness, economical consequences and environmental benefits in the short term

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September 2012

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A Dissertation Submitted to
the Graduate School for International Development and Cooperation
of Hiroshima University in Partial Fulfillment
of the Requirement for the Degree of
Doctor of Philosophy

September 2012

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Chapter 1: Introduction, objective, study significance and structure of disssertation

1.1 Introduction

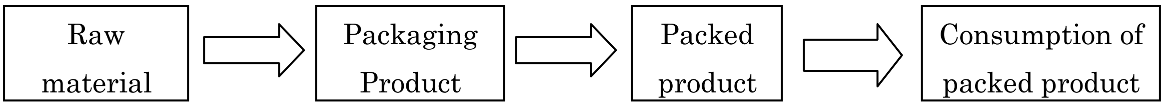
Now-a-days commercialization and trade manifests a rapid increase in the amounts and varieties of commodities supplied to the general public. Every now and then, new products are contemplated, developed, produced and commercialized. As the worldwide society needs increase, the production sectors of the global economy are quick and eager to respond by new products being able to satisfy those needs.

Packaging has become an intrinsic part of the commercialized products in today`s world. Indeed, one can`t think of a single commodity which is place in the market un-packed. The purpose of packaging is not only safe-keeping, but serves as a mean to increase the products attractiveness. Prettying up the product and making it appealing to the costumer`s eyes represents a half realized sale. The product is not sold, the product sales itself in the words of marketing. The packaging is a mean to achieve this objective.

Packaging on the other hand, represents the non-consumable portion of the product. Truly, we purchase food, cosmetics, beverages, tobacco and medicines in packed shape. However, we do not eat, drink, intake or smoke the respective packaging. As it is not consumed, the packaging portion of the product is immediately discarded upon consumption commencing mainly not to be used again. Such implications rise questions to the whole necessity of packaging use and ways to put remedy.

The packaging material and product flow could be summarized as in the following graph:

Graph 1-1: Packaging material and product flow



The flow begins with the raw material necessary to make the packaging product. The raw materials in this case would be: paper, paperboard, glass, various plastics, various metals, textiles, wood etc. It is important to remind that these raw materials are not employed for packaging production alone. From this point, the raw material is purchased by the packaging producing firms that generate the various packaging commodities which vary in terms of material, weight, volume, size and shape. In this group we can mention: paper and paperboard boxes, plastic boxes, bottles, cans, foils, bags etc. Once the packaging commodity is created, the users purchase it. Normally, industries purchase packaging products (industrial packaging) to pack the commodities they produce. However, households do use certain packaging products (consumer packaging) such as: paper and plastic bags, aluminum foils or plastic and paper boxes for household food conservation. The second group is of course in minority. On the other hand, the various industries represent the predominant packaging purchaser. It is important to emphasize that packaging products represent a final commodity to the industrial firms purchasing it.

However, in terms of the final industrial good consumer, the packaging represents the non-consumable portion of the commodity they buy.

The European Union area and to be more precise, the EU-15 area represents a major packaging consuming block. Especially in the 90s and 2000s, packaging consumption has developed an increasing trend both in terms of quantities and consumption per capita. In table 1.1 are shown the figures for total non-wood packaging placed in the EU-15 area and in the respective countries for the period 1998-2006:

Table 1.1.1: Total non-wood packaging placed in EU-15 member states (000 tons)

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Austria	1,055	1,070	1,100	1,027	997	1,099	1,039	1,042	1,089
Belgium	1,284	1,320	1,284	1.266	1.324	1,448	1,445	1,467	1,475
Denmark	838	846	852	865	857	849	855	862	865
Finland	424	443	443	457	451	463	446	483	471
France	9,945	10,098	10,389	10,223	10,207	10,094	10,088	10,143	10,362
Germany	12,122	12,472	12,765	12,650	13,053	12,958	13,198	13,063	13,500
Greece	795	856	890	930	951	969	986	1.007	996
Ireland	683	704	795	820	850	720	740	804	915
Italy	8,796	8,718	8,689	8,730	8,764	8,967	9,202	9,165	9,368

Luxem.	77	79	80	79	85	81	84	90	96
Nether.	2,525	2,593	2,483	2,586	2,719	2,785	2,774	2,816	2,897
Portugal	1,025	1,143	1,199	1,236	1,298	1,323	1,339	1,373	1,646
Spain	5,628	5,642	5,992	5,951	6,374	6,658	6,696	6,856	7,061
Sweden	955	972	977	1,010	1,029	1,030	1,057	1,072	1,118
U.K.	8,944	8,860	8,510	8,644	8,499	8,655	8,826	8,876	9,291
Total	55,096	55,816	56,448	56,474	57,458	58,099	58,775	59,119	61,150

Source: EUROPEN, 2009

In the period 1998-2006, the amount of non-wood packaging placed in the EU-15 area market has increased by 11% translated into 1.4% per annum (considered to be a mild increase). Of course, performance varies across the member states with most countries experiencing gradual increases over the years. Furthermore, we provide figures in terms of per capita packaging use by country (Table 1.1.2):

Table 1.1.2: Per capita non-wood packaging consumption in EU-15 member states (in kg)

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Austria	132	134	137	128	124	136	128	127	132
Belgium	126	129	125	123	128	140	139	140	140

Denmark	158	159	160	162	160	158	158	159	159
Finland	82	86	86	88	87	89	85	92	90
France	166	168	172	168	166	163	162	162	164
Germany	148	152	155	154	158	157	160	158	164
Greece	74	79	82	85	87	88	89	91	90
Ireland	185	189	210	214	218	182	184	196	217
Italy	155	153	153	153	154	156	159	157	159
Luxem.	182	185	184	180	191	181	185	195	205
Nether.	161	165	157	162	169	172	171	173	177
Portugal	101	113	118	121	126	127	128	130	156
Spain	142	142	150	147	156	160	158	159	161
Sweden	108	110	110	114	116	115	118	119	124
U.K.	153	151	145	147	144	146	148	148	154
Average	147	148	150	149	151	152	153	153	157

Source: EUROPEN, 2009

Per capita consumption has increased by 6.8% over the period translated into 0.85% steady increase per annum. It is quiet interesting to see that the smaller countries (in terms of population and economic activity) exhibit the higher values of packaging consumption per capita (like Denmark, Luxembourg, Ireland). The next table (Table 1.1.3) shows EU-15 consumption figures by type of non-wood packaging:

Table 1.1.3: Packaging consumption (000 tons) and per capita consumption (in kg) by packaging category in the EU-15 market

Category	1998	1999	2000	2001	2002	2003	2004	2005	2006
Paper	25,203	25,729	26,380	26,282	27,010	27,245	27,572	27,654	28,706
	(67)	(68)	(70)	(69)	(71)	(71)	(72)	(71)	(74)
Plastic	9,856	10,094	10,295	10,708	11,146	11,536	11,972	12,364	13,138
	(26)	(27)	(27)	(28)	(29)	(30)	(31)	(32)	(34)
Glass	15,149	15,379	14,903	14,613	14,458	14,666	14,608	14,516	14,744
	(40)	(41)	(40)	(39)	(38)	(38)	(38)	(37)	(38)
Metals	4,580	4,417	4,628	4,631	4,614	4,457	4,456	4,392	4,391
	(12)	(12)	(12)	(12)	(12)	(12)	(12)	(11)	(11)

Source: EUROPEN, 2009

According to Table 1.1.3, paper and paperboard packaging exhibits the highest consumption amongst the packaging categories. The total packaging consumption has been increasing and at the same time has per capita consumption. Plastics and glass share common portions. Plastic consumption on the other hand has developed a rapid increase in the period 1998-2006. The share of glass exhibits a decrease in the period since year 2000. Metals are in the bottom of the table both in terms of total and per capita consumption.

The increased packaging consumption implies inevitably increased packaging waste generation. The more packaging is used, the more waste is generated for it. Certainly, packaging recycling occurs enabling the re-introduction of the commodity in the production process. However, the waste problem persists and European member states have pursued from time to time responsive action in the facilitation of the packaging waste problem. Some of these response policies are reviewed in the next section.

1.2 European packaging policy – past and present

European Union members begun addressing the packaging consumption and packaging waste problem back in the 1970s and 1980s (Brisson, 1993). Especially, in the late 1980s and early 1990s, the packaging policy gained increased momentum as the major developments occurred (Pearce and Turner, 1993). Policies included regulatory approach in the form of command-and-control policies (in the case of Germany, the Netherlands, Belgium, France and the UK). Other countries have chosen market based instruments (Austria, Denmark, Finland, Sweden, Portugal, Switzerland and Norway). In several cases, the states have applied a dual system of both regulatory and policy based instruments (Germany, France, UK, Belgium). Let us have a look at some of these policies.

A European example of command-and-control packaging policy is the German Packaging Directive of 1991 (Klepper and Michaelis, 1991). The importance is not only related to the content which is very far reaching but also to the fact that other countries have used the German directive as a model for their own policies (Brisson, 1993). The directive addressed the issue of packaging weight (to be reduced as much as possible), refillability (pursued to the limit of what is economically feasible) and reprocessing (when refilling is not possible). The directive covers:

-transport packaging – defined as the packaging used for protecting the packaging on the way from the producer to the sales outlet (Brisson, 1993);

-secondary packaging – defined as packaging applied to provide protection from theft and achieve consumer attraction;

-primary packaging – packaging required by the consumer for protecting and transporting the product.

In the case of primary packaging, a deposit refund system was introduced for beverage, detergent and paint containers (deposit set between 0.5 and 2.0 German Marchs, currency used at the time). That created a dual system for the primary packaging with both a standard and a market based instrument overlapping.

The directive was contemplated considering the relative un-availability of landfills within German territory and the people`s unwillingness to accept waste disposal facilities close to their living quarters. The directive was set to include all packaging types belonging to both consumer and industrial use. Two sets of targets were established for the years 1993 and 1995 with very harsh collection and re-processing limits (Brisson, 1993). The targets were set on the assumption that re-use and reprocessing were desirable occurring without any prior consideration to the general costs that these policies would impose especially on the industrial sector.

In the Netherlands, the policy addressed the waste generation potential of packaging (Ministry of Housing, Physical Planning and Environment, 1991). The command-and-control policy established in the late 1980s aimed at the reduction of landfill waste from packaging. According to the target, the amount of packaging waste landfilled in 1997 had to be reduced to 40% of the 1986 landfilled amount. In year 2000, no packaging waste was to be landfilled. Furthermore, the Dutch Packaging Industrial Chain agreed to reduce the amount of virgin packaging (new packaging placed into the market) by 10% in year 1997 compared to the 1991 level. At the same time a 50% overall target was set for reprocessing (in year 1997). The introduction of new technologies with the aim of producing lighter and thinner packaging was the cornerstone of achieving the agreed targets. The difference compared to the German directive was that the target could be re-negotiated should the costs turned to be unacceptable.

In other European countries, the packaging policy was imbedded within a more general waste policy (Pearce and Turner, 1993). Belgium set a 30% of waste to be recycled by year 1995 target with the balance to be incinerated and landfilling used only as last resort. The UK set a target to recycle 50% of all recyclables by year 2000. France set an undated 50% recycling target involving either material recycling or energy recovery. In all, cases the policies produced positive outcomes in the sense of increased packaging recycling rates (EUROPEN, 2009). The command and control policies applied in the different European countries are summarized in Table 1.2.1:

Table 1.2.1: Summary of packaging command and control policies in Europe

Country	Targeted packaging commodity	Policy	Target
Germany	All packaging	- Weight reduction as much as possible; - Refillability until economically feasible; - Reprocessing when possible	Packaging producers and final consumer
Netherlands	Beverage packaging	- 40% of landfilled packaging waste by	Final consumer

		1997 compared to 1986 level; - No more landfilling from year 2000 - 10% reduction of virgin packaging by 1997 compared to 1991 level; - 50% reprocessing target	
Belgium	Beverage packaging	-30% of packaging waste to be recycled by year 1995	final consumer
UK	Recyclable packaging	-50% recycling target by year 2000	Final consumer
France	Beverage packaging	-50% packaging material recycling (undated)	Packaging producers

Another group of countries chose the application of market based policies including deposit refunding, recycling credits and eco-taxation. In the case of the UK, a recycling credit scheme was introduced in 1990 for stimulating the recycling rate of household waste.

The credits (payments) were allocated to households proving the ability to increase the recycling rate of certain materials including plastics, metals, paper and glass.

In Denmark two different policies were applied. In 1978 the country introduced the first product charge (tax) for beer, carbonated soft drinks and juice containers. In 1988 an amendment included milk cartons to the policy scope. The purpose was to stimulate re-use and refill of beverage containers as opposed to the one-way use. Additionally, the country set up a deposit-refund system for PET bottles to encourage return by consumers.

Austria applied a deposit-refund system for refillable beverage containers. In the case of Finland, the approach combined a product charge for non-returnable beverage containers and a deposit-refund system for the refillables. Product charges were also applied in Italy for non-biodegradable plastic bags and in the Netherlands for non-recyclable packaging. For beverage containers, product charges were applied in the cases of Norway, Portugal, Sweden and Switzerland. The same countries also applied deposit-refund systems mainly for refillable beverage containers. Germany begun the application of a deposit-refund system for beverage containers but later the policy was extended to include other packaging as well

Clearly, the early market-based packaging policies addressed mainly beverage containers considering their extensive use in every-day life and increasing associated waste generation problem. Apart from the case of Germany, the policies did not include non-beverage packaging. However, this was just a prelude of more elaborated policies to come. In all these countries (with the exception of Denmark), market based policies were combined to command and control instruments. Generally, there has been improvement in terms of higher recycling rates. However, it is assumed that most credit goes to the larger policy (the command and control). Table 1.2.2 summarizes market based instruments applied on packaging commodities in the European countries:

Table 1.2.2: Summary of packaging market based instruments in European countries

Country	Targeted packaging commodity	Policy	Target
Germany	Beverage, detergent and paint containers	- Deposit refund system	Final consumer
UK	Household packaging waste	- Recycling credit scheme	Final consumer
Denmark	beer, carbonated soft drinks and juice containers, milk cartons, PET bottles	- weight base tax; - deposit refund system in the case of PET bottles	Taxation on industrial users; deposit-refund on final consumer
Austria	Refillable beverage	- Deposit-refund	Final consumer

	containers	system	
Finland	Non-returnable and refillable beverage containers	- deposit refund system; - product charges	Final consumer
Netherlands	Non-recyclable packaging	- product charges	Industrial users
Italy	Non-biodegradable plastic bags	- product charges	Final consumer
Norway, Portugal, Sweden, Switzerland	Beverage containers	- product charges	Final consumer

In 1994, the European Commission promoted the Directive 94/62/EC on packaging and packaging waste (see Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste, Eur-lex, 2010). The purpose of this directive was to provide a new stimulus in the field of policy promotion for packaging waste reduction. At the same time, the Commission feared the disparities in legislation between the member states (Bailey, 2002). The directive was sought as an attempt for harmonization. In respect to the member countries` sovereignty, the policy did not indicate which measures to apply leaving the choice right to the states. On the other hand, the directive suggests the application of market based instruments as more efficient means of achieving environmental targets.

As a result, packaging policy in Europe flourished (EUROPEN, 2000) to include not only the traditional field of beverage containers but expand to other packaging categories as well. Furthermore, new EU members embarked in the path of packaging policy (the case of Hungary, Estonia, Latvia). Of particular interest is the rapid spread up of eco-taxation. Belgium introduced a volume based taxation system for industrial packaging for solvents, inks, glues and pesticides. Hungary applied a weight basis taxation system for non-reusable packaging including plastics, composites, paper, aluminum, glass, wood, tinplate and textiles. Norway remained in the beverage containers field but expanded the tax system to other container types. Latvia applied a weight based taxation system for all consumer goods and foodstuff packaging (industrial packaging) with the rate depending on the packaging type.

The country where packaging eco-taxation exhibited remarkable developments was Denmark. Indeed, the new policies introduced in late 1999s and early 2000s, managed to expand taxation coverage to include all packaging categories (EUROPEN, 2000). More specifically, the new taxation maintained the previous taxation systems for beverage containers. At the same time, two additional taxation systems were introduced. The first advocated the application of a weight based charge on non-reusable shopping bags made of plastic and paper for a capacity exceeding 5 liters. Additionally, a weight-base product charge taxation system was introduced for packaging applied predominantly but not exclusively to dairy products, foodstuffs and household products like toiletries, paints and cleaning agents. The purpose of the product charge is to reduce the demand for virgin packaging either through direct reduction of packaging use and/or increased recycling.

1.3 Objectives, significance of study and dissertation structure

The study presented in this dissertation is structured to rotate around the Danish latest policy. As mentioned in the previous section, three separate taxation system policies are operated in the country. The focus of this analysis however is constrained to the third system: the weight basis policy applied on the packaging used primarily for diary products, foodstuffs and certain household products being the newest policy in the country.

Regarding packaging category, the analysis is not going to cover all kinds of packaging but is going to focus on two main categories: paper/paperboard and plastics. The choice of paper/paperboard relates to the fact that the category is top ranked both in terms of quantity used and per-capita consumption. On the other hand, plastic packaging shares have been rapidly increasing and the same applies to per capita consumption (see section 1.1). The other two major packaging categories *i.e.* glass and metals are mainly used in the field of beverage containers for which a volume based taxation system applies. The choice of paper/paperboard and plastics has also another reason which we are going to discuss in the next chapter.

Furthermore, Denmark is a predominantly importer of packaging (Danish Statistics, 2010). Very little of the domestically consumed packaging is produced in the country. Therefore, ours analysis is going to focus only on Danish imported packaging.

The main objective of the study is the determination of the policy effectiveness in each case: paper/paperboard and plastics. Considering that the Danish policy law does not specify any particular target regarding to demand reduction and/or increased recycling, any reduction in the demand for virgin packaging is going to be considered as effective outcome. On the other hand, if the demand does not respond to the policy, the outcome would be considered as non-effective. Separate analysis is to be conducted for paper/paperboard and plastic packaging. As the analysis deals with packaging imports, import demand modeling is going to be the chosen approach.

Additionally, when the policy effectiveness is confirmed, the determination of the economical consequences would represent the next objective. Truly, effectiveness would be translated as reduced Danish imports of packaging (either paper/paperboard or plastic or both of them). Therefore, we are confronted with a symmetrical effect: reduced imports in the case of Denmark and reduced exports in the case of the trade partner country. Both effects are associated with economical consequences experienced on both sides: Denmark and the partner coutry/ies. Reduced imports represent savings in the case of Denmark; on other hand, export decrease represents loss in the case of the partner countries. Due to data unavailability, we are not going to perform a simulation for the purpose of establishing the policy impact (in the case the policy is effective). The analysis of economic costs is to be carried out in terms of packaging unit (ton of paper/paperboard and ton of plastic packaging).

Next, it is also another derived objective of this research to determine the environmental benefits associated with effective policy implementation. Demand reduction in the case of Denmark would mean reduced waste generation. In the case of the exporting country, reduced exports mean induced reduction in externalities associated with the production of the "non-exported" commodities *i.e.* emissions. The calculation of such environmental benefits preferable in monetarized manner represents the third objective of the study.

In the case of Danish export partners, two opposite effects occur should the Danish policy be effective: on one hand their exports decrease and this is a loss; on the other hand they experience environmental benefits in terms of reduced emissions and this is a gain. It would be interesting to evaluate the net benefits (or net losses) accruing to the exporting countries. This would be the fourth objective of the study.

The last objective of the study is supplying alternative policy should the Danish actual one proves unsuccessful. If the policy is deemed as unable to reduce Danish packaging demand, an alternative one/s is/are going to be advanced. Furthermore, the study is going to determine what were going to be the consequences if Denmark instead of its present policy, had applied the one suggested. That would be the fifth objective of the study.

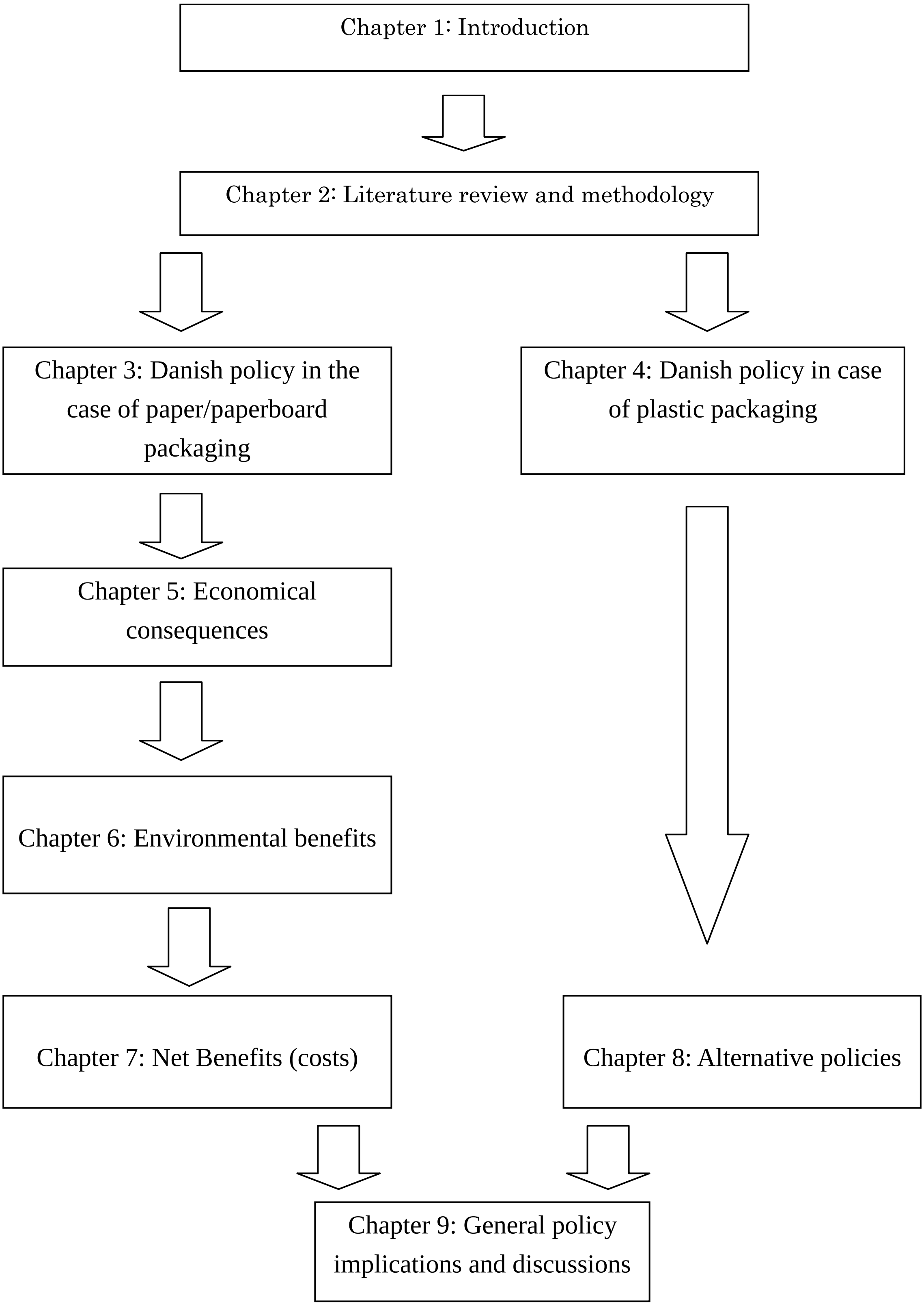
The lack of literature in the matter would be a first reason for this analysis to be conducted. Indeed, being that the Danish policy is relatively new, it has been prone to only marginal and tangential analysis. That is also related to the fact that the application of product charges for environmental purposes in the case of packaging represents a “new” undertaking with very few cases of application. Denmark is therefore a model and pioneer. Also, eco-tax analytical studies are mostly concentrated around issues related to emission reduction with taxes coming in the form of emission charges or levies. Product charge literature remains relatively thin and undeveloped.

The literature discrepancy is also experienced in the field of economical consequences associated with the application of eco-taxation. That is particularly true in the case of packaging taxation and more especially product charges. However, in order to judge on the overall impact of the policy, it is very important to fully realize the induced processes (being both economical and environmental) associated with policy effective application. Contemplating the nature and amount of induced costs, benefits and the difference between the two represents a fundamental issue in the overall policy judging, suggestion of changes and proposition for future application.

Another important issue in terms of significance is connected to the policy draw-backs. Evidencing the possible short-comings that a policy might have or exhibit in certain circumstances under pressure of certain factors would be an important element in the suggestion of policy implications for future applications.

The dissertation is structured to include overall eight chapters including the actual one. The next chapter is going to include the necessary literature review altogether with the analysis methodology and expected results. Chapters 3 and 4 deal with determining the policy`s effectiveness: chapter 3 concentrates around the paper/paperboard packaging demand whilst chapter 4 around plastic packaging demand. Chapter 5 investigates the economical consequences in the case when the policy was effective in reducing packaging demand. In chapter 6 are estimated environmental benefits in the case of Denmark and the partner exporting countries again in the case of effective policy. In chapter 7, economical costs and environmental benefits are compared for the purpose of determining the net effect. Chapter 8 is dedicated to the policy alternatives and countermeasures in the case of non-effectiveness. Finally, chapter 9 summarizes the study`s results providing a discussion on policy implications and supplying a special section for the limitations and possible future prospects. The structure of the dissertation is revealed in Graph 1-2

Graph 1-2: Dissertation structure



Following chapter 2 which deals with the literature review and the methodology, the dissertation divides into two separate streamlines. The first one includes chapters 3, 5, 6 and 7 dealing with the case of paper/paperboard packaging. In chapter 3, we investigate the policy effectiveness in the case of paper/paperboard packaging. The policy is proven effective in this case meaning an import demand reduction for paper/paperboard packaging. Having established this fact, we continue to chapters 5 and 6 with the derived objectives: economical consequences and environmental benefit determination respectively. In chapter 7, the findings of chapters 5 and 6 are combined to reveal and net benefits (or costs) that derive from demand reduction in Denmark. The cost-benefit analysis is carried out according to three scenarios and in all cases, costs overwhelmingly surpass the benefits.

The second streamline includes chapters 4 and 8 dealing with plastic packaging. In chapter 4, we determine the policy effectiveness in this case particular case concluding that the policy was ineffective in reducing plastic packaging import demand in Denmark. Consequently, in chapter 8 we provide policy suggestions that could produce positive outcomes in terms of reduced packaging demand.

Finally, the two streamlines converge once again into chapter 9 which invokes the policy implications and discussions. In this chapter, we first discuss on the general limitations concerning our investigations and prompt on possible future research plans. Limitations will be associated with the general approach, the methodology, the data employed, the conclusion and the general application of these conclusions. Next, we will provide an overview of the general conclusions that are derived from our research and the possibility to generalize them to other countries (especially fellow European countries). Finally, we focus on the policy implications that are associated with the effectiveness and outcomes (economical and environmental) sourcing from the application.

As a final word for this introduction, we feel it is important to emphasize certain contributions of this investigation. First, the investigation focuses on a stand-alone market based instrument. As mentioned in the previous section, in many European countries market based instruments were complimentary of command and control target set in advance. In the end, although the objectives were reached, it was very difficult to attribute the credit as it was hard to separate the effects of the two policies (Brisson, 1993). By default, it is assumed that the most of the merit goes to the larger policy (the command and control) however this is a statement to be considered with caution. On the other hand, in our case study, there is only a taxation instrument being applied without a command and control policy circumventing it. Therefore, in this case we are able to determine the effectiveness of the market based instrument alone.

Secondly, the investigation focuses on a packaging taxation policy which is applied in rare cases. As we mentioned earlier, most market based instruments include deposit-refund systems for mainly beverage packaging and burdened on the final consumer. In this case, there is a packaging tax burdened on the industrial users and it is in the case of non-beverage packaging. As the literature in this case lacks, it is very important to determine the policy effectiveness and consequences for the sake of future possible applications by other countries. As a matter of fact, as we are going to point out in the next chapter, the European countries are moving towards Environmental Taxation Reforms and it is expected that in the future the bulk of environmental policies is going to be taxation policies (that includes packaging and packaging waste policy). In this sense, policy makers have to realize how the policy works in actual cases before suggesting it to a larger scale and a larger region (the EU as a whole).

Finally, the investigation contributes in identifying possible consequences associated with an effective policy, in particular actual and possible side-effects. An effective policy within Denmark (an EU country) does not represent the whole story. As we are going to show in the next chapter, EU environmental policies in the past have been characterized with certain draw-backs. In particular, emission reduction policies (particularly for CO2 emissions) have been associated with a carbon-leakage effect and possibly with a pollution heaven occurrence. These undesirable experiences could occur again the future and packaging is seldom prone.

With these last remarks we conclude the first chapter of introduction moving to the second one. Chapter 2 deals with the literature review and methodology explanations. We will first begin with the literature on packaging and more general EU environmental policy.

Chapter 2: Literature review, methodology and expected results

2.1 Literature Review

2.1.1 The Environmental Tax Reform in the European continent

The application of eco-taxation in packaging spurred at a moment when larger developments also related to environmental taxation were characterizing the European continent. As a matter of fact, eight European countries, namely Denmark, Finland, Germany, Italy, the Netherlands, Norway, Sweden and the UK embarked in the so-called Environmental Tax Reforms (ETR) (Bosquet, 2000). These reforms called for a shift of taxation burden from economical mediums such as employment, income and profit towards environmentally related bases: such as pollution, emissions, waste, resources etc (von Wizsächer and Jesinghaus, 1992). Other terminologies applied are Green Tax Reform (Goulder, 1995), Environmental Fiscal Reform (Carraro and Siniscalco, 1996) and Green Tax Swap (Hamond et al., 1997). This taxation swap was introduced on the basis of achieving a double-dividend (Busquet, 2000): eliminating tax related inefficiencies possibly affecting employment and income while internalizing environmental externalities and providing incentives for improving environmental performance.

Sweden was the first country to embark in the reform as early as 1990 with taxation shift from personal income, energy taxes on agriculture and continuous education towards CO_2 and SO_2 emissions (Bosquet, 2000). The accumulated revenues amounted to almost 2.4%

of GDP. In the case of Denmark taxation was raised on gasoline, cars, water, electricity and also CO_2 and SO_2 emissions. Accumulated revenues reached 6% of total revenues by year 2002 (Klok et al., 2004). Similarly, the Netherlands, Norway and Finland raised taxes on CO_2 emissions (in the case of Norway also SO_2) emissions (Busquet, 2000; Wright and Mallia, 2003). On the other hand, Germany and Italy began applying eco-taxation on petroleum products (OECD, 1999).

An ample literature exists on the effects of ETR in assuring both environmental and economical efficiency. Bosquet (2000) reviews 139 modeling simulations of ETR application concluding that significant gains are achieved in terms of emission reduction with marginal gains in employment. In the short and medium term, some marginal loss in terms of economic activity is to be expected with investment decreasing and prices increasing moderately. To be noted is the fact that the double dividend is achievable particularly in the case of distorting labor taxes. In the short-term gains are achieved in terms of emission reduction and increased jobs and economic activity in the non-polluting sectors. These results are more ambiguous in the longer term.

Porter and van der Linder (1995) and DeCanio (1997) find out that eco-taxes could lead to improved productivity and competitiveness especially in the case of eliminating distortive taxation systems. Furthermore, when promoting the application of energy-saving practices, eco-taxes can induce job creation and expand activities (Carraro et al., 1995; Mabey and

Nixon, 1997). The possibility to apply technological changes makes the burden of eco-taxation less heavy (Goulder and Schneider, 1999).

Bailey (1999) advocates a note of caution in the application of eco-taxation stating that positive effects are highly constrained in the case of price sensitive demand characterizing the commodities. The price in-sensitivity could be related to the poor recycling capabilities and/or unavailability of alternative technologies. Nevertheless, as the majority of studies involve ex-ante investigation, they tend to overlook the possibility of eco-taxation to generate perpetuating incentives in the longer run (Fullerton and Metcalf, 1998). Additionally, the first applied taxation policies addressed energy and CO_2 emissions. Should the ETR expand to broader fields like land and resources, more revenues would be available for the government and more distortive taxes would tend to be eliminated (OECD, 1997).

Despite all pros and cons, eco-taxation is today a reality. Spreading from the Nordic countries, ETR have spurred to the UK, Germany and Italy. Other countries that have been considering ETR application include Austria, Switzerland, Canada and the USA. Also in Japan eco-taxes are quiet common even though a true ETR is not in place yet.

Hoerner and Bosquet (2001) argue that for the ETR to produce the desirable effects, the policy design is crucial. They advocate the following for a successful ETR:

-include labor tax reduction preferable targeting lower-wage workers;

-protect the competitiveness of energy-intense industries;

-policies to prevent a wage-price inflation spur;

-policies to stimulate the contemplation and diffusion of cost-effective environmental friendly technologies;

-policies to compensate low-income households outside the work-force.

2.1.2 The Danish ETR and packaging taxation

Denmark began considering the implementation of taxation policies for environmental purposes back in the 1970s (Pedersen, 2003). At those days, eco-taxation application was limited and confined to certain commodities (Klok, 2002). However, since 1987 major environmental concern spread out amongst the population stimulating the government to take responsive action the field of environmental guaranteeing (Klok et al., 2006). A target of reducing CO_2 emissions by 20% in year 2005 compared to the 1988 level was established.

At first, eco-taxes were raised on household energy consumption. An attempt was made to apply CO_2 taxation on the industry as well, but since the country was under economic recession, the government belonged to the centre-right (business friendly) and the Federation of Danish Industry protested, the parliament withdrew from industry taxation dispositions (Klok et al., 2006).

Since 1993, the government moved to the center-left specter of politics and the new government begun analyzing the possibility of introducing business CO_2 taxation. Taxes were applied commencing in year 1995. They were however fed-back to the business through reductions in labor and profit tax (Hoerner and Bosquet, 2001; Klok et al., 2006).

Regarding packaging eco-taxation, Denmark could be considered a pioneer, as we also mentioned in the previous chapter. The policy was first established in year 1978 with product charges raised on beer, carbonated soft drinks and juice containers (Brisson, 1993). The 1988 amendments included milk cartoons to the scheme as well.

In the late 1990s, the country experienced the major development in terms of packaging taxation. The new 1999 when the Consolidated Act on Taxes on certain types of Packaging, Bags, disposable tableware and PVC foils set out to place a product charge on nearly all packaging products. The charges were calculated upon a weight basis on packaging purchases. As a result, the packaging user (purchaser), aside from the market price, is to pay the tax as well. Different packaging categories exhibit different charges calculated on life-cycle considerations (ECOTEC, 2001). The charges by packaging category are shown in Table 2.1.1:

Table 2.1.1: Danish product charges by packaging category

Category	Charge (Danish Kroners/kg)
Paper and paperboard primary; textiles	0.95
Paper and paperboard secondary	0.55
Plastic (except EPS and PVC), primary material	12.95
Plastic (except EPS and PVC), secondary material	7.75
EPS and PVC	20.35
Tinplate and steel	9.25
Glass and ceramic	1.85
Wood	0.55

Source: Danish Ministry of Taxation; 1 Danish Kroner = 0.19 USD

The taxation policy albeit with different taxation rates, was applied to the entire packaging outfit in order to stimulate overall reduction in packaging demand and avoid undesirable substitution effects between the categories. As already mentioned in the previous chapter, our focus is on paper/paperboard primary packaging and plastic primary packaging alone.

2.1.3 Packaging taxation

In the case of packaging, environmental taxes come in two main forms: material levies and product charges (Pearce and Turner, 1993). Material levies are applied on the raw material used to make the packaging product and are designed to improve material efficiency. In this case, the tax purpose is to artificially increase the price of the raw material and induce packaging producers to adopt production technologies that require lower quantities of it. Hekkert et al. (2000a, 2000b) identify several production technologies that improve material efficiency in the case of primary and transport packaging (including plastic packaging). Product charges, on the other hand, are applied on the final packaging product and the purpose is to reduce final demand. According to Pearce and Turner (1993), product charges could induce a change in the purchased quantity of virgin packaging by either stimulating a source reduction (direct demand reduction) and/or increasing the recycling rate. In the case of increased recycling, even though the quantity of used packaging is the same, more recycled packaging is employed in substitute of virgin one. The result is therefore the same: lower demand for virgin packaging. Product charges are what we deal with in our analysis.

Success could be highly stimulated by the presence of a price sensitive demand (Bailley, 1999, 2002; Beder, 1996; Ekins, 1999). If demand reacts to price changes, it could also react to taxation policy. It is therefore important to see if the demand for packaging is price sensitive or price in-sensitive in the case of paper/paperboard and plastic packaging.

In the case of paper/paperboard packaging, there is an ample literature supporting the presence of a price sensitive demand. Suhohen (1984) analyzes the demand for three categories of paper and paperboard in the case of the European Economic Community countries using historical data from 1968 until 1980. Results reveal demand was related negatively to the price in the case of the category denoted as "Other Paper and Paperboard" which includes packaging. Prestemon and Buongiorno (1993) investigate a sample of 24 OECD countries analyzing the demand for three paper and paperboard categories (one of them includes packaging). Once again, the results showed the presence of negative correlation between demand and price in the case of the packaging category. Brooks et al. (1995) conducted a similar analysis reaching the same results in the case of four European countries. Chas-Amil and Buongiorno (2000) applied a country-by-country analysis for 14 members of the EU using short term elasticities of demand for forest products. In the case of Denmark, results revealed a negative correlation between demand and price for the paper and paperboard packaging group with statistical significance at 1% levels of confidence. There are also examples of global demand modeling. Simangunson and Buongiorno (2001) using an international demand equation for forest products and applying four different methodologies, define the price elasticities in the case of nine paper and paperboard related products (including paper/paperboard packaging). According to each method, the demand for paper/paperboard packaging is price sensitive and statistically significant at 5% intervals of confidence. Empirical investigations including paper/paperboard demand modeling where price sensible characteristics are present, also include the following examples: Buongiorno (1978); Baudin and Lundberg (1987).

In the case of plastic packaging, the available literature is not so ample. There are however certain signals denoting the presence of a price in-sensitive demand. We can mention here Palmer et al. (1996): in their study on the US market of packaging products stabilized a price in-sensitive demand for plastic packaging. Furthermore, Zhang and Buongiorno (1998) define plastic packaging as a luxury commodity featuring a demand not affected by price variations. At the same time, the EuPC (European Plastic Converters), based on plastic packaging market observations, determines that despite the continuous price pressures that have characterized the European market, demand for plastic packaging continues to grow relentlessly.

Another important element to be accounted for is the eventuality of the tax being pushed back to the final consumer of the packed product. Indeed, facing a situation where they have to pay a tax for purchasing the required packaging, the users (the firms in this case) might raise the price of their products unleashing the whole burden of the tax on the consumer`s shoulders. That would go against the purpose of taxation. As the purchasers would remain unaffected, so would their demand disallowing effectiveness. Fortunately, that was not the case of the Danish product charge under investigation in this paper. ECOTEC (2001) report on environmental taxes and charges in EU and member states finds no evidence supporting a charge push-back to final consumers in the case of the Danish packaging tax. That could be explained on the basis that upon adopting such policy, the

Danish government compensated by lowering taxes elsewhere *i.e.* labor related taxes (Bosquet, 2000; Hoerner and Bosquet, 2001).

Finally, we mentioned that in case of product charges, the policy effectiveness is achieved either by means of overall demand reduction or a shift from virgin packaging to recycled packaging. We also mentioned that in the shorter term with giver packaging technologies, it is highly improbable to encounter direct demand reduction. Therefore, the only possibility remains increased recycling rates. That would require a high degree of cooperation between the industrial firms, the retail premises and the final consumer of goods. As a matter of fact, the final consumer has to somewhat conserve the packaging (after has consumer the product) and return it to designated locations. The industrial firms have also to set up facilities for the collection and in some cases certain incentives have to be allocated to stimulate return on the part of the final consumers. Industrial managed "voluntary" deposit systems have been witnessed in the cases of Finland and Norway (EUROPEN, 2000). However, in cases where waste disposal costs (collection fees) are quiet high, already exists an incentive to return and further measures are not necessary. That is the particular case of Denmark.

2.1.4 Consequences of Environmental policies

Generally, literature addresses the transboundary spillover of unilateral national environmental policies and the associated implications in two mainstreams. The first mainstream deals with the spillover of environmental efficiency. In other words, as the world becomes more and more globalized, environmentally superior innovations in the form of technologies and policies spread across national boundaries (Perkins and Neumayer, 2009). The geographic spread of environmentally efficient innovations is found in theories of diffusion (Rogers, 1995) and studies related to connectivity (Grubb et al. 2002; Wallace, 1996). Regarding the form of spillover, analysis focuses mainly on trade, foreign direct investment (FDI) and telecommunications (Perkins and Neumayer, 2008; 2009).

International trade openness is known to have an increasingly important role in diffusing environmental efficiency. That is especially the case on diffusion from environmental efficient countries (developed countries) to environmentally less-efficient countries (developing countries) (Wolf, 2004). The diffusion comes in the form of local firms emulating from their environmentally “more advanced” peers (O`Neill et al. 1998); price and/or quality competition (Jenkins et al., 2002); through the introduction of superior policies and standards (Vogel, 1997); and buyer-induced motives (Drezner, 2001). Regarding the speed of diffusion, quantitative studies by Perkins and Neumayer (2005) emphasize that higher levels of trade openness are associated with higher speed of diffusion. Similar conclusions are obtained by Wheeler and Martin (1992). Additionally, Frank et al. (2000) find that trade openness increases the likeliness of adoption of more advanced environmental policies. Prakash and Potoski (2006), find out that when certain countries intensify export toward countries with more EMS standards, they tend to increase their own environmental efficiency. There also studies (like Heil and Selden, 2001) which encompass the other side of the medal: trade openness increases emissions in developing countries.

The other streamline of studies deals with load relocation and induced cross-boundary economical cost related to unilateral environmental policies. Muradian et. Al (2002) find out that when a country`s domestic production becomes cleaner, this can be associated with higher imports and lower exports of “dirty products” suggesting emission displacement. The phenomenon known as “carbon leakage” is well addressed by Jacoby et al. (1997) and Barker (1999) for greenhouse gas emissions. The results suggest that since the “leakage” is not taken under consideration, the benefits accruing to the regulatory countries are much overestimated. Suri and Chapman (1998) emphasize that industrialized countries have increased environmental efficiency by augmenting the imports of manufactured goods. Similar conclusions are reached by Friedl and Gentzer (2003) regarding Austria. Paltsev (2001) goes forward to measure the scale of the leakage as a result of the proposed Kyoto Protocol using year 1995 as baseline. Figures tell for a 10.5% leakage overall with EU to China counting for most of it. Bruvoll and Haen (2005) find out that environmental benefits decrease when a international perspective (not a national one) is taken in consideration. All these studies point toward the existence of the so-called “pollution heavens” however empirical evidence does not confirm the existence of such locations unequivocally (Cole, 2004). That is mainly because empirical literature does not confirm a strong relation between unilateral environmental policies in developed countries and associated production investment re-allocation in developing ones (Zarsky, 1999; Eskeland and Harrison, 2003). The same holds for changing trade patterns as a result of unilateral environmental policies (Jaffe et al., 1995; Janicke et al., 1997). That could be related to several problems concerning data measures (Jaffe et al., 1995). Additionally, there is another explanation. Unilateral environmental policies in developed countries together with “dirty” domestic production could also affect “dirty” imports coming into these countries from the rest of the world. Pathak et al., (2000), investigate such occurring in the case of US greenhouse reduction policies and its impact on Indian exports toward the US market (or US imports from India). The results point out to the fact that certain exports of “dirty” products are indeed reduced with very little effect on the overall Indian economy. A similar study (TERI, 1997) obtains similar results in the case of US to Indonesia and US to Bangladesh trade relationships. These findings reveal that unilateral environmental policies (being energy related and/or non-energy related) could have positive environmental effects in trade partner countries that defined not as policy spillover but as actual beneficial effect. The last two studies also investigate the economical consequences of US measures on the exports from India, Bangladesh and Indonesia. Pathak et al., (2000) use export elasticities to calculate the effect regretfully pointing out the unavailability of input-output tables for a deeper and more comprehensive analysis.

2.2 Methodology and expected results

As we mentioned in the introductory chapter, the first of our objectives is to establish the policy effectiveness in the two separate cases: paper/paperboard packaging (chapter 3) and plastic packaging (in chapter 4). In the first chapter is also mentioned that the Danish government upon implementing the policies did not establish a general objective in terms of target. Therefore, if the analysis shows the packaging demand decreasing as a result of eco-taxation, the policy is going to be deemed as successful.

Considering that our analysis is focused on Danish imports of paper/paperboard and plastic packaging, we deal with a trade element (imports). The most popular model explaining trade flows is the gravitation model (Tinbergen, 1962) developed to explain bilateral trade between countries, regions and continents. It is called “gravitation or gravity model” as a namesake of Newton`s law of Universal Gravity. In this model, the trade components (exports, imports or both) are featured as dependent variables. Amongst the explanatory variables are include proxies of demand and supply (Real GDP, Real GDP per capita, and population of the trade partners), distance (km between the two capital cities), common borders and proxies for other contributing factors. In particular, gravitation models are applied to determine the effectiveness of trade agreements in order to reveal if they contribute to extended bilateral trade between the signatory partners (Aitken, 1973). The trade agreement impact is captured by means of one or more dummy variables (binary variable) taking values of 0 (before the trade agreement) and 1 (after the trade agreement). The dummy is justified on the basis of capturing the impact of a changing circumstance (in this case the trade agreement).

The gravitation model is not applied only to explain overall trade, but it can be also employed to explain the bilateral trade of certain commodities. In that case, the variables are more case-specific. That is exactly our case study which focuses on packaging commodities (paper/paperboard and plastic). The variables we employ (to be explained in detail in chapters 3 and 4) represent demand and supply proxies for packaging. In this case, the taxation policy represents the equivalent of the trade agreement in the general gravitation model. The taxation policy is introduced as a changing circumstance, the effect of which is captured by means of a dummy variable taking value 0 before the tax policy application and 1 after the application.

The applied methodology in this case is going to be econometrical modeling. The packaging import demand is going to be expressed as e function of several explanatory variables including a dummy variable capturing the impact of the taxation policy. Two separate equations are to express paper/paperboard packaging import demand; and plastic packaging import demand. Panel data estimations are to be carried out. In the case of paper/paperboard packaging is expected a successful taxation policy implementation considering the predominant literature suggesting a price sensitive demand. In the case of plastic packaging, the available literature is not enough for us to make a prognosis of the expected results at this point.

When patterns of industrial production or consumption are affected by environmental regulation, there surface the issue of induced effects. Input-output represent a useful tool in dealing with induced effect under environmental regulation pressure (Perman et al, 2003) in capturing economic impacts. Furthermore, when environmental input-output tables are available, the environmental effects sourcing from environmental policy are determinable as well (Munksgaard et al, 2008).

In our case, when the policy is effective in reducing import demand, the next step is going to include the determination of the economical consequences. As we mentioned in the previous chapter, reduced Danish demand produces two symmetric effects: Danish imports decrease and the exports from the partner countries also decrease. In this case, Denmark experiences import savings whilst the partner countries experience export loss. In the case of losses, a more general induce impact on the rest of the economy: on general output and general income. In order to capture these effects, input-output impact analysis approach is to be carried out. The analysis is to be carried out for each exporting country separately (when input-output data is available). This analysis is to be carried out in terms of unit of packaging (tons) considering that we are unable to determine the policy impact scale due to data unavailability. This objective is reflected in chapter 5.

In chapter 6, the environmental benefits associated to the policy are going to be established for both Denmark and the partner countries. In the case of Denmark, the environmental benefits are associated with reduced waste quantities as a result of reduced packaging (when the packaging demand shrinks as result of the policy). Waste collection and disposal cost factors will be employed to feature the environmental benefit in monetarized pattern. In the case of the partner countries, environmental benefits are represented by the induced reduced emissions as a result of the non-production of non-exported commodities ceteris paribus. In our analysis, we are going to be estimated the saved waterborne and airborne emissions in monetarized form. Once again, analysis is conducted per ton of packaging demand reduction.

Chapter 7 deals with comparing the economical losses and environmental gains in the case of the exporting countries and at international level (including Denmark). In this case, no complicated methodology is to be employed. Simple differences between gains and losses are to determine the net benefits (or net costs) induced to the partner countries and worldwide as a result of the Danish policy. Due to the fact that the ultimate net benefit (or cost) is closely related to the input-output production function (that change from year to year), the applied waste generation factors, the applied emission abatement, damage and monetarization factors (also changing from year to year), we cannot have expectations on this result at this particular moment.

In chapter 8, alternative policies are to be advanced in the case the Danish taxation practice being non-effective. Suggestions are to be based on literature findings, especially those literatures involving technological changes. Furthermore, we will try to determine the impact of applying one such technological change in the case of Denmark. In Table 2.2.1, we summarize the overall methodology applied in the research which follows the parallel streamlines of the dissertation structure:

Table 2.2.1: Summary of methodology

Objective	Paper/paperboard packaging streamline	Plastic packaging streamline
Effectiveness	Trade gravitation model with tax policy dummy (chapter 3)	Trade gravitation model with tax policy dummy (chapter 4)

Economic consequences	Input-output impact analysis (chapter 5)	
Environmental benefits	Waste generation and waste cost factors; emission abatement, emission damage and emission monetarization factors (chapter 6)	
Net benefit (cost)	Aggregated annul cost-benefit analysis (chapter 7)	
Alternative policy suggestion		Effects of alternative policy application (chapter 8)

As we mentioned previously and as we are going to show later, the policy was effective in the case of paper/paperboard packaging, whilst proved ineffective in the case of plastic packaging. Therefore, economic consequence determination, environmental benefit calculation and cost-benefit analysis are to be conducted in the case of paper/paperboard packaging only. On the other hand, the suggestion and simulation of the alternative policy concerns the ineffective case (that of plastic packaging).

For the sake of objectivity, we have to point the various limitations characterizing our approach. First of all, the application of a trade gravitation model will produce a single coefficient related to the tax dummy variable. One single variable can explain a general aggregated effect of the policy for all import components included in the panel data set (imports by country). Separate time series analysis for Danish import from each partner could produce separate tax policy coefficient (which would be more accurate), however the unavailability of long-enough time series data dictates the application of panel data analysis for the purpose of expanding the sample. Furthermore, the data on packaging itself is reported in terms of commodity groups and not commodities, although the commodities comprising the commodity group are characterized by homogeneity.

Additionally, the input-output impact analysis features limitations of its own. For starters, we deal with a fixed production function in a given year assuming the structure does not change within this time period. These limitations require the results to be interpreted with extreme caution. Nevertheless, the method is very suitable due to the available data and represents a very popular methodology in dealing with economic impacts of environmental policies.

Chapter 3: Danish policy in the case of paper/paperboard packaging

3.1 Framework, model and data

The methodology relies on a trade gravitational regression model built around Danish paper and paperboard packaging imports. We decided to investigate the import trade pattern considering that imports are the major source of paper and paperboard packaging supply in the country (Statistics Denmark, 2010). The gravitational model approach is very popular in analyzing trade flows and was applied successfully in many studies investigating the effectiveness of trade liberalization agreements. Aitken (1973), Resnick and Truman (1974) and Verdoorn and Schwartz (1972) applied the gravitation model in the case of the European Economic Community and European Free Trade Agreement cases. Adam et al. (2003) and Kernohan (2006) applied it in the case of the Free Trade Agreements of South-Eastern Europe. Paramount in the case of trade gravitation regression models is the choice of the appropriate proxies that can truly capture the effects intended by the researcher. In this case, we construct the model for the purpose of observing the behavior of paper/paperboard packaging imports. Using panel data estimation featuring Danish paper and paperboard packaging imports from major partner countries as dependent variable with a tax dummy among the explanatory variables, we try to determine whether the tax policy effectively reduced the domestic industrial demand for the commodity.

The sample includes 13 major trading partners in terms of paper and paperboard packaging import quantities. The analysis is conducted for the period 1994-2007 assuming the tax policy being fully implemented in 2001. We mentioned earlier that the tax law was instituted in year 1999. However, several amendments took place during year 2000. We therefore assumed that the law was implemented in its entire shape from year 2001. The period was chosen to include observations prior and after the tax policy was implemented. Furthermore, the choice isolates such enormous political and economical events like the transformations characterizing the European continent following the dissolution of the Soviet block or the major economic and financial crisis engulfing the globe (and Europe) in year 2008.

Before defining the equation, an important issue has to be solved. As we are addressing industrial paper and paperboard packaging, it is important to identify which sectors of the Danish industry are the major purchasers. Data from Statistics Denmark (2010) show that the Food, Beverage and Tobacco manufacturing sector is the major purchaser of paper and paperboard packaging with quantity shares being consistently above 60% in the period 2000-2007. The other sectors fall far behind with Plastics, Glass and Concrete in second place with 7% of total quantity purchased across the years. Unfortunately, packaging purchasing data is not broken down to the subsectors representing a major liability to the investigation. Having determined the major purchaser, we define the regression equation as follows:

$$lnIMP_{jt} = \beta_1 lnSFBTt + \beta_2 lnRGDPj_t + \beta_3 lnRPRI_{jt} + \beta_4 DIST_j + \beta_5 TI_{jt} + \beta_6 BOR + \beta_7 TAX + \varepsilon \ (1)$$

IMP_{jt} – quantity imports from partner country j into Denmark in period t in kg;

$SFBT_t$ – sales of the Danish Food, Beverage and Tobacco sector in real 2005 DKr and seasonally adjusted in period t;

$RGDP_{jt}$ – Real GDP of exporting partner country j in period t;

$RPRI_t$ – price of paper and paperboard packaging imports in real 2005 DKr in period t;

$DIST_j$ – distance in km between Copenhagen and the partner country j capital;

TI_{jt} – Denmark Trade Integration with partner country j at period t (dummy);

BOR_j – common border between Denmark and partner country j (dummy);

TAX_t – tax application on paper and paperboard packaging purchases in period t (dummy).

As we mentioned earlier, the dependent variable represents Danish imports of paper and paperboard packaging from partner country j in period (year) t measured in kg. The Sales of the Danish Food, Beverage and Tobacco sector expressed in real DKr and seasonally adjusted are defined as a demand proxy. Considering that the sector in question is the major purchaser of paper and paperboard packaging, we tried to determine the best variable capturing demand. However, there are certain limitations in using this proxy. As we neglected the other sectors, the variable fails to capture the entire demand. Nevertheless, for practical purposes we decided to run the model using this variable and expect it to be positively correlated with imports.

RGDP is defined as real GDP of partner country j in the year t and represents a supply proxy. We assumed that the larger the partner country, the higher would be its producing and exporting potential and therefore the more Denmark would import from it. The variable is expressed in real 2000 USD once again adjusting for price effects.

The Real Price of paper and paperboard packaging imports before the tax is introduced based on the literature implications. As demand for paper and paperboard packaging seems to be price sensitive, the price effect must be separated from the tax effect. As there is no data availability, we conducted price calculations based on the available data. Using monthly total import data expressed both in quantity and value we calculated the nominal price per each month for the period 1994-2007. Then, we applied the monthly domestic supply and import price index (available from Statistics Denmark, 2010) for paper and paperboard to calculate the real monthly price. After obtaining monthly real values for each year, we calculated the annual average real price figures. We expect a negative sign for the price variable.

The distance in km between the Danish capital Copenhagen and the partner country capital is an important proxy capturing transportation costs. Regretfully, we were not able to obtain better data regarding transportation cost estimates. Additionally, Trade Integration is important in facilitating trade flows. The dummy we use takes values 1 in the case of European Union member partner countries considering the high level of trade integration characterizing the bloc. The dummy for common borders captures the regional trade occurring with neighbor countries like Germany, Sweden and Norway. Both land and naval borders are considered in this case. In the end, the tax dummy is supposed to capture the effect of the packaging taxation policy. We would expect a negative sign and statistical significance. The data for paper and paperboard packaging Imports and Sales of the Food, Beverage and Tobacco were obtained from the Statistics Denmark (2010). Before running the equation, we must emphasize that is not our purpose to develop the best possible model that describes the import trade pattern. The effectiveness of the tax policy is our only concern. Therefore, the crucial part in the results is explaining the sign and significance of the tax dummy.

Additionally, special dummy variable have been included to test for the possibility of fixed effects related to cross-sections, years and trend. These fixed effects are related to possible un-observed effects as a result of omitted variables.

3.2 Running the model

In the application of econometric model, the procedure follows certain step. In the first step (before running the actual model), all variables (dependent and explanatory) are checked for stationarity by applying Unit Root test (Dickey and Fuller, 1979). The reason is that only stationary variables can be applied in an econometric model. The application of non-stationary variables would lead to spurious and therefore incorrect estimations. Once stationarity of all variables is determined, the model is to be run using Ordinary Least Squares and thereafter checked for the problems of heteroskedasticity and autocorrelation. The existence of these two problems represents a serious issue requiring solution. In this circumstance, Seeming Unrelated Regressions (SUR) are carried out to produce the unbiased results. Additionally, the model is checked for multicollinearity problems and finally a unit root test of the residual is performed to check on the model`s retained specification or misspecification. The same procedure will be applied in Chapter 4 for the model involving plastic packaging. Now we turn to actual procedure starting with the unit root test.

Before running the econometrical model, we conduct Unit Root testing for the dependent and explanatory variables using two methodologies: the Augmented Dickey-Fuller test (ADF) and the Phillip-Perron test (PP). Results are shown in Table 3.2.1:

Table 3.2.1: Unit root test for dependent and independent variables

Unit Root Method	lnIMP (level)	lnSFBT (level)	lnRGDP (level)	lnRPRI (level)
ADF	48.6479 (0.0045)	0.50910 (1.0000)	15.46 (0.9810)	33.0876 (0.1596)
PP	53.3382 (0.0012)	0.02898 (1.0000)	18.25 (0.7905)	14.7022 (0.9625)
	lnSFBT (1st diff)	lnRGDP (1st diff)	lnRPRI (1st diff)	
ADF	81.4951 (0.0000)	47.1969 (0.0014)	53.0909 (0.0013)	
PP	84.2238 (0.0000)	122.549 (0.0000)	54.5245 (0.0009)	

The tests are conducted at individual intercept using Schwarz automatic lag selection, Bartlett method and Newey-West Automatic bandwidth selection. Probabilities are displayed in parentheses.

Table 3.2.1 reveals that lnIMP variable is stationary at level whereas lnSFBT, lnRGDP and lnRPRI variables are stationary at first difference. Under such circumstances, it is not possible to apply the traditional co-integration technique since that would require dependent and explanatory variables to be integrated in the same order. Pagan and Wickens

(1989) suggest that in the cases where there is a dependent variable integrated I(0), there must be at least two explanatory variables of the same order of integration to avoid misspecification. The presence of misspecification is determined by running unit root test for the residual. If the residual is stationary at level, misspecification is rejected. However, if the residual is non-stationary at level, the model would be misspecified. In our case there are two integrated I(1) explanatory variables. Upon running the model, the residual will be tested for unit root. We run first in can in Ordinary Least Squares mode. Estimations are shown in Table 3.2.2.

Table 3.2.2: Regression OLS results

Variable	Coefficient
lnSFBT	1.23
	(5.04)***
lnRGDP	-0.064
	(-0.38)
lnRPRI	-0.99
	(-1.29)
lnDIST	-2.07
	(-4.72)***

TI		-1.74
		(-1.92)*
BOR		0.88
		(1.69)*
TAX		-0.62
		(-1.69)*
R-squared	0.34	
Adjusted R-squared	0.32	
Durbin-Watson stat	0.48	

t-stat shown in parenthesis. * significance at 10% confidence intervals; *** significance at 1% confidence intervals.

The next step would be to test for heteroskedasticity. Using the White`s General Heteroskedasticity Test (White, 1980), we obtained an nR^2 value of 25.67 which is higher than the 5% critical χ^2 distributed value of 14.0671 rejecting the null hypothesis of no heteroskedasticity. Additionally, from table 2 we can observer that the Durbin-Watson statistic is far smaller than 2 suggesting the presence of positive autocorrelation. We would therefore need to correct for both the heteroskedasticity and autocorrelation problems.

We achieve this by applying Generalized Least Squares one-step weighting with Seemingly Unrelated Regressions (SUR) (Zellner, 1962). Beck and Katz (1995) argue that when using SUR method, the estimated standard errors are downward biased. Messener and Parks (2004) have suggested the application of bootstrapped standard errors. However, Atkinson and Wilson (1992) confirm that the estimated error terms are downward biased also in the case of bootstrapping therefore the bootstrapping estimator cannot dominate the SUR estimator. Therefore, we use Cross-Section SUR method to obtain the following results:

Table 3.2.3: GLS ones-step weight with Cross-Section SUR

Variable	Coefficient
lnSFBT	1.50
	(23.69)***
lnRGDP	-0.068
	(-1.16)
lnRPRi	-0.937
	(-5.02)***
lnDIST	-2.189
	(-19.55)***
TI	2.157
	(19.55079)***

BOR	0.80
	(7.377597)***
TAX	-0.58
	(-5.549538)***
R-squared	0.95
Adjusted R-squared	0.95
Durbin-Watson stat	1.96

t-stat shown in parenthesis; *** significance at 1% confidence intervals.

Now remains to be seen if we have managed to retain model specification. We perform Residual Unit Root test. Results are shown in Table 3.2.4.

Table 3.2.4: Residual Unit Root test

Unit Root Method	Residual (level)
ADF	54.36 (0.0025)
PP	12.46 (0.0523)

The tests are conducted at individual intercept using Schwarz automatic lag selection, Bartlett method and Newey-West Automatic bandwidth selection. Probabilities are displayed in parenthesis.

Unit Root tests show the residual to be stationary at level. Therefore there is no risk of misspecification. Finally, using Variance Inflation Factors (VIF) (Fox and Monette, 1992) we tested the possibility of multicollinearity between the explanatory variables. Test results rejected the eventuality. Additionally, we tested for possible fixed effects related to cross-section, year and trend. No such effects were found.

3.3 Results

Regression results from table 3.2.3 reveal that the Sales from the Food, Beverage and Tobacco sector are positively related to the packaging imports. The variable is statistically significant at 1% levels of confidence. We must remind once again of the limitations associated with using this proxy. The results however can justify our choice as appropriate variable. On the other hand, the supply proxy we used (RGDP of the exporting country) produced a negative sign but was statistically insignificant.

The price variable displays the expected sign as well. Regression results represent a further confirmation to the fact that paper and paperboard packaging demand (import demand in this case) is definitely price insensitive. The level of statistical significance is a proof of the persisting relationship.

Transportation costs represented by the distance variable seem to play an important role in paper and paperboard packaging trade. Once again the statistical significance reaches 1% confidence intervals. The same applies to the common border dummy. The Trade Integration dummy however did also produce the expected sign. Trade integration seems to have a positive correlation with imports.

As mentioned in the previous section, the main purpose is to observe the effect of the tax policy. Results from table 3.2.3 reveal the tax dummy to display a negative sign and statistical significance at 1% levels of confidence. The tax policy managed to successfully decrease the demand for imported paper and paperboard packaging reducing the quantity of virgin packaging placed in the market. The finding is all but unexpected. By simultaneously introducing the price and tax variables, apparently we successfully managed to separate the effects from one another. Paper and paperboard packaging imports reacted both to the price and tax. Reaction to price confirms literature findings on demand modeling. The sign and significance of the tax dummy reveals demand being sensitive to the applied tax policy.

3.4 Conclusions and discussions

In this chapter we attempted to evaluate the effectiveness of the Danish packaging tax policy in decreasing the import demand for industrial paper and paperboard packaging. Considering the lack of research in the matter, we tried to explore a somewhat unknown territory of green-tax policy application. The emphasis on import trend is justified on the basis that Denmark is a net importer for the commodities in question. Furthermore, as the tax policies is charged on a weight basis for packaging purchases (DKr per kg of paper and paperboard packaging purchased and paid by the purchaser), it would be appropriate to investigate the trade patterns of the major source of paper and paperboard packaging supply *i.e.* imports.

Regarding the methodology, we applied a trade gravitational regression model for the panel data analysis comprising 13 of Denmark`s major partners in terms of imported quantities of paper and paperboard packaging. The choice is motivated upon the successful implementation of the model in other studies related to trade pattern research. Additionally, model practicability and simplicity of application represent two additional motives. In our case, imports of paper and paperboard packaging measured in kg represented the dependent variable. Explanatory variables included proxies for demand, price, transportation costs, trade integration and regional trade. The effectiveness of the tax policy was captured by employing a dummy variable. Analysis was conducted for the period 1994-2007 with the tax dummy taking values 1 for the period 2001-2007 (we assumed full policy application started from year 2001). We used Seemingly Unrelated Regressions to correct for the heteroskedasticity and autocorrelation problems encountered in the OLS regression. All variables produced the expected sign. In all cases statistical significance reached 1% levels of confidence. The price coefficient and significance revealed the price sensitive nature of demand for paper and paperboard packaging (as literature suggests).

Regarding the tax dummy, the coefficient was positive and statistically significant at 1% intervals showing that the tax policy applied on the purchases of paper and paperboard packaging products supplied the desired effect. Import demand was reduced and import quantity fell. This case represents a positive example of effective green-tax application.

The problem of the fiscal objective colliding with the fiscal one at the moment of charge calculation would seem to be unimportant. The nature of the product demand seems to have the outmost importance in establishing a successful or unsuccessful environmental taxation policy. Price sensitivity of demand appears to be essential in assuring tax effectiveness. This consideration should be kept in close attention when contemplating future adoption of environmental taxation not just in the case of packaging, but in other fields as well.

Chapter 4: The Danish policy in case of plastic packaging

4.1 Framework, model and data

The analysis will focus on one major plastic packaging commodity group as defined in the Danish Nomenclature (Statistics Denmark) to measure the impact of the product charge policy. The commodity group is defined as Boxes, cases, crates and similar articles of plastics representing a major clustering in terms of weight. The major packaging purchaser in this case is the Danish Food, Beverage and Tobacco industrial sector with shares above 65% over the years (in terms of quantity). This is an important consideration that will help explain the variable choice when we expose the model equation later on.

Our analysis is constrained to the imports of the commodity group. The reason is that according to the data (Denmark Statistics), Denmark is a major importer. We chose the trade gravitational model approach considering its popularity and relative simplicity in analyzing trade impacts. The model we applied is the following:

$$lnIMP_{jt} = \beta_1 lnSFBTt + \beta_2 lnRGDPj_t + \beta_3 lnRPRI_{jt} + \beta_4 DIST_j + \beta_5 TI_{jt} + \beta_6 BOR + \beta_7 TAX + \varepsilon (2)$$

IMP_{jt} – quantity imports from partner country j into Denmark in period t in kg;

$SFBT_t$ – sales of the Danish Food, Beverage and Tobacco sector in real 2005 DKr and seasonally adjusted in period t;

$RGDP_{jt}$ – Real GDP of exporting partner country j in period t

$RPRI_t$ – price of paper and paperboard packaging imports in real 2005 DKr in period t;

$DIST_j$ – distance in km between Copenhagen and the partner country j capital;

TI_{jt} – Denmark Trade Integration with partner country j at period t (dummy);

BOR_j – common border between Denmark and partner country j (dummy);

TAX_t – tax application on paper and paperboard packaging purchases in period t (dummy).

The dependent variable represents quantity imports of Denmark belonging to the subjected commodity group from partner country j in period t expressed in kg. As the product charge policy is supposed to decrease packaging demand, decreased quantity imports would be the signal of effective policy implementation.

The first explanatory variable (SFBT) represents sales of the Danish Food, Beverage and Tobacco industrial sector and is defined as a proxy of demand. As the sector in question stands as major purchaser of plastic packaging, we expect it to be the most affected by the policy (should the policy have any effect). Sales are expressed in real Danish Kroners (DKr) in 2005 prices and seasonally adjusted. The adjustment enables to correct for any possible market price related, inflationary or seasonal effect in order to obtain a purer figure. We expect a positive sign and statistical significance for this variable.

RGDP is defined as real GDP of partner country j in the year t and represents a supply proxy. We assumed that the larger the partner country, the higher would be its producing and exporting potential and therefore the more Denmark would import from it. The variable is expressed in real 2000 USD once again adjusting for price effects.

RPRI is defined as real annual average price of commodity imports in the year t expressed in real 2005 DKr per kg of product. This is the price domestic purchasers have to pay for each kg of imported plastic commodity they buy. As mentioned earlier, we are not sure of the price-sensitive or price-insensitive nature of import demand. By including the price variable we manage to obtain a more complete model that will solve this uncertainty. Secondly, we manage separate the pure price effect from the product charge effect.

The variable DIST reflects the distance in km between the Danish capital Copenhagen and the partner country j capital. This is a proxy of transportation costs which could have certainly affected trade flows. The next two explanatory variables are both dummies. TI is denoted as trade integration proxy taking values 1 for the periods when the partner country j was member of the European Union. It is commonly acknowledged that the EU represents a very well-integrated market where there is ample freedom in the movement of goods, capital and labor.

BOR is a dummy variable identifying common borders (both land and naval) between Denmark and the partner country j as a proxy of regional trade. Being a peninsular country, Denmark shares land borders with Germany in the south. On the north-west, north and north-east naval borders delimit the Danish territorial waters from those of Norway and

Sweden. For both variables we expect a positive sign and statistical significance. The last variable is a dummy for taxation policy. The dummy takes values 1 from 2001 and on, the years when the packaging product charge was applied in its entire form. We mentioned earlier that the tax policy was first activated in 1999. However, several amendments were proposed and adopted during the year 2000. For this reason we assume 2001 as the first year when full implementation begun. In the analysis we have included 19 partner countries chosen as the major supplier of the plastic packaging commodity in question. The period of analysis stretches from 1994 until 2007. The choice is not random. First, we made sure to include a sufficient number of years from both before and after the policy implementation. Secondly, we managed to leave out time periods featuring major economical shocks that could have certainly affected trade relationships between countries in the region in question. We can mention here the dissolution of the Soviet block in early 1990s and the economical and financial crisis which has been pounding Europe and the whole world since 2008. Data on imports and sales from the Food, Beverage and Tobacco sector were obtained from the Danish Statistics database. Calculations for real prices were conducted based on data from the same source. Real GDP data for partner countries were retrieved from the IMF database. Additional, dummy variables were included to test for possible fixed effects related to cross-section, year and trend.

4.2 Running the model

The method procedures are the same as the ones explained in chapter 3. Before conducting regression analysis, it is crucial to establish whether the dependent and independent variables are stationary. Non-stationary variables could produce spurious and therefore unreliable results. Unit root analysis was conducted using the Augmented Dickey-Fuller and Phillips-Perron tests. Results of unit root test at level are shown in table 4.2.1:

Table 4.2.1: Unit root test results for equation 1 variables (at level)

Method/Variable	lnIMP	lnSFBT	lnRGDP	lnRPRI
ADF	75.5447 (0.0003)	0.74407 (1.0000)	4.84784 (1.0000)	81.0388 (0.0001)
PP	68.1463 (0.0019)	0.04236 (1.0000)	3.58482 (1.0000)	80.5924 (0.0001)

The tests are conducted at individual intercept using Schwarz automatic lag selection, Bartlett method and Newey-West Automatic bandwidth selection. Probabilities are displayed in parentheses.

From the Unit Root tests, it can be observed that the dependent variable is stationary at level. However, there are explanatory variables non-stationary at level. In this case there is two of them: lnSFBT and lnRGDP. Unit Root test is then conducted on the first difference for the explanatory variables that are non-stationary at level. Results are shown in table

4.2.2:

Table 4.2.2: Unit root test results for explanatory variables first difference

Method/Variable	lnSFBT	lnRGDP
ADF	81.4951 (0.0000)	54.3133 (0.0419)
PP	84.2238 (0.0000)	56.6539 (0.0263)

The tests are conducted at individual intercept using Schwarz automatic lag selection, Bartlett method and Newey-West Automatic bandwidth selection. Probabilities are displayed in parentheses.

The results provide a most singular case. The dependent variable is stationary at level as mentioned earlier. Two explanatory variables are stationary at first difference. Therefore, it is not possible to apply co-integration technique as that would require both dependent and independent variables to be integrated in the same order (Engle and Granger, 1987). In this case, Pagans and Wickens (1989) argue that when a dependent variable is stationary at level, there must be at least two independent variables of the same order of integration for the equation to be correctly specified. Furthermore, there exists a way to determine whether the model retains specification. This is achieved by running unit root test of the residual. If results show that the residual is stationary at level, the model retains the correct specification; otherwise is misspecified.

In the case of our equation, there are two non-stationary at level explanatory variables: lnSFBT and lnRGDP . Upon running the model and obtaining the results, it is necessary to run unit root test for the residuals.

Having conducted the preliminary stationarity tests, we can move on with running the models. First, we apply Ordinary Least Square method. The results are shown in table 4.2.3:

Table 4.2.3: OLS regression results

Variable	Coefficient
lnSFBT	0.82 (5.40)***
lnRGDP	0.32 (6.51)***
lnRPRI	0.49 (0.59)
lnDIST	-0.83 (-6.09)***
TI	-0.54

	(-2.18)***
BOR	1.43
	(6.108)***
TAX	0.0016
	(0.99)
R^2	0.47
Adjusted R^2	0.46
DW stat	0.46

t-stat shown in parenthesis. * significance at 10% confidence intervals; *** significance at 1% confidence intervals

The next step would be to conduct heteroskedasticity and autocorrelation tests. Applying the White`s General Heteroskedasticity Test, we obtained an nR^2 value of 36.15738. The 5% critical χ^2 distributed value is 14.0671. Since the obtained nR^2 value is higher than the critical χ^2 distributed value, the null hypothesis of no heteroskedasticity is rejected which means that we are in the presence of the phenomenon. Apart from the problem of heteroskedascity, is also encountered the problem of autocorrelation. From table 3 we can observe that the Durbin-Watson statistics is 0.467353 announcing the existence of positive autocorrelation. To correct for both problems we applied Generalized Least Square one-step weights with Seemingly Unrelated Regression Method (Zellner, 1962). The method of Seemingly Unrelated Regressions (SUR) allows for such correction and is efficient asymptotically and in small samples (Parks, 1967; Messener and Parks, 2004). The method features however the problem of downward bias of the estimated standard errors (Beck and Katz, 1995) and bootstrapped standard error technique is suggested (Messener and Parks, 2004). On the other hand, Atkinson and Wilson (1992) note that bootstrapped estimators also produce downward biased standard errors and cannot dominate the SUR estimator. We therefore apply the SUR method with results shown in table 4.2.4:

Table 4.2.4: SUR method results

Variable	Coefficient
lnSFBT	0.77 (9.53)***
lnRGDP	0.85 (6.51)***
lnRPRI	-0.32 (-1.33)
lnDIST	-0.58 (-3.98)***
TI	-0.33

	(-5.95)***
BOR	1.26 (4.47)***
TAX	0.072 (1.01)
R^2	0.19
Adjusted R^2	0.17
DW stat	1.97

t-stat shown in parenthesis. *** significance at 1% confidence intervals.

We have therefore reached a situation where heteroskedasticity and autocorrelation problems have been corrected. The next step is to determine whether model specification is preserved by running unit root test of the residuals with the same methods applied beforehand for the variables. Results are shown in table 4.2.5:

Table 4.2.5: Unit Root test for residuals

Method	Results
ADF	75.8402 (0.0003)
PP	64.5204

(0.0046)

The tests are conducted at individual intercept using Schwarz automatic lag selection, Bartlett method and Newey-West Automatic bandwidth selection. Probabilities are displayed in parenthesis.

From table 4.2.4 it can be observed that the residual is stationary at level therefore retaining model specification. In the end, we also performed Variance Inflation Factors (VIF) analysis (Fox and Monette, 1992) to test on the eventuality of multicollinearity. Results rejected such eventuality. Having performed all necessary tests, we can move on with the result explanation. Fixed effects dummies revealed none such.

4.3 Results

Variable coefficients and signs reflected what we somewhat expected prior to running the model. First, the variable representing sales from the Food, Beverage and Tobacco sector is positively related with commodity exports and supplies a statistical significance at 1% intervals. Some applies for the real GDP of partner country. On one side, the first variable carefully captured the demand effect from the users of plastic packaging. The larger the amount of sales of packed products, the larger the quantity of packaging demanded. On the other side, the second variable denotes that the larger the economy of the partner country, the more plastic packaging it exports to Denmark.

The variable capturing transportation costs (distance in km between the capitals) also produced the expected sign and statistical significance. The negative sign suggests that the larger the distance between Copenhagen and the partner country capital, the higher the transportation costs, the lower would be the imports from that partner country in terms of quantity. Once again, there is a statistical significance at 1% intervals. Additionally, the obtained sign and statistical significance from the common border dummy reveals the presence of substantial regional trade with neighboring countries. The positive sign and statistical significance at 1% intervals reflects the presence of intense trade relations (at least in terms of the commodity group in question) with partners sharing common borders. On the other hand, the trade integration dummy did not produce the expected sign. It would seem that the partner country being a EU member state (as Denmark) is reversely related to the dependent variable. Although surprising, it is not our major concern and we are not going to concentrate on this issue.

To our immediate concern are the remaining explanatory variables, namely the real price and especially the product charge dummy variables. First, the real price variable produced a negative coefficient suggesting an inverse relationship between real price and quantity imports. However, the t-statistic reflects a statistical insignificance therefore denoting the presence of a price insensitive import demand.

The other variable of paramount importance is the tax dummy capturing the impact of the product charge policy. The sign is positive but a statistical insignificance is present suggesting that the product charge was ineffective in reducing import demand at least in the case of the plastic packaging commodity group under investigation. This is all but surprising. Considering the presence of a price in-sensitive demand and the fact that tax policies are basically price related policies, such a result was expectable. By introducing both a price and a tax dummy in the equation as explanatory variables, we managed to separate the effects from one another. Of course, neither factor had any impact on the dependent variable.

4.4 Conclusions and discussions

The paper investigates the effectiveness of the 1999 Danish Weight basis product charge policy on the imports belonging to a major plastic packaging commodity group. To achieve the goal, we applied a trade gravitation regression model adopting quantity imports (expressed in kg) as a dependent variable. A tax dummy taking values 1 for the years when the tax policy was applied *i.e*. 2001-2007, was introduced amongst the explanatory variable.

The rest of explanatory variables included demand and supply proxies, transportation cost proxies, trade integration and regional trade proxies. Furthermore, a variable expressing real import price (before tax) was introduced to achieve a separation between the price and tax effect (should there be any effect). The sample included 19 major partner countries while the period of analysis stretched from 1994 until 2007 assuming full tax application starting in 2001. In order the correct for the heteroskedasticity and autocorrelation problems encountered in the OLS regression, Seeming Unrelated Regression (SUR) method was applied followed by unit root test of the residuals to judge on the retained model specification. Furthermore, we tested on the possibility of multicollinearity between explanatory variables rejecting such eventuality.

Model results reflected the following. Considering the revealed presence of a price insensitive demand, we were not surprised to find out that the impact of the product charge dummy variable was insignificant. The real price variable produced a negative sign but was statistically insignificant. The product charge variable produced a positive sign but was at the same time statistically insignificant. In the end, we could say that the Danish product charge policy was not effective at least in the case of the commodity group in question.

Apparently, environmental taxation policies remain very sensitive to the characteristics of the targeted product. By characteristics is meant the price sensitive or price in-sensitive demand for the product (in our case import demand) and the plastic packaging commodity group reflects a price in-sensitive demand. Furthermore, as mentioned in the literature section, Pearce and Turner (1993) suggest that product charges can impact by either stimulating a source reduction or incenting increased recycling rates. It wouldn`t be very realistic to pretend a direct source reduction at the first instant a tax is applied, however it is possible to achieve increased recycling (if such incremental rates are technically possible to achieve). Unfortunately, the recycling rates of plastic packaging suggest the presence of barriers to achieve improvements. EUROPEN (2009) report reveals that plastic packaging is characterized by the lowest recycling rates compared to all the other packaging types. In the EU-15 area, the rate reached 26% in 2006 increasing barely 8% since 1998. During the same period, Denmark has been improving the plastic packaging recycling rates but remains below the EU-15 average with a mere 20% in 2006. Apparently, the nature of plastic packaging does not allow for high recycling. Such recycling performance could help explain the price in-sensitive demand for virgin packaging. In the end, increasing quantities of virgin material penetrating in the market coupled with poor recycling performance lead to increased quantities of waste generation and an increased waste management problem.

Ultimately, some alternative taxation policy could be suggested at this point. An important variation would be the application of material levies. As described in the literature session, several technologies that enable same levels of production with lower quantities of raw material input are available in the case of plastic packaging (Hekkert et al, 2000). A material levy policy could stimulate the application of such technologies at larger scale improving material efficiency. Such technologies would achieve the goal of producing lighter packaging resulting in smaller quantities of waste. However, this resolves only one part of the problem considering that waste is as much an issue of volume as an issue of weight. Furthermore, the application of material levies would grant benefits in the case of producing countries. More insight on the alternative policies is reflected in chapter 8.

Chapter 5: Economical consequences in the case of effective policy

5.1 Introduction

In chapters 3 and 4, we analyzed the impact of the Danish packaging taxation policy in the cases of industrial paper/paperboard packaging and industrial plastic packaging. According to the econometric results, the policy was effective only in the first case (paper/paperboard packaging). Considering that the results from the two equations provide a strong price-demand relationship for paper/paperboard and weak price-demand relationship for plastic packaging, it can be assumed that the price sensitivity was the main factor for successful policy implementation in the first case; at the same time, price in-sensitivity was the inhibitor in the second case.

Therefore, in the case of paper/paperboard packaging, the demand decreased as result of the taxation policy. That is bound to produce economical consequences on the exporting partner countries and Denmark. In the case of the exporting partner countries, exports of the respective paper/paperboard suppliers (*i.e.* the national Pulp and Paper Product sectors, see Eurostat, 2010) diminish producing a loss in export earnings. Through the backward linkages, this loss is transmitted to the rest of the economy in the form of output and income loss. On the other hands, there are consequences on Denmark as well. In this case, imports decrease and the packaging purchasers find themselves with extra savings.

In order to determination the overall economic consequences, it is necessary to establish first the impact scale of the policy achievable through simulation. Unfortunately due to data unavailability we are unable to perform this task. The original equations of chapters 3 and 4 are aggregate panel data analysis. Carrying out econometric simulation by means of aggregated results for the purpose of disaggregated estimations (country by country) would produce biased results that do not really reflect an accurate impact scale. Another option is the establishment of general equilibrium models. Once again data unavailability and the fact that multiple countries are to be aggregated together increase the scale of difficulty making the task almost impossible. Therefore, we are not going to calculate the policy impact scale. All determinations of economic consequences would be determined on the base of paper/paperboard packaging unit (ton of packaging). In the case of the impact scale being higher than 1 ton (demand reduction by more than 1 ton), the determination of the overall economic impact is simply calculable by multiplying the reduction scale with per unit (per ton) economic impact.

The analysis is to be carried out separately for Denmark and the exporting countries. First, in the case of Denmark, there is import reduction; in the case of exporting countries there is symmetrical export reduction. Furthermore, in the case of the exporting countries, input-output impact analysis is applied on an annual base and country by country to determine the induced impact in terms of overall output and income reduction (through the backward linkages) (analysis conducted for Germany, Norway, the Netherlands, Finland

and France due to available input-output tables on annual basis for these countries only). Analysis for induced impact in Denmark is not carried out due to the fact that we are not aware on how the import expenditure savings are employed (only the direct import reduction is determined in the case of Denmark). In the analysis, we use non-competitive input-output tables in which the import component is already removed.

In the next section (5.2), the calculations are carried out in the case of Denmark, whilst in Section 5.3 input-output analysis results for each exporting country are shown.

5.2 Economic gains in Denmark

As we mentioned in the introductory part of this chapter, the domestic taxation policy produces a shrink in the import demand for industrial paper/paperboard packaging. In other words, the Danish paper/paperboard packaging purchasing industries will find themselves with extra amounts of monies (as a result of import savings). Therefore, Denmark experiences import expenditure saving. The amount of this savings is determined in terms of paper/paperboard packaging unit (1 ton) by multiplying the average annual import purchasing price of paper/paperboard packaging featured in terms of Euros per kg (Danish Statistics, 2010) to the analysis unit (1 ton = 1,000 kg) according to the following formula:

$$S_{IMPt} = P_{IMPt} \text{ x } D_{IMPt} \text{ (3),}$$

where S_{IMPt} represents Danish packaging import savings in period (year) t, P_{IMPt} represents packaging import unit price in period (year) t expressed in Euro/kg and D_{IMPt} represents the reduced Danish packaging import demand in period (year) t expressed in kg. As we mentioned earlier, we assume a constant D_{IMPt} in all years amounting to 1 ton = 1,000 kg. Calculations are carried out annually for the period 2001-2006 and results are shown in Table 5.3.1

Table 5.3.1: Danish average import price and annual import savings per ton of paper/paperboard packaging (Real 2000 Euros)

Year	2001	2002	2003	2004	2005	2006
Paper/paperboard packaging import unit price (Euro/kg)	3.22	2.20	1.77	1.96	2.59	2.65
Import savings reduction per 1 ton of paper/paperboard import demand	3,220.18	2,201.76	1,771.51	1,963.95	2,587.87	2,647.74

reduction (Euros)

Source: Danish Statistics (2010) and own calculations

According to the results, import savings per ton of paper develop a decrease from 2001 until 2003 (due to the decrease in the per kg import price) and increase again in the period 2004-2006 (due to the price increase). Obviously, import savings in Denmark represent export losses in the exporting countries in the same amount.

5.3 Economic costs in the exporting countries

As we mentioned in the introductory section, the exporting partner countries experience consequences symmetrical to those occurring in Denmark. As a result of the Danish taxation policy, the five countries witness the decline of their exports of paper/paperboard packaging to Denmark. Therefore, they lose export revenues.

The sector responsible for paper/paperboard packaging supply is the Pulp, Paper and Paper products sector (see Eurostat, 2010). As a result of export decline, the Pulp, Paper and Paper products sectors of the respective five countries experience a decline in their final demand. This decline is transmitted to the rest of the economy through the backward linkages of the sector in question producing declining effects in overall output and income.

In order to determine output and income impacts in the respective countries, we employ the input-output tables of these countries (Eurostat, 2010) and obtain the annual output and income multipliers of the Pulp, Paper and Paper products sectors for each country (Miller and Blair, 1985). Induced output effect is determined based on the following formula:

$$\Delta X = L\Delta f \quad (4)$$

where ΔX represents the induced output effect and Δf represents the change in final demand of the particular sector (in our case export reduction from the Pulp and Paper products sector of the Danish trade partners). L represents the Leontief inverse matrix (a.k.a. the multiplier) which is expressed as:

$$L = (I - A)^{-1} \quad (5),$$

where I represents the "identity matrix" and A the "technical coefficient matrix". We must emphasize that the output multipliers are calculated using input-output tables which are closed to the household sector. Therefore, these represent the total output multipliers inclusive of induced income effects. In order to separate the income effect, we commute the income multipliers as well. All annul multipliers by country are produced in Table 5.4.1.

Table 5.4.1: Annual output and income multipliers of the Pulp, Paper and Paper products sector for the five exporting countries

Year	2001	2002	2003	2004	2005	2006
Output multipliers						
Germany	2.4948	2.4489	2.4697	2.4622	2.5104	2.5876

Norway	2.34105	2.47418	2.52917	2.62536	2.65361	2.63632
Netherlands	2.72688	2.64923		2.67092	2.71367	2.75090
Finland	2.25565	2.34165	2.52197	2.55507	2.55507	2.72434
France	2.66648	2.65213	2.65014	2.68266	2.75567	2.84382
Income multipliers						
Germany	0.5912	0.5642	0.5709	0.5621	0.5406	0.5229
Norway	0.46658	0.54252	0.54142	0.52108	0.52108	0.50618
Netherlands	0.57463	0.57315		0.56999	0.55347	0.53645
Finland	0.36366	0.39143	0.44145	0.43263	0.42879	0.43017
France	0.55631	0.57239	0.58766	0.58981	0.59360	0.59493

Source: Eurostat (2010) and own calculations; input-output tables for year 2003 are not available for the Netherlands

Based on the multipliers from Table 5.4.1 and the figures from Table 5.3.1, we are able to determine the annual output and income losses in the case of each country as a result of the Danish policy induced export reduction (assuming 1 ton reduction of paper/paperboard packaging exports in the case of each country separately). Figures for annual output losses are shown in Table 5.4.2 and for income losses in Table 5.4.3.

Table 5.4.2: Annual output losses by country (per ton of paper/paperboard packaging export reduced) (Real 2000 Euros)

Year	Germany	Norway	Netherlands	Finland	France	Total
2001	8,033.70	7,538.61	8,781.04	7,263.87	8,586.73	40,203.94
2002	5,391.89	5,447.55	5,832.98	5,155.82	5,839.39	27,667.63
2003	4,375.10	4,480.45		4,467.80	4,694.74	18,018.09
2004	4,835.65	5,156.09	5,245.58	5,018.18	5,268.67	25,524.18
2005	6,496.59	6,867.19	7,022.74	6,612.24	7,131.71	34,130.47
2006	6,851.30	6,980.31	7,283.68	7,213.66	7,529.71	35,858.65
Total	35,984.24	36,470.21	34,166.01	35,731.57	39,050.94	181,402.96

Source: own calculations

Table 5.4.3: Annual income losses by country (per ton of paper/paperboard packaging export reduced) (Real 2000 Euros)

Year	Germany	Norway	Netherlands	Finland	France	Total
2001	1,903.77	1,502.47	1,850.41	1,171.05	1,791.42	8,219.11
2002	1,242.23	1,194.50	1,261.94	861.83	1,260.26	5,820.77
2003	1,011.36	959.13		782.03	1,041.05	3,793.57
2004	1,103.94	1,023.38	1,119.43	849.67	1,158.36	5,254.78

2005	1,399.00	1,348.49	1,432.31	1,109.65	1,536.16	6,825.61
2006	1,384.50	1,340.23	1,420.38	1,138.98	1,575.22	6,859.32
Total	8,044.80	7,368.20	7,084.47	5,913.21	8,362.47	36,773.15

Source: own calculations

According to the results from Table 5.4.2, total output loss per ton of paper/paperboard packaging across the 5 countries amounts to 181,400 Euros. Income losses amount to 36,000 Euros. The figures vary across the years and countries due to the change in the output and income multipliers.

5.5 Conclusions

Chapter 5 was dedicated to quantifying the economical benefits and costs associate with the successful implementation of the taxation policy in the case of paper/paperboard packaging. Under the impossibility to determine the impact scale of policy in terms of reduced demand, all calculations on economic consequences were made on a paper/paperboard unit base (1 ton). Afterwards, we calculated the differences between the actual imports from each country and the simulated ones to obtain the scale of impact of the policy.

First, we estimated Danish import reduction (import savings) per 1 ton of paper import reduction in annual terms. Danish import reduction represents at the same time export reduction for the counterparts (the exporting countries). In the next step, for the exporting countries, we determined induced output and income losses as a result of 1 ton paper/paperboard packaging export reduction applying input-output impact analysis. Estimations were carried out annually (period 2001-2006) and separately for five out of thirteen exporting countries included in the panel data equation (Germany, Norway, the Netherlands, Finland and France). The country choice is made based on data availability considerations. Overall, 1 ton annual paper/paperboard packaging export reduction for each country produces an overall output loss of 181,042 Euros and an overall income loss of 36,773 Euro across the six years of analysis.

The determination of economic consequences represents the first step in the cost-benefit analysis. In the next chapter, we are going to reflect the environmental benefits expressed in monetary fashion that accrue as a result of paper/paperboard packaging demand reduction. That represents the other flip of the coin in the path of overall cost-benefit analysis realization.

Chapter 6: Environmental benefits of the policy

6.1 Introduction

This chapter is dedicated to the calculation of the environmental benefits associated with the successful implementation of paper/paperboard packaging taxation policy in Denmark. As the previous chapters might suggest, the analysis is once again to be carried out for two cases separately: Denmark and the exporting partner countries. The division is conducted considering that the two categories (Denmark and the partner countries) experience different environmental benefits. Once again, all analysis is carried out in terms of ton of paper/paperboard packaging reduction.

In the next sections, we not just going to identify the environmental cases in the two cases, but also quantify them in monetary terms. The purpose will proof useful in the next chapter when we conduct total cost-benefit analysis for the exporting countries. In this case we are also going to explain how the conversion from non-monetarized to monetarized benefits is realized. In the next session, we begin with the case of Denmark: identification and quantification of environmental benefits.

6.2 Environmental benefits in Denmark

In order to determine the environmental benefits in Denmark, it is important to remind ourselves of the purpose of the taxation policy in the first place. Being that the objective is the reduction in packaging demand the purpose of the policy is waste management. The explanation is simple: lower packaging demand means lower packaging use; that is translated into reduced packaging disposal and therefore reduced packaging waste. In the end, reduced waste is the ultimate environmental benefit in Denmark.

In order to establish the monetarized environmental benefit, it is necessary to figure out what is that Denmark has gained or better what is that Denmark saved as a result of the packaging waste reduction. In other words: what is the cost of having waste. The two elements of waste in Denmark are collection and disposal (Eunomia, 2001). A report of 2001 to the Directorate General of the Environment at the European Commission (Eunomia, 2001), calculates collection costs of paper waste (including paper packaging waste) in Denmark to the amount of 74 Euros per ton of waste. Disposal costs on the other hand, depend on the disposal mechanism.

There are two types of disposal available in Denmark: landfilling and incineration. The same report calculates costs of landfilling to the amount of 94 Euros per ton of waste (including 44 Euros of gate fee and 50 Euros of tax). The report also mentions that landfilling is becoming less and less relevant due to bans. On the other hand, incineration costs include the following:

- Pre-tax cost net of revenue estimated at 30-45 Euro/ton (37.5 Euros/ton average);
- Tax estimated at 44 Euro/ton
- Bottom ash treatment estimated at 34 Euro/ton

- Flue gas residues treatment at 134 Euro/ton
- Total costs at 249.5 Euros per ton of waste (Eunomia, 2001)

6.3 Identifying environmental benefits in the partner countries

Having established the environmental benefits in the case of Denmark, we move on the determined the environmental benefits in the exporting countries (5 countries). As mentioned in the previous chapters, the reduction of exports from the respective countries produces economical costs which we promptly calculated in chapter 5. At the same time, the non-production is associated with induced environmental benefits coming in the form of saved emissions. The production of paper in general and paper/paperboard packaging in particular generates emissions divided into: waterborne and airborne (CEPI, 2009). The data on emission generation is obtained from the sustainability report of the Confederation of European Paper Industries (2009) in which the five countries part of our analysis are members. The data on annual waterborne and airborne emissions calculated in base of life-cycle analysis are shown in table 6.3.1:

Table 6.3.1: Specific Waterborne and Airborne emissions per ton of paper/paperboard production

	2000	2005	2006	2007
Waterborne emissions				
BOD (kg/t)	1.68	1.03	0.99	0.93
COD (kg/t)	9.08	6.65	6.69	6.57
AOX (kg/t)	0.0446	0.0412	0.0378	0.0344
Airborne emissions				
SO_2 (kg/t)	0.402	0.384	0.366	0.348
NOx (kg/t)	0.876	0.862	0.848	0.834
CO_2 direct (t/t)	0.43	0.38	0.36	0.35
CO_2 indirect (t/t)	0.15	0.11	0.13	0.12

Source: CEPI, 2009

Table 6.3.1 shows that paper production is quiet intensive in terms of CO_2 emissions. The differentiation between direct and indirect in the case of CO_2 is made to distinguish between the emissions at source (paper mills) and those induced on other sectors of the economy as a result of paper production. Additionally, it can be observed that paper production is comparatively not-intensive in terms of waterborne, SO_2 and NOx emissions.

As we have mentioned in the previous chapters, the analysis is to be conducted for the period 2001-2006. However, from table 24 it can be observed that specific emission data is missing for several years (2001-2004). In order to obtain the data for this year, we are forced to make an assumption. In all cases, the emission factor reduces between 2000 and 2005. We are going to assume that the reduction happens gradually and evenly across the years. Under this assumption, we are able to place emission factors for the missing years with the entire pictures shown in Table 6.3.2:

Table 6.3.2: Specific Waterborne and Airborne emissions per ton of paper/paperboard production

	2001	2002	2003	2004	2005	2006
Waterborne emissions						
BOD (kg/t)	1.5717	1.4634	1.3551	1.2468	1.03	0.99
COD (kg/t)	8.594	8.108	7.622	7.136	6.65	6.69
AOX (kg/t)	0.0446	0.0412	0.0378	0.0344	0.032	0.03
Airborne emissions						
SO_2 (kg/t)	0.402	0.384	0.366	0.348	0.35	0.33
NOx (kg/t)	0.876	0.862	0.848	0.834	0.86	0.82

CO_2 direct (t/t)	0.42	0.41	0.4	0.39	0.38	0.36
CO_2 indirect (t/t)	0.142	0.134	0.126	0.118	0.11	0.13

Source: CEPI (2009) and own calculations

The next step is to decide on the proper monerization factors that are to be applied for the conversation of emission in monetary shape.

6.4 Literature on the calculation of pollution costs

In this most, we are faced with perhaps the most difficult part of the analysis. Converting physical emission to monetary fashion is most controversial and uneasy considering that are many different estimations in the matter. In order to choose the appropriate “conversion factor”, we begin by providing a review of the existing literature on pollution cost calculation.

As one can intuitively figure out, the majority of studies and research in the matter address the issue of air pollution and CO_2 emissions. In the literature, CO_2 emission costs are defined in terms of Marginal Damage Cost (MDC) and/or Marginal Abatement Cost (MAC). Literature calculating or attempting to calculate MDC of CO_2 emission is quiet abundant. Tol (2005) reviews as many as 28 sources of MDC estimations. These estimates vary from very low figures, i.e. 3 USD/ton (Plambeck and Hope, 1996), 5.7 USD/ton

(Newell and Pizer, 2003); 5.9 USD/ton (Nordhaus and Boyer, 2000); to medium estimations, *i.e*. 85 USD/ton (Azar and Sterner, 1996); 101.5 USD/ton (Clarkson and Deyes, 2002); 170 USD/ton (Eyre et al., 1999); to very high estimations, i.e. 800 USD/ton (Hohmeyer, 1996); 1666.7 USD/ton (Hohmeyer and Gaertner, 1992). Olsthoorn (2001) calculates MDC in range from 1.10 to 25.7 Euro/ton. Tol (2005) argues that such costs can not be higher than 50 USD/ton in worst case. Martin-Cejas (2010) argues that it is very difficult to make the right choice in terms of estimations considering that different researchers employ different assumptions (particularly in terms of future developments in global warming) and different discount methods.

On the other hand, literature regarding MAC is less abundant. Criqui et al. (1999) commuted MAC curves for CO_2 emission for OECD and Annex B countries of the Kyoto protocol conducting under POLES method. In the group of OECD countries, 15 members of the EU are included. Figures reveal emission abatement for a shadow price ranging from 0 to 600 USD/ton. Kuik et al., (2008) conduct a meta-analysis on recent studies dealing with MAC calculations. They conclude that estimations are influenced by a number of factors including stabilization level, control variable choice, future technological assumptions etc. In the case of EU countries, under the 2°C target, MAC would range from 74 Euro/ton to 227 Euro/ton in 2025; and between 132 Euro/ton and 381 Euro/ton in 2030.

An important source of MAC estimations is the Gains-Europe model developed by IIASA as successor of the RAINS model (GAINS, 2011). The model provides estimates for emissions, mitigation potential and costs of air pollutants and greenhouse gases included in the Kyoto Protocol. Estimations are provided for 43 European countries including European Russia.

Regarding waterborne emissions, the available literature is much scarcer compared to airborne emissions and the studies are principally related to MAC estimations. Hailu (2003) investigates the issue of pollution abatement in the case of Canadian pulp and paper industries in the period 1970-1993. Analysis is conducted separately for 4 Canadian provinces (Quebec, Ontario, British Columbia and Atlantic and Prairies) as well as for all four combined for BOD and suspended solids (TSS). Figures on BOD shadow price reveal an increase in MAC from 30.06 dollars/metric tone in 1970 to 433.27 dollars/metric tone in 1993 with an average of 135.10 dollars/metric ton across all regions. Qi et al. (2004) estimate the MAC for BOD and other pollutants by country in the period 1980-2000. Figures of MAC in the case of BOD vary from 964 USD/metric ton (1995 international dollars) in the case of Japan to 77,714 USD/metric ton in the case of Canada. On the other hand, the Nordic Environmental Financial Corporation (NEFCO) produces estimates of BOD abatement cost for the projects included in the proper portfolio (NEFCO, 2007). The figure amounts to 320,000 Euros/ton.

6.5 Calculation of environmental benefits in the partner countries

Considering the ample literature at hand, we admit that it is not easy to make the right choice in terms of emission conversion factor. We are also aware that any choice we make will be reserved the benefit of doubt and the result use is to be prone of scrutiny. In any case, we have decided to include only two pollutants in our analysis. CO_2 is included on the basis that paper production exhibits high emission intensities in the matter. The MAC factor we use is provided by the GAINS model-Europe and is specific to the pulp and paper mills. The figure is estimated at 375 Euros/ton of CO_2. We must emphasize that this MAC factor is to be applied in the case of direct CO2 emission only. In the case of indirect CO_2 emission, we are unable to apply a single MAC factor. Therefore, we are forced to apply the MDC factor under two scenarios:

-low cost scenario at 50 USD/ton (Tol, 2005);

-high cost scenario at 1,666.7 USD/ton (Hohmeyer and Gaertner, 1992)

Under these assumptions, we are able to calculate the annual direct CO_2 emission benefits expressed in saved CO_2 emission costs by country. That is achieved by multiplying the calculated direct CO_2 emission savings from Table 6.3.2 to the 375 Euro/ton MAC factor. Figures are of course same for all countries being that both emission factors and monetarization factors are equal in the cases. The figures are shown in Table 6.5.1:

Table 6.5.1: Annul direct CO2 emission benefit in terms of saved costs (Euros)

Year	2001	2002	2003	2004	2005	2006
Cost	157.5	153.75	150	146.25	142.5	135

GAINS (2011) and own calculations

Indirect CO_2 emission benefits are commuted based on the two scenarios stated above. The figures for the low cost and high cost scenarios are shown in Table 6.5.2:

Table 6.5.2: Indirect CO2 emission savings under low cost and high cost scenario (Euros)

Year	2001	2002	2003	2004	2005	2006
Under low cost scenario	5.68	5.36	5.04	4.72	4.4	5.2
Under high-cost scenario	184.6	174.2	163.8	153.4	143	169

Tol (2005), Hohmeyer and Gaertner (1992) and own calculations

Additionally, we have commuted the environmental benefits in terms of saved BOD emission costs per ton of paper.. The figures are shown in Table 6.5.3:

Table 6.5.3: Annual saved BOD emission costs by country (Euro)

Year	2001	2002	2003	2004	2005	2006
Cost	502.944	468.288	433.632	398.976	329.6	316.8

NEFCO (2007) and own calculations

6.6 Conclusions

In chapter 6, we have shown the environmental benefits associated with paper/paperboard packaging reduction. Once again, the figures were shown for Denmark and the exporting countries. In the case of Denmark, benefits are associated with waster generation reduction. Waste costs are divided into collection and disposal costs. Collection costs are estimated at 74 Euros/ton whilst disposal costs are estimated under two scenarios: 94 Euro/ton in the case of landfilling and 249.5 Euros/ton in the case of incineration.

In the case of the exporting countries, the environmental benefits are associated with emission reduction as a result of paper/paperboard packaging production reduction. Firstly, we obtained emission factors (per ton of paper/paperboard produced) for three waterborne (BOD, COD and AOX) and three airborne pollutants (CO_2, SO_2 and NOx). Emission factors were obtained from the CEPI sustainability report (2009).

In the next step, we calculated annual saved emission costs by year (figures are same for all countries). The calculations were limited to CO_2 end BOD emission due to data availability. In the case of CO_2 emissions, MAC figures (GAINS, 2011) were applied for direct CO2 emissions. In the case of indirect CO_2 emission, MDC for a low cost scenario (50 USD/ton) and a high-cost scenario (1,666.7 USD/ton) were applied instead. For BOD emissions, we applied MAC (NEFCO, 2007).

As a last note, it is important to emphasize certain limitations that characterized our calculations. For one, we have failed to include the calculations for the rest of pollutants (COD, AOX, SO_2 and NOx) both in terms of direct and indirect emission saving costs. Also, indirect BOD emission savings were not incorporated in the analysis. On the other hand, we believe that the estimations conducted under the high-cost scenario for CO_2 emissions manage to compensate and provide balance for the pollutants that were not included in the analysis. Therefore, instead of providing exact estimation, we believe to have obtained an interval of the saved costs. Therefore, we believe the saved costs could not be higher than those commuted under the high-cost scenario for CO_2 emissions.

On this note we conclude chapter 6 moving on to the next one. In chapter 7, we provide the cost-benefit estimations pooling together all economical and environmental items of the analysis.

Chapter 7: Cost-benefit analysis

7.1 Introduction

In the previous chapter, we have calculated the economical and environmental costs and benefits for Denmark and the five exporting countries. In order to obtain a better picture of the induced effects from the Danish policy, it is important to pool together the cost and benefit items being both economic and environmental. In this way, we can commute the net benefit (or cost) and give a proper judging on the induced role of the policy.

In this chapter, we conduct the cost-benefit analysis at three levels:

- Industry level;
- Country level;
- International level

In all cases, the calculations will be conducted annually without any need for discounting and net value estimation. What we do is compare the costs and benefit that accrue in each year during the period 2001-2006. Aside from the cost-benefit difference calculation, we also commute cost/benefit ratios in all cases in order to determine the magnitude of each item relative to the other. Once again, all analysis is conducted at unit base (ton of paper/paperboard packaging). In section 7.2 we begin with the cost-benefit analysis at industry level.

7.2 Cost-benefit analysis at Industry Level

This cost benefit analysis will involve the exporting countries only. The industry in question is the Pulp and Paper industry producing the paper/paperboard packaging. In the previous chapter, we mentioned that the exporting countries experience export reduction. The cost of export reduction is export revenue loss (per ton of paper/paperboard packaging) as a result of the policy. This revenue loss represents the cost for the pulp and paper industry in each country.

On the other hand, we mentioned that as a result of non-production, the producing firms do not have to endure emission costs expressed in emission abatement. These saved costs were calculated in chapter 6 and involve direct CO_2 emission and BOD emission abatement representing the benefit accruing to the firms. In Table 7.2.1 are summarized the industry based costs and benefits accruing in the exporting countries as a result of the Danish policy:

Table 7.2.1: Summary of industry level costs and benefits

Costs	Benefits
Export revenue loss	Direct CO_2 emission saved abatement cost
	BOD emission saved abatement cost

Both costs and benefits have been calculated in the previous chapters. At this point we simply commute the annual cost-benefit differences and cost/benefit ratios by year. Considering that the analysis is carried out at unit of paper/paperboard packaging and also the price, emission factors and emission monerization factors are the same for all the countries, the cost-benefit differences and ratios are also same for all countries in all years. Therefore, the results shown in Table 7.2.2 are unique for all countries involved.

Table 7.2.2: Annual Cost-benefit differences (Euros) and cost-benefit ratio

Year	Cost-benefit difference (Euros)	Cost-benefit ratio
2001	2,559.732	4.88
2002	1,579.721	3.54
2003	1,187.879	3.04
2004	1,418.729	3.60
2005	2,115.769	5.48
2006	2,195.942	5.86

Own calculations

Results from Table 7.2.2 reveal that costs were higher than benefits in all years. In terms of ratio, the range is from 3 to 5.8. It can be observed an increase in cost-benefit ratio in the last years of analysis. That is partly due to the fact that the emission intensities decrease for both pollutants decreasing overall emission and therefore abatement costs. On the other hand, the commodity price increases in the period 2003-2006 worsening export revenue loss. In this way, as costs increase and benefits decrease, the cost-benefit ratio increases.

7.3 Cost-benefit analysis at country level

Having concluded the cost-benefit analysis at industry level, we move to the second part of the chapter: the calculations at country level. Once again, the analysis is conducted for the exporting countries only. In this case however, we experience a different set of costs and benefits. The economical costs are associated with the output loss induced as a result of the taxation policy in Denmark (per ton of paper/paperboard packaging demand reduction). The calculations for output and income loss were shown in chapter 5. However, as income is considered as part of the value added in the input-output tables, pooling it together with output would be considered a double-calculation. Therefore, in this case the cost is just the output loss.

On the other hand, the benefits are slightly different compared to section 7.2. Direct CO_2 emission and BOD emission saved abatement costs would be permanent in this calculation as the industries are also part of the country. To these benefits are added the indirect CO_2 emission saved abatement costs also shown in Chapter 6. We would like to remind that indirect CO_2 saved damage costs were determined under two carbon price scenarios. The summary of overall costs and benefits would be as shown in Table 7.3.1:

Table 7.3.1: Summary of costs and benefits at country level

Costs	Benefits
Annual output loss	Direct CO_2 emission saved abatement cost
	BOD emission saved abatement cost
	Indirect CO_2 emission saved damage cost

We would like to remind that indirect CO_2 saved abatement costs were calculated under two carbon cost scenarios: low-cost and high-cost. In addition, the cost-benefit analysis is also to be carried out under these same two scenarios. Once again, the calculations are conducted annually with cost-benefit differences and cost-benefit ratios commuted for each country. Results under the low-cost scenario are shown in Table 7.3.2

Table 7.3.2: Annual cost-benefit differences (Euros) and cost-benefit ratio at country level under low-cost scenario

Country	Germany		Norway		Netherlands	
Year	Difference	Ratio	Difference	Ratio	Difference	Ratio

2001	7,367.575	12.06	6,872.487	11.31	8,114.911	13.18
2002	4,764.492	8.59	4,820.155	8.68	5,205.578	9.29
2003	3,786.428	7.43	3,891.781	7.61		
2004	4,285.705	8.79	4,606.149	9.37	4,695.634	9.54
2005	6,020.094	13.63	6,390.686	14.41	6,546.245	14.73
2006	6,394.302	14.99	6,523.311	15.27	6,826.678	15.93

Country	Finland		France	
2001	6,597.746	10.90	7,920.603	12.89
2002	4,528.423	8.22	5,211.988	9.31
2003	3,879.13	7.59	4,106.065	7.97
2004	4,468.236	9.12	4,718.728	9.58
2005	6,135.737	13.87	6,655.207	14.96
2006	6,756.656	15.78	7,072.707	16.47

Own calculations

From Table 7.3.2, we can observe that the results are missing in the case of the Netherlands for year 2003. That is because as we have already explained, the input-output tables are not available for this country in this year. From the results we can observe that once again the costs are much higher than the benefits in all cases. The ratio experiences an increase in the period 2003-2006 because of the reason we explained in the previous section. Output losses are of course dependent on the Leontief production function and do not really posses a trend. The ratios are higher compared to the industry level case analysis since the increase in costs as a result of output inclusion is much higher than the increase in benefits as result of the indirect CO_2 emission saved abatement costs inclusion. In the next table 7.3.3, we show the result under the high-cost scenario:

Table 7.3.3: Annual cost-benefit differences (Euros) and cost-benefit ratio at country level under high-cost scenario

Country	Germany		Norway		Netherlands	
Year	Difference	Ratio	Difference	Ratio	Difference	Ratio
2001	7,188.655	9.50	6,693.567	8.92	7,935.991	10.39
2002	4,595.652	6.77	4,651.315	6.84	5,036.738	7.32
2003	3,627.668	5.85	3,733.021	5.99		
2004	4,137.025	6.92	4,457.469	7.38	4,546.954	7.51
2005	5,881.494	10.56	6,252.086	11.16	6,407.645	11.41
2006	6,230.502	11.03	6,359.511	11.24	6,662.878	11.73
Country	Finland		France			
2001	6,418.826	8.59	7,741.683	9.92		
2002	4,359.583	6.47	5,043.148	7.10		

2003	3,720.37	5.98	3,947.305	6.03
2004	4,319.556	7.18	4,570.048	7.16
2005	5,997.137	10.75	6,516.607	10.84
2006	6,592.856	11.62	6,908.907	12.00

Own calculations

As in the previous case, the costs are higher than the benefits. The ratios are however smaller considering that a higher carbon cost scenario is applied. Nevertheless, the ratios range between 5.85 and 12, witnessing a pressing superiority of costs over benefits. Without any doubt, paper/paperboard economical potential is higher compared to its pollution intensity. These figures could produce some serious consequences which we are going to touch upon in Chapter 9 when we refer to policy implications.

In the case of Denmark, we encounter a peculiar condition. The country experiences just benefits and no costs. As we mentioned earlier, the economic benefits are related to export savings whilst environmental benefits to avoided waste cost. The waste avoided cost is associated with the disposal scenario (landfill or incineration). When paper/paperboard packaging demand reduces by 1 ton/year (in Denmark), the overall annual benefits are shown in Table 7.3.4:

Table 7.3.4: Benefits experienced in Denmark as result of 1 ton reduction in demand

(Euro)

Year	Import savings	Waste avoided cost (landfill scenario)	Total benefit
2001	3,220.18	168	3,388.18
2002	2,201.76	168	2,369.76
2003	1,771.51	168	1,939.51
2004	1,963.95	168	2,131.95
2005	2,587.87	168	2,755.87
2006	2,647.74	168	2,815.74
Year	**Import savings**	**Waste avoided cost (incineration scenario)**	**Total benefit**
2001	3,220.18	323.5	3,543.68
2002	2,201.76	323.5	2,525.26
2003	1,771.51	323.5	2,095.01
2004	1,963.95	323.5	2,287.45
2005	2,587.87	323.5	2,911.37
2006	2,647.74	323.5	2,971.24

Eunomia (2001) and own calculations

Of course, as Denmark is experiencing only benefits, the cost-benefit ratios amount to 0 in all cases.

7.4 Cost Benefit analysis at International Level

In this last part of the analysis, the consequences experienced in Denmark are added to the equation. At this point, the analysis compares the overall benefits and costs occurring aggregately in Denmark and the five exporting countries. As we pointed out in chapter 5, Denmark experiences solely benefits reflected in terms of saved import expenditure and saved waste collection and disposal costs. By pooling together these items, we obtain the aggregate benefits accruing to Denmark. In the case of the exporting countries, the cost-benefit structure is the same summarized in section 7.3. The cumulated overall costs and benefits are displayed in Table 7.4.1:

Table 7.4.1: Summary of costs and benefits in Denmark and exporting countries

Costs	Benefits
	Import expenditure saving (Denmark)
Aggregate output loss in the five exporting countries	Waste accumulation and disposal cost saving (Denmark)

	Direct CO_2 emission saved abatement cost (exporting countries)
	BOD emission saved abatement cost (exporting countries)
	Indirect CO_2 emission saved damage cost (exporting countries)

Once again the analysis is conducted annually. We would like to remind from Chapter 5, that waste disposal cost calculation in Denmark were determined based on two disposal scenarios: incineration and landfilling. At the same time, indirect CO_2 emission saved damage costs in the exporting countries were calculated based on two-scenarios: low-cost and high-cost. Therefore, the cost-benefit analysis at International Level is conducted under four scenarios:

- Incineration and low-cost (Scenario 1)
- Incineration and high-cost (Scenario 2)
- Landfilling and low-cost (Scenario 3)

- Landfilling and high-cost (Scenario 4)

The analysis is carried out annually and by exporting country. In this case, exporting countries are considered as operating back-to-back with Denmark. The results under all four scenarios are shown in Table 7.4.2:

Table 7.4.2: Annual cost-benefit differences and ratios at international level

Scen.	1		2		3		4	
				Germany				
Year	Diff	Ratio	Diff	Ratio	Diff	Ratio	Diff	Ratio
2001	3,803.89	2.11	3,624.97	1.82	3,979.39	1.98	3,800.47	1.90
2002	2,219.23	2.43	2,050.39	1.61	2,394.73	1.79	2,225.89	1.70
2003	1,671.41	2.62	1,512.65	1.53	1,846.91	1.73	1,688.15	1.63
2004	1,978.25	2.44	1,829.57	1.61	2,153.75	1.80	2,005.07	1.71
2005	3,088.72	2.10	2,950.12	1.83	3,264.22	2.00	3,125.62	1.93
2006	3,403.06	2.01	3,239.26	1.90	3,578.56	2.09	3,414.76	1.99
				Norway				
2001	3,308.811	1.78	3,129.89	1.71	3,484.311	1.86	3,305.39	1.78
2002	2,274.89	1.72	2,106.05	1.63	2,450.39	1.82	2,281.55	1.72

2003	1,776.77	1.66	1,618.01	1.57	1,952.27	1.77	1,793.51	1.67
2004	2,298.69	1.80	2,150.01	1.72	2,474.19	1.92	2,325.51	1.82
2005	3,459.31	2.02	3,320.71	1.94	3,634.81	2.12	3,496.21	2.04
2006	3,532.06	2.02	3,368.26	1.93	3,707.56	2.13	3,543.76	2.03
				Netherlands				
2001	4,551.23	2.08	4,372.31	1.99	4,726.73	2.17	4,547.81	2.07
2002	2,660.31	1.84	2,491.47	1.75	2,835.81	1.95	2,666.97	1.84
2003								
2004	2,388.18	1.84	2,239.	1.74	2,563.68	1.96	2,415	1.85
2005	3,614.87	2.06	3,476.27	1.98	3,790.37	2.17	3,651.77	2.08
2006	3,835.43	2.11	3,671.63	2.02	4,010.93	2.23	3,847.13	2.12
				Finland				
2001	3,034.07	1.72	2,855.15	1.65	3,209.57	1.79	3,030.65	1.72
2002	2,450.39	1.63	1,814.32	1.54	2,158.66	1.72	1,989.82	1.63
2003	1,952.27	1.65	1,605.35	1.56	1,939.61	1.77	1,780.85	1.66
2004	2,474.19	1.76	2,012.10	1.67	2,336.28	1.87	2,187.60	1.77
2005	3,634.81	1.94	3,065.76	1.86	3,379.86	2.05	3,241.26	1.96
2006	3,707.569	2.09	3,601.613	2.00	3,940.913	2.20	3,777.113	2.10
				France				

2001	4,356.92	2.03	4,178.00	1.95	4,532.42	2.12	4,353.50	2.03
2002	2,666.72	1.84	2,497.88	1.75	2,842.22	1.95	2,673.38	1.84
2003	1,991.05	1.74	1,832.29	1.64	2,166.55	1.86	2,007.79	1.75
2004	2,411.273	1.84	2,262.59	1.75	2,586.77	1.96	2,438.09	1.86
2005	3,723.837	2.09	3,585.237	2.01	3,899.337	2.21	3,760.73	2.12
2006	4,081.46	2.18	3,917.66	2.08	4,256.96	2.30	4,093.16	2.19

Own calculations

The results from Table 7.4.2 reveal a shrunk supremacy of costs over benefits. Both differences and ratios become smaller, however costs remain higher than benefits even under very generous emission monetarization factors.

7.5 Conclusions

In Chapter 7, we have conducted annual cost-benefit analysis for the induced impact of the Danish packaging taxation policy in the case of paper/paperboard packaging. According to the methodology, the cost-benefit differences and ratios were calculated annually for the period 2001-2006 (the period of policy application) without any need for discounting.

First, we compared the costs and benefit at industry level: costs and benefits affecting the pulp and paper industries of the five exporting countries. In this case, the costs were represented by the annual export revenue losses, whilst benefits represented the saved abatement costs for direct CO_2 and BOD emissions. The analysis was conducted separately for each country. According to the results, costs were much higher than benefits in all countries and all years with ratios ranging between 3 and 5.86. It was observed an increase in ratios for the period 2003-2006 that explained on reduced emission intensities.

Secondly, we conducted the analysis for the overall costs and benefits accruing to the exporting countries as a whole (not just the respective pulp and paper industries). In this case, costs included the annual output losses whilst benefits the saved emission abatement for direct CO_2 and BOD emission, and saved damage costs in the case of indirect CO_2 emissions. Considering that the calculation of saved damage cost for indirect CO_2 emissions were carried out under the two cost scenarios (low-cost and high-cost), the same principle was applied in terms of cost-benefit analysis. Under both scenarios, costs had the supremacy over benefits. This supremacy was witnessed as more vivid in the case of the low-cost scenario with ratios ranging between 7.43 and 14.96. Under the high-cost scenario the ratios were smaller compared to the low-cost scenario (ranging between 5.86 and 12). In any case, under both cases, the benefits were not even remotely comparable to costs.

Last, the analysis was conducted by pooling together the overall costs and benefits affecting Denmark and the five exporting countries on a back-to-back basis (each exporting country against Denmark). In this case, the Danish benefits expressed in import expenditure saving and saved waste cost were added to the equation with the rest of cost and benefits remaining the same as in the country level investigation. The analysis was conducted based on four scenarios coupling waste disposal type s(incineration and landfilling) in Denmark with saved damage cost scenarios for indirect CO_2 emissions in the exporting countries. Under these circumstances, the cost-benefit ratios become relatively smaller (ranging between 1.63 and 2.62), however still costs remain higher compared to the benefits. These facts have important implications which we are going to discuss in the last chapter.

Chapter 8: The alternative policy in the case of plastic packaging

8.1 Introduction

In Chapter 4, we analyzed the effectiveness of the taxation policy in the case of the selected plastic packaging commodity group including boxes, crates, plates and cups made of plastic. According to the result, the taxation policy did not manage to reduce import demand for this commodity group. Instead, the taxation dummy variable was positively related (albeit statistically insignificant) to the import demand raising the question of the commodity behaving as a luxurious good. At the same time, the price variable was negatively related to demand but statistically insignificant signaling that the price does not affect the demand very much in the case of this commodity (relative price in-sensitive).

In this chapter, we investigate the possible causes that might have produced tax ineffectiveness in this case. The process is carried out through literature review (particularly engineering articles) associated with plastic packaging in general and the commodity group under analysis in particular. Furthermore, we attempt to find and propose an alternative policy that might produce a positive impact in terms of reduced demand for the commodity group. Last, we assume the application of the policy in Denmark for the period 2001-2007 and investigate the possible outcomes.

8.2 Possible cause of tax ineffectiveness

In the chapter 2, we pointed out that there were two ways the tax could promote the desired outcome:

- direct source reduction (using less packaging);
- increased recycling;
- or both;

In the short run, the first option is out of question. The available technologies reflect source reduction as unavailable at least for the moment (Hekkert et al., 2000a; 2000b). Therefore, the only applicable option is increased recycling. In this way, the issue becomes very simple: if it is possible to recycle and/or increase recycling rate, the taxation policy is effective being that it taxes only “virgin” and not recycled packaging. However, in the inability to recycle and/or when recycling is comparatively expensive, the packaging users would not change their behavior continuing to purchase “virgin” packaging although at a higher price. Than the question is: what are the possibilities for plastic packaging recycling?

Starreveld and Van Ierland (1994) investigate the possibility of tax application for plastic recycling increment (including packaging) in European countries. They find out that plastic recycling is very difficult since the costs of recycling are very high. Only the application of very high tax rates would allow for recycling to occur. The application of such high taxes would be an enormous economic distortion of the market and might lead to eventually no positive outcomes in terms of recycling behavior. Chappin et al. (2005) investigate the pattern of packaging waste behavior in the Netherlands in the period 1986-1999. They conclude that product re-use and recycling was a main factor that decreased the amount of packaging waste in general. In the specific case of plastic packaging, recycling and re-use is experienced mainly in the category of beverage containers (PETE bottles) and not in the rest of group. Re-use and recycling remains poor for plastic boxes and containers used mainly in the food packaging department. Shenta et al. (1998) investigate the possibilities of plastic recycling by conducting physical research. They conclude that since plastic materials are mixed for product production, it is very difficult to separate them from one-another. The available technological processes that allow for separation feature various limitations maintaining separation costs high. Fletcher and Mackay (1995) analyze plastic packaging recycling behavior in Australia. The find out difficulties in terms of recycling achievement due to the short economical life of plastic packaging; economical life which is much shorter compared to the physical life.

Another way on the possible increasing recycling effect as a result of the taxation policy in the case of Denmark is by viewing the figures for packaging recycling before and after the policy application as compared to recycling for other packaging materials. Data is shown in Table 8.2.1:

Table 8.2.1: Recycling rates (%) for packaging materials in Denmark

Material	1998	1999	2000	2001	2002	2003	2004	2005	2006
Glass	75	85	80	76	90	95	102	109	115
Metal	40	36	48	40	44	40	40	60	63
Plastic	6	11	13	14	15	17	16	19	20
Paper	58	59	62	65	61	60-	59	60	62

Source: EUROPEN, 2009

The recycling rate for plastic packaging increased nearly 6% between 2001 and 2006 (the years when the policy was applied). We have to emphasize that the figures reflect recycling rates for the overall plastic packaging group which includes commodities that are not subject to the taxation policy under investigation. As a matter of fact, beverage packaging (like PET bottles) display very high recycling rates (more than 80%) (Hemmingsen, 2011). These high figures for this particular commodity impact the overall recycling rate for the entire plastic group. Therefore, if beverage packaging is removed, the recycling rates for the rest of plastic packaging would be much smaller (perhaps close to 1%).

Therefore, the literature and data seem to emphasize the difficulties to recycle non-beverage plastic packaging. Under these circumstances, an alternative possibility is to be searched and implemented.

8.3 The alternative option

Considering that recycling is also a minor possibility in the case of plastic packaging, an alternative solution has to surface. From the literature, we find out that such an alternative could be improved material efficiency resulting in reduced packaging weight. Worrel et al. (1994) discover the material efficiency improvement being possible in the case of the Netherlands. Using 1988 as base year, they find out material reduction potential for plastic packaging at 34 ± 7% (157 ± 30 ktonne of virgin plastic); plus improved energy efficiency in the amount of 31%. Hekkert et al. (2000) find out packaging improvements through the development of lighter packaging, material substitution and reuse in European countries. In the case of plastic packaging, they advance the following improvements with respective CO_2 emission reduction:

Table 8.3.1: Packaging improvement technological changes

Category	Old Technology	New Technology	CO_2 emission reduction (%)
Lighter	PP film	PP film thin	1.1

packaging			
Lighter packaging	LDPE film	LDPE film thin	1.1
Lighter packaging	HDPE bottle	Light HDPE bottle	1.8
Substitution	PS cup	PP cup	1.4
Recycling	PET bottle one way	PET bottle to be recycled	1.0
	Light HDPE bottle	Recycled HDPE bottle	2.9
Re-use	PET bottle one way + PET bottle to be recycled	PET bottle reuse recycled	15.1

Source: Hekkert et al. (2000)

From Table 8.3.1, we can observe that the majority of technological changes include beverage packaging and plastic packaging film (categories not under the taxation policy subject of investigation). On the other hand, PS cups and PP cups are subject to the taxation object of our analysis.

PS and PP cups are amply employed in the food industry for the packaging of diary products (cheese, butter, margarine, milk cream etc.). Hekkert et al. (2000) take a 14 g PS cup as standard reference and propose the substitution with a 12 g standard PP reference cup enabling a 14.2% decrease in total weight in the case of purchased packaging. Considering the difficulties of plastic packaging recycle, 14.2% decrease in packaging use would mean 14.2% decrease in terms of packaging generated waste. Benefits would also occur at the production end considering that gross energy requirement for a standard PS cup is higher compared to the PP cup, respectively 102.1 GJ/t and 80 GJ/ton (Hekkert et al., 2000) not to mention the 1.4% reduction in terms of CO_2 emissions. No barrier to this technological change is reported. The possible application of this technology in the case of Denmark is going to be analyzed in the next section.

8.4 Application of technological change in Denmark

In this section, we are going to assume that between 2001 and 2007, Denmark managed to successfully promote the technological change of substituting PS cups for PP cups. In this case, we take the annual PS cup demand in Denmark between 2001 and 2007 and convert it to the PP cup equivalent under the 14.2% weight reduction, commuting the weight differences for each year. The results are shown on table 8.4.1

Table 8.4.1: PP cup for PS cup conversion in Denmark (2001-2007)

Year	2001	2002	2003	2004	2005	2006	2007
PS cup demand (t)	3,929	3,856	4,148	5,278	5,362	5,109	5,859
PP cup equivalent (t)	3,339	3,277.60	3,525.80	4,486	4,557	4,342.65	4,980
Diff (t)	-589.35	-578.4	-622.2	-791.7	-804.3	-766.35	-878.85

Source: Danish Environmental Protection Agency (2009) and own calculations; negative sign in the last row denoting the weight reduction as a result of the substitution

According to the results, the application of this technological change in the case of Denmark would enable a packaging weight reduction of 5,031 tons across the 7 years. That is translated in reduced waste cost estimated at 472,914 Euros across the 7 years, applying a 94 Euro/ton landfilling cost for plastic packaging in Denmark (Eunomia, 2001). Furthermore, the exporting countries would experience a total of 111,188.4 GJ on energy saving and 1.4% decrease in CO_2 emission for packaging production.

The benefits mentioned above did not materialize since the taxation policy that Denmark applied does not differentiate between PS and PP cups. Instead, a unique tariff is levied on both commodities. Under these circumstances, the packaging users are indifferent between

PS and PP cups having not incentives to choose the later. The possible solution is this case would be the modification of the taxation structure maintaining the tariff for PS cups and reducing or removing it completely for PP cups. Another possibility is the application of a packaging standard forbidding the use of PS cups overall.

8.5 Conclusions

In chapter 8, we have investigated the possible cause of the taxation policy ineffectiveness in the case of the plastic packaging commodity group. Additionally, we have looked into possible solutions to the problem and advanced two alternative policies. The problem of policy ineffectiveness is associated to the difficult and expensive recycling opportunities for non-beverage plastic packaging. That is also confirmed by the poor recycling rates for these commodities.

The alternative solutions suggested by the literature are related to material efficiency improvements. More specifically, we looked into the possible substitution of PS cups for PP cups and found out that this technological change is applicable in the case of Denmark considering that the literature reports no barriers.

In section 8.4, we simulated this technological application in the case of Denmark substituting annual PS cup demand with the PP cup equivalent. According to the results, Denmark would have saved around 5,000 tons of packaging purchase translated into 5,000 tons of reduced waste and 472,914 Euros of reduced waste disposal cost. Positive benefits are also experienced in the exporting countries in terms of energy saving and CO_2 emission saving.

Considering that the actual taxation structure does not incent this technological change due to the fact that does not differentiate between the two commodities, we advance two alternative policies. Denmark could change the taxation structure allowing for the tariffs being levied on PS cups only and reduced or completely removed for PP cups. Otherwise, Denmark could install a packaging standard forbidding the use of PS cups.

Chapter 9: Conclusion and policy implications

9.1 Introduction, study limitations, future research prospects and contributions

In the past 8 chapters, we have conducted an investigation around the Danish taxation policy for paper/paperboard and plastic packaging. We have analyzed the policy effectiveness, the induced economical consequences and environmental benefits. Additionally, we have conducted a cost-benefit analysis pooling the economic and environmental items together (determined per ton of paper/paperboard packaging demand reduction). Additionally in the case of policy ineffectiveness, we have advanced proposals for alternative solutions that would ultimately bring the desired benefits. The 9^{th} and last chapter addresses two main issues. First, it provides a general summary of all the research with particular emphasis on the conclusions generated at each step. Secondly, it touches upon the issue of policy implications associated with the different conclusions.

Before we move on to actual summary and discussion topic, it is important to emphasize the contributions and certain limitations characterizing this investigation. Starting with the limitations, those can be associated with general objectives, methodology and conclusions. Beginning with the study`s objectives, we could mention the fact that the policy scale of impact is not determined in this investigation. Truly, we have determined the policy effectiveness (in the case of paper/paperboard packaging). However we have not determined: “by how much” did the policy manage to reduce packaging demand for each given trading partner? As we have mentioned in chapter 2, that is associated with the available data. Unfortunately, time series data for imports by each trading partner are not long enough to conduct separate time series analysis with a model for each country. Additionally, although we point out to the fact that packaging users (the industries) responded by increasing their recycling rates, it was not the scope of this investigation to figure out how each packaging user economic unit reacted to the policy. Obviously, recycling augmentation potentials are different across packaging users and they do not all respond by lowering the virgin packaging demand by the same scale. Regarding the investigation methodology, we already pointed out in chapter 2 the limitations and assumptions associated with the application of trade gravitation model and input-output impact analysis. Once again, we emphasize that the methodology choice was dictated by the data availability at this moment.

Regarding future prospect, we feel that the calculation of the scale of impact and differentiated users` responses represent the cornerstone of our future research projects. Obviously, these would require a more sophisticated methodology and mode detailed data input. General equilibrium modeling would represent the obvious choice considering its ability to capture such changes at different scales across stakeholders. However, we have to remind also the connecting problem associated with the fact that multiple countries have to be incorporated into the model since the packaging issue involves a user`s angle (the industries in Denmark) and also a supplier angle (the producing firms in the exporting countries). Incorporating all these factors together, especially during a period that is not the present is a big barrier.

Nevertheless, the research as it is features certain contribution. In chapter 1, we have mentioned the contributions associate with the scope of this investigation regarding the selection of a packaging tax applied on industrial packaging users; the fact that a stand-alone packaging market based (without a circumventing command and control target policy) instrument is investigated; investigation of a market instrument applied on non-beverage packaging; the analysis of economic and environmental cost and benefits including a cost-benefit analysis in case of effective policy application. Contribution is also associated with the alternative policy we advanced in the case of plastic packaging. Furthermore, contributions are to be associated with the chosen methodology as well. The applied approach per se is not an innovation, considering that trade gravitation model and input-output impact analysis are long established methods. However, we have applied a bilateral trade model to explain the demand for “environmentally intensive” commodities. Additionally, unlike the cases studies where gravitation model are applied to capture the effect of trade and demand stimulating factors, we apply a model with the purpose of capturing the impact of a trade and demand inhibiting circumstance (the taxation policy). Additionally, we have applied the input-output impact analysis to determine the associated economic costs sourcing from environmental policy in the specific case of packaging demand and a packaging demand policy. Ultimately, the cost-benefit analysis we carry out in chapter 7 represents an important issue as it raises questions on the general justification of this policy in the case of Denmark and elsewhere.

9.2 Taxation policy application

In chapters 3 and 4, we analyzed the policy effectiveness for two packaging groups: paper/paperboard and plastics. In chapter 2, we justified our choice on the basis that paper/paperboard represents the major packaging group in terms of volume, whilst plastic packaging is the fastest increasing. Furthermore, the literature seems to point out that paper/paperboard packaging exhibits a price insensitive demand, whilst plastic packaging a price insensitive one. Considering that taxation policy represents a price market based policy, we foresaw different results between the two cases. The analysis is constructed around packaging import demand since Denmark represents a predominant packaging importer (not producer).

The applied methodology consisted of two separate econometrical gravitational models incorporating packaging import demand for paper/paperboard and plastic packaging respectively as dependent variables. Independent variables included proxy of demand, price, transportation costs, trade integration and also a dummy variable capturing the impact of the taxation policy. Carefully, we managed to separate the pure market price effect (price without tax) from the taxation effect including price before tax as an explanatory variable in the equation. The models were constructed around panel data analysis with a 13 country set in the case of paper/paperboard packaging and 19 in the case of plastic packaging. The partner countries were selected to include the majority of import partners in each case. The period of analysis stretched between 1994 and 2007 assuming the taxation policy application commencing in year 2001 (dummy variable of tax becoming 1 from 2001 until 2007). The models were run under Seemingly Unrelated Regressions (SUR) to resolve the problems of autocorrelation and heteroskedasticity encountered in the OLS regression.

The results revealed what we had anticipated beforehand. The taxation policy was effective only in the case of paper/paperboard packaging with the dummy variable exhibiting a negative sign and high statistical significance (at 1% intervals). The price variable exhibited similar sign and statistical significance denoting the import demand to be affected by both market price and tax. In the case of plastic packaging, the tax dummy exhibited a positive sign and statistical insignificance. Additionally, the price variable exhibited a negative sign but was also insignificant. Therefore, the strong price-demand relations seemed to be the reason for positive policy effect in the case of paper/paperboard packaging. In the case of plastic packaging, the relatively weak demand-price relation was deemed the reason for non-effective policy application.

9.3 Induced effects

Upon evidencing the policy effectiveness in the case of paper/paperboard packaging, we moved to determine the induced economic and environmental effects associated with the policy in Denmark and the exporting countries respectively. Additionally, we attempted to compare the induced costs and benefits under different levels and scenarios for the period of policy application 2001-2006. In the analysis, we included apart from Denmark, five exporting partner countries: Germany, Norway, the Netherlands, Finland and France. The choice of only 5 countries out of 13 included in the panel data estimation is dictated on the basis of data availability. For the determination of induced economic costs in the exporting countries, we applied input-output impact analysis and input output tables are available annually only for the 5 countries mentioned above. Also, the tables are not available for year 2007 forcing us to remove it from the analysis.

As we were unable to determine the policy impact scale (due to data unavailability), we conducted the economic and environmental impact calculation based on paper/paperboard unit (ton). From the results of chapters 3 we realized that the demand for packaging was reduced in the case of paper/paperboard (although we could not determine by how much). In any case, cost-benefit determination and comparison would be the same weather the analysis is carried out at unit base or impact base.

In the case of Denmark, the economic consequences are represented in terms of import savings. Indeed, reduced packaging demand is translated in reduced packaging imports and therefore reduced import expenditure. On the other hand, exporting countries experience export losses symmetric to Danish gains. Furthermore, the exporting countries experience induced effects in terms of overall output and income losses. The calculation of these induced losses were carried out by means of input-output impact analysis conducted annually (in the period 2001-2006) and for each exporting country

The additional benefit in Denmark is environmental and is related to the saved waste costs as a result of reduced packaging demand. These saved costs were determined based on saved collection cost and saved disposal costs. To calculate the later, we advanced two scenarios of disposal: total incineration and total landfilling. Total saved waste costs were calculated based on the two scenarios separately.

On the other hand, the exporting countries experience emission reduction as a result of non-production. In chapter 6, we calculated annual emission savings for three airborne and three waterborne pollutants. Saved emission costs were ultimately calculated for CO_2 and BOD emissions only due to the fact of data availability. In the case of CO_2 emissions, calculations were conducted separately for the direct emissions bound to the pulp and paper industries (the packaging producers) and indirect CO_2 emission associated with the induced effect to the rest of the economy. In the case of the former, MAC factors were applied; in the case of the later MDC factors were applied instead due to abatement data unavailability for the rest of the economy. MDC factors were applied according to two scenarios: low-cost and high-cost. For BOD, we applied MAC factors only.

Having calculated, the induced economical and environmental costs and benefits (per ton of paper/paperboard packaging export demand reduction), we moved on to compare them in a cost-benefit analysis carried out in three levels. First, the analysis was conducted for the pulp and paper industries of the exporting countries. In this case, annual export revenue losses were compared to the saved abatement costs for direct CO_2 and BOD emissions. Under all circumstances, the costs far superseded the benefits with cost-benefit ratios ranging between 3 and 5.86.

Next, the analysis for conducted at national level in the case of the exporting countries. In this case, output losses were compared to the emission savings in terms of direct CO_2 abatement cost, BOD abatement cost and indirect CO_2 damage cost. The analysis was conducted separately for each scenario of indirect CO_2 emission cost. Once again, the costs far outreached the benefits.

In the third case, Denmark was included in the analysis which compared the overall costs with overall benefits under four different scenarios. Once again, costs were higher than the benefits in all cases but the cost-benefit ratios were much smaller compared to the previous analysis.

9.4 Policy implications regarding the effectiveness matter

In relation to the issue of effectiveness, the taxation policy is effective only in the case of paper/paperboard packaging and not in the case of plastic packaging. Therefore, the policy is justified in respect to its objective in the case of paper/paperboard packaging. The existence of a strong price sensitive demand in the case of this commodity group, represent the reason of effectiveness and justification. In the case of plastic packaging, the weak price-demand relation is the reason for the policy ineffectiveness, making the policy not justifiable in the case of this commodity group.

In chapter 8, we emphasized how the opportunities to enhance recycling rates played in favor of the taxation policy in the case of paper/paperboard packaging. In the case of plastic packaging, recycling opportunities are scarcer and more expensive, making it more difficult to change behavior (substitute virgin with recycled packaging). The alternative would be improved material efficiency and we showed how the technological change featuring substitution of PS cups with PP cups would produce positive outcomes. In order to achieve this technological change, we proposed the taxation differentiation strategy or the adoption of a packaging user standard. In both cases, the emphasis is on incenting the use of PP cups over PS cups.

On the other hand, in the case of paper/paperboard packaging, the policy implication is to retain the existing policy. As far as the policy objective is concerned, taxation is working just fine for the time being and the effect could be enhanced in the future considering that there is still ample opportunities to recycle paper/paperboard. In the case of plastic packaging, the policy is not appropriate in the present fashion. Tariff differentiation is necessary to promote the positive outcome or transition to a harder line policy (standard) is the necessary alternative if the country persists in pursuing a packaging demand reduction objective. However, if the country wishes to pursuit a revenue accumulation objective, the policy is fine as it is. The necessary environmental benefits however, are to be forfeited.

9.5 Implications regarding induced effects

Under the cost-benefit analysis, the costs exceeded the benefits in all circumstances. Particularly, in the analysis focused on the exporting countries alone, the ratio reached 12 and 14. That does not mean that the policy is non-justifiable considering that the policy objective is waste management and not emission mitigation. However, the fact remains that the economical potential of paper/paperboard is much higher than its environmental intensity putting pressures on the policy justification.

This phenomenon of costs highly outweighing benefits in the case of paper industries brings about the problem of trade diversion. We have mentioned in chapter 2 the problems of “carbon leakage”. In this case, a problem of “packaging leakage” or “package dumping” might occur. In other words, the exporting countries faced with export revenue losses, might be forced to search, find and exploit alternative markets with less strict or no environmental policy whatsoever. Under these circumstances, the Danish policy instead of solving the problem, simply exports the problem to another area.

The occurring of trade diversion was not analyzed in this research. The first reason is that we focus on the short-term effect of the policy, whilst trade diversion takes a longer time to surface. Additionally, as we mentioned in chapter 2, the European countries have advanced different packaging policies at different times. Associating packaging trade diversion to each policy separately could be difficult if not impossible. That is also a problem pointed out by the literature. Furthermore, the analysis would require for demand proxies of the importing countries and in the case of particular developing countries, obtaining this kind of information could be very difficult due to data unavailability. Overlooking these factors might produce biased results.

Nevertheless, we acknowledge that the risk of trade diversion exists and could potentially materialize in the future (assuming it has not materialized yet). Some countermeasures could be necessary to ease or eliminate the effect. One solution could be the implementation of Border Adjustment Tax (Moore, 2010) in the case of packaging leaving the European Union. That would remove any incentive on European producers to search for less-strict markets as a result of EU domestic policies. However, the application of such measures requires the adoption of a single packaging policy in the Union and this circumstance is not yet a reality.

A major problem might be associated with the fact of costs outweighing benefits at society level (international level in our analysis). In the cost-benefit analysis conducted at international level, we merged the producer (exporter) and the consumer (importer a.k.a. Denmark). In this case, we imagine the policy being implemented in one country being both producer and consumer (one society). Once again, costs were much higher compared to the benefits. This might produce doubts on the general justification for applying such policy. Obviously, it is more costly than it is beneficial. Future potential applicants must keep this in close consideration.

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