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Carbon Pricing as a Policy Instrument to Reduce Energy Based Emissions in Apparel Sector

T.L.W. Karunaratne and T.S. Jayawickrama
Department of Building Economics
University of Moratuwa
Sri Lanka
tkarunaratne.uom@gmail.com, tsjayawickrama@yahoo.com

Abstract

Price based emission reduction instruments are deemed to be effective in achieving emission reductions, as they induce emission reductions through price signals, and also generate revenues which can later be used. Among all, carbon tax systems and emission trading schemes are identified as the most popular pricing instruments. The success of a carbon pricing instrument heavily depends on the way the firms respond to it after the implementation. However, a study conducted on assessing the response of firms is not done. Hence, this research was aimed at evaluating the response of firms to carbon pricing instruments in Sri Lankan apparel sector. Initially, a comprehensive literature review was carried out from which a conceptual framework was developed, indicating how carbon pricing policy instruments are derived from principles of environmental economics and five decision alternatives available for firms in response to carbon pricing instruments. From the expert interviews it was found that the above decision is influenced by three decision criteria, which indicated analytic hierarchy process (AHP) as the best method to identify the response of firms. Hence, as a part of this study, hierarchical structure of AHP was developed using the findings of literature review and expert interviews.

Keywords
Carbon pricing instruments, carbon tax, emission trading scheme and climate change

1. Introduction

In order to address the issue of climate change and global warming, countries have reached agreements over individual and collective commitments to reduce harmful emissions. Initiation of United Nations Framework Convention on Climate Change (UNFCCC) ensured international agreements, which were directly focused on Greenhouse gas (GHG) emission reduction (Schipper 2006). Advent of the international agreements have alarmed countries to look for methods of achieving emission reductions. Many countries have adopted various emission reduction policy instruments for many years without much success. In the earlier stages, direct command and control mechanisms such as emission cap and energy efficiency mandates were given more emphasis (Parry and Williams 1999). However, with the below par results, the attention expanded to incentive based approaches which impose a price on carbon emissions (Goulder and Parry 2008).

According to Cong and Lo (2017), during the past ten years, the countries have inclined more towards price-based climate policy instruments. Moreover, carbon tax system and emission trading system (ETS) are considered as the two most common carbon pricing instruments (Goulder and Parry 2008). Carbon pricing instruments focus on internalizing external environmental costs in to the production cost (Lin and Li 2011). According to Andrew and Kaidonis (2011), this additional environmental cost is expected to induce behavioural changes in firms to minimize carbon emissions. Both ex-post evaluations in the implemented countries and ex-ante simulations provide evidences for effectiveness of carbon pricing instruments in achieving emission reductions (Wang et al. 2016). Despite the availability of scientific evidence to prove the effectiveness, implementation of carbon pricing instruments is not widely popular among developing countries.

This paper presents a conceptual framework to evaluate the response of firms to carbon pricing instruments in Sri Lanka. The conceptual framework indicates how principles of environmental economics and

international agreements on climate change have combined in introducing carbon pricing instruments and the available decision alternatives for firms in response to carbon pricing instruments. It was found that the decision of firms in response to carbon pricing instruments is governed by several criteria. Hence, analytical hierarchy process (AHP) is considered as the suitable method to evaluate the response of firms to carbon pricing instruments. As a part of the study, hierarchical structure for evaluating firm's response was developed from the findings of literature review and expert interviews.

2. Principles of Environmental Economics

At the beginning of the industrial revolution most of the costs of pollution were imposed on the community as the firms were permitted to externalize environmental pollution through the pollution of air, soil and water (McGuire and Lynch 2017). The adverse impacts of environmental pollution such as health complications and natural disasters were borne by the society. Further, Callan and Thomas (2013) have argued that market decision making has a direct link to environmental damage and resource depletion. Because, according to the authors, it is the market that decides the demand and supply of goods and the required level of cost efficiency for firms to be competitive. Firms adjust the production processes according to market behavior and that adapted production process and choices made during that process dictates the level of environmental damage caused by a particular firm (Soytas et al. 2007). Therefore, the concepts of environmental economics came up in 1960s, to understand the nexus between economic activity and environment, for clear decision making of firms and governing bodies (Sandmo 2005). Environment is a commodity which is used and exploited as an input for economic growth. However, Wiesmeth (2012) emphasizes that, unlike ordinary commodities, the condition of the environment influences the short and long-term prosperity of human beings all around the globe. Therefore, the integration of the environment into the economic system has been long identified as an essential criterion for sustainable growth (Grossman and Krueger 1995).

Extended Circular Flow Model and "Pigouvian" principle are two main principles of environmental economics. In the extended flow model, the essential inputs of natural resources including solar energy and waste pollution and waste in the production process are also recognized, unlike in standard circular flow model in economics (Harris and Roach 2017). This indicates that the human well-being is dependent on these resources and thus there should be alternative indicators to measure human well-being in place of standard economic metrics such as gross domestic product (GDP). Similarly, the Both these aspects suggest that the economic system is constrained by the availability of natural resources and the ability of environment to absorb and digest pollution.

"Pigouvian" principle suggests that pollution should be priced at marginal external cost (Goulder and Parry 2008). The main idea of Pigouvian" principle is also in the form of principle of compensatory justice, where an obligation inflicted to compensate for the damage caused to the environment. Moreover, Steininger et al. (2015) state that, there are three main relevant principles of compensatory justice as,

- Polluter Pays Principle (PPP)- attributes the compensation responsibility to the emitter
- Beneficiary Pays Principle (BPP)- attributes the compensation responsibility to the beneficiary of emissions
- Community Pays Principle (CPP)- attributes the compensation responsibility to members of a community

3. International Agreements Against Global Warming

UNFCCC was adopted at the Rio Summit in 1992 with the aim of stabilising GHG concentrations in the atmosphere (Banan and Maleki 2013). The first agreement under UNFCCC was the Kyoto protocol (1997) followed by the Doha amendment to Kyoto protocol in 2012. The latest agreement under UNFCCC is the Paris agreement which was adopted in 2015. Those details of those agreements are indicated in Table 1.

Table 1: International agreements against global warming

Agreement	Year	Effective Period	Countries	Targets
Kyoto Protocol	1997	2008-2012	Developed countries	Enforced
Doha Ammendment	2012	2012-2020	Developed countries	Enforced
Paris Agreement	2015	2020 and beyond	All countries	Voluntary

Kyoto Protocol contains legally binding emissions targets for 37 countries (and the European Union), also known as Annex I countries to reduce their collective greenhouse gas emissions by 5.2% (compared to 1990 level) at the end of the first commitment period (2008- 2012) (United Nations 1998). Doha amendment to the Kyoto Protocol was agreed on the 8th Conference of the Parties in Doha in 2012. It establishes a second commitment period from 2013 to 2020. The influence of the second commitment period was limited to 14% of global emissions because only 27 countries from European Union and Australia have commitments while the Russia, Canada, Japan and New Zealand, who previously signed the Kyoto Protocol, have opted out (McCrary 2017). There are major criticisms over the success of Kyoto Protocol. According to Prins and Rayner (2007), despite massive economic cost and political capital invested in Kyoto Protocol, it has failed to create a noticeable impact on global carbon emissions. Kyoto Protocol was not successful due to its different treatment to developed and developing countries and the top down nature of emission reduction targets (Savaresi 2016).

The Paris Agreement aims to reinforce the global response to the issue of climate change by maintaining the global temperature rise of this century well below 2 degrees Celsius above pre-industrial levels and to follow the prospects of limiting it even to a temperature rise of 1.5 degrees Celsius. It deals with GHG emissions mitigation from year 2020 and beyond, where the effective period for the second commitment period of Kyoto protocol ends (Savaresi 2016). The Paris Agreement requires all parties to estimate their own emission reduction targets through Nationally Determined Contributions (NDCs) and to achieve these targets while exerting maximum efforts in the years ahead (McCrary 2017). This was aimed at mitigating the differentiation that was created in the Kyoto Protocol between developed and developing nations.

4. Emission Reduction Policy Instruments

With the introduction of Paris Agreement, the countries will have to develop and introduce policies to achieve pledged emission reduction targets (Baranzini et al. 2017). For many years, numerous policy instruments have been implemented by various countries with the aim of reducing GHG emissions. These include both direct command-and-control instruments which are regulatory instruments and incentive-based instruments which are price based instruments (Goulder and Parry 2008). According to Cong and Lo (2017), during the past ten years, the world has witnessed a shift in climate policy preference from non-price based, command and control instruments to price-based market instruments. Carbon pricing instruments induce behavioural change in firms by sending a price signal. When the firms receive a price signal, the firms will change from carbon fuels to renewable green energy sources (Andrew and Kaidonis 2011). Baranzini et al. (2017) and Hong et al. (2017) have suggested carbon tax and ETS as the two main instruments of setting up a carbon price. Carbon taxes are closely compared with ETS as policy instruments to achieve emission reductions. These two have one common aspect, which is to put a price on emissions. However, the primary difference between the two instruments is that the tax puts a price on the emissions while ETS puts a cap or limit on the emissions which would later generate a price due to the competition among firms (Sumner et al. 2014).

The first carbon tax initiative was taken in Finland back in 1990 and the first ETS mechanism is European Union ETS which commenced in 2005 (Liu et al. 2010). Since then, with the introduction of NDCs, many countries, states and regions around the world have adopted carbon pricing mechanisms with the aim of reaching NDCs. As of 2017, 42 national and 25 subnational jurisdictions are putting a price on carbon under 47 carbon pricing initiatives (World Bank 2017). Moreover, according to World Bank (2017) over the past decade, the number of jurisdictions with carbon pricing initiatives has doubled. These subnational jurisdictions include cities, states, and subnational regions.

4.1 Carbon Tax System

Carbon tax is a consumption tax which is based on the carbon content or CO2 emissions of fossil fuels with the ultimate focus of reducing of CO2 emissions (Lin and Li 2011). In practice, the tax is levied on the fossil fuels based on their carbon content as carbon dioxide emissions are proportional to carbon content of the fuel (Goulder 1992). Thus, according to the author, a tax whose value is based on the carbon content of a given fossil fuel is effectively a tax relative to CO_2 emissions. The basic concept behind carbon tax is Pigouvian principle which focuses on internilising negative externalities in to the market price to create market signals which would ultimately reduce GHG emissions (Lin and Li 2011; Wang et al. 2016). This concept is found to be successful as the environmental costs associated with fossil fuel use are mostly external to the firms unless otherwise a carbon pricing mechanism is used. Hence the introduction of carbon taxation can be perceived as a corrective tax, which would seek to internalize the environmental costs of fossil fuel usage, which are external to market decisions. Thus, this promotes reduced fossil fuel use by firms.

Implementation of a carbon tax is not a straight forward task as it entails numerous design considerations. Design considerations include questions such as which sectors to tax, where to set the tax rate, how to use tax revenues, what the impact will be on consumers, and how to ensure that emissions reduction goals are achieved (Wang et al. 2016). Carbon taxes generally work with other emission reduction policies concurrently to achieve significant emission reductions and hence the scope of carbon tax has been limited to certain sectors (Sumner et al. 2014). Moreover, it is the government that decides which energy sources to impose the tax on (Burke 1997). According to the author, in general, carbon taxes are imposed on gasoline, coal and natural gas as direct sources and on electricity as an indirect source where CO2 content of electricity will depend on the composition of country's electricity generation. When it comes to the tax rate, it is ideally determined on the marginal damages caused by the emissions (Kerkhof et al. 2008). Conversely, Liang and Wei (2012) suggest that the tax rate could also be based on what is considered as politically feasible, marginal abatement cost of carbon or budgetary requirements of the government. Since the environmental damages caused by emissions depend on the quantity rather than the value of fossil fuels burned, carbon taxes are designed as specific or unit taxes as opposed to designing as an ad valorem tax (Goulder 1992).

4.2 Emission Trading System (ETS)

Emission trading scheme is a market-based system derived from the principle of 'cap' and 'trade', where 'cap' puts a limit and 'trade' establishes a market to transact carbon permits between liable entities, who aim to improvise in order to meet or come below their allocated limit (Chaabane et al. 2012). In this system, the 'cap' is decided by the regulator of the country or the region in line with their emission reduction targets and later distributes the allowable permits among individual firms under in a reasonable manner (Hong et al. 2017). European Union ETS is the worlds' first and oldest carbon trading scheme which was implemented in 2005 (Xiong et al. 2016). EU ETS was implemented in two phases, while adding changes progressively. The first phase was the trial phase which took place from 2005 to 2007 and the second phase was the execution phase which was in line with the first phase of the Kyoto Protocol, spanning from 2008 to 2012 (Zhang 2016).

Allowance allocation mechanism explains the process of determining total initial emission cap and individual emission caps for firms covered by the emission trading scheme while allowance distribution governs the allotment of the derived allowances for firms and continuous management of these allowance in the post distribution period (Cong and Wei 2010). After determining the total emission cap and individual emission allowance, there are two approaches that can be used to distribute carbon permits as grandfathering and auctioning (Benz et al. 2010). According to Sijm et al. (2006), when 100% free distribution or godfathering approach is used, some firms with higher bargaining capacity over consumers would experience windfall profits by passing the opportunity cost of pollution licenses to consumer prices. Moreover, Rose and Stevens (1993), contended that grandfathering can lead to corruption and disputes between firms and between firms and regulator. However, the resistance from firms when implementing the emission trading schemes would be less due to the reduced costs to the firms (Cramton and Kerr 2002).

On the other hand, allowance distribution from auctions raises public revenue, which offers the potential to fund emission reduction programmes or reduce distortionary taxes (Zhang et al. 2016). Furthermore, Benz et al. (2010) argue that the auctioning is a fair approach as it avoids the possibility of windfall profits and holds

the characteristics of 'polluter pays principle' firmly compared to grandfathering. Nevertheless, auctions have the disadvantage of greater management and enterprise costs (Liao et al. 2015). From an all-inclusive point of view, Cramton and Kerr (2002) identify auctions as the more advantageous approach which brings more benefits to the society. But when looked at from the firms' side, auctioning is a costlier approach, as the firms have to incur for both abatement and purchasing allowances for residual emissions, where as in grandfathering, firms only have the cost of abatement (Sorrell and Sijm 2003). Alternatively, Xiong et al. (2016) have demonstrated the potential of integrating grandfathering and auctioning overtime, which is identified as an effective approach by. A key example for this phenomenon is allowance distribution system used in European Union ETS, where grandfathering which was used at the beginning, gradually transformed in to auctioning (Martin et al. 2015). After the initial allocation and distribution of carbon credits, the firms either retain, buy or sell carbon credits based on their requirement in a secondary carbon market (Tang et al. 2015). At the end of the given period (say 1 year), the firms that emit less than the allotted limit may bank the excess permits for future use or may sell them to other firms who are seeking permits (Cong and Lo 2017; Li and Haasis 2017). In the secondary market, the price of carbon permits is depended on the subsequent demand and supply created by the firms (Hong et al. 2017: Li and Haasis 2017). According to Zhang (2016), the prices are uncertain and tend to vary rapidly in the carbon market as the demand changes due to factors such as energy demand, energy price and irregular weather so on. The potential penalties attached to non-compliance is significantly high in an emission trading system (Cong and Lo 2017). Hence it is imperative for all firms to either acquire adequate carbon permits or to reduce emissions to match the existing permits.

5. Recycling Carbon Pricing Revenue

Both carbon tax and ETS are emission reduction policy instruments which are capable of raising revenue while inducing behavioural change in firms (Sumner et al. 2014). However, the difference is that, while carbon tax system continues to accumulate revenue as long as the tax is imposed, ETS will only collect revenue at the initial allocation phase, that too only if the allowances are auctioned. After the initial allocation, the governing body does not get any revenue as the allowances are only transferred between the firms in a secondary market. Sumner et al. (2014) have stated that the choice of revenue utilization method at the start would impact the political sustainability of the tax. Moreover, according to Wang et al. (2016), a carbon tax without revenue recycling, tends to be regressive which puts more burden on low income firms. According to authors, this is because the low income firms lack the high efficient technologies which come at a greater cost. Throughout literature three main revenue utilization mechanisms are explained.

(1) Funding carbon mitigation programmes
This is the more perceived approach of utilisng revenues, from an emission reduction perception. In this, governments or the regulating bodies earmark carbon mitigation programmes (Kibria et al. 2018). Sumner et al. (2014) have identified reforestation programs, investment in research and development of low carbon and energy efficient technologies as carbon mitigating programmes on which the collected revenue could be invested.

(2) Using revenue to supplement government budgets
The second approach is to absorb tax revenues in to government budgets. This is an approach which can cause political opposition from both public and the industries covered by the tax. Even though it is clear that this approach is not popular among relevant parties, countries such as Sweden and Norway are using tax revenue to enhance government budgets (Sumner et al. 2014). When the revenue is absorbed in to the government budget, it is difficult to ensure that the revenue is utilized back to fund carbon mitigation programmes.

(3) Reduction of other taxes such as income taxes
This is considered as a revenue neutral approach, as it does not raise revenues for government or other governing bodies or emission reduction programmes. According to Parry (2003), revenue neutral approaches could yield double dividends by reducing emissions and also by mitigating prevailing tax distortions due to taxes such as income taxes.

6. Response of Firms to Carbon Pricing Initiatives

The implementation of a carbon pricing instrument is perceived as an addition to the production costs of the firms (Neuhoff 2010). Hence, authors indicate that the firms need to respond to this additional cost to negate the effect on business profitability. The response of firms to carbon pricing initiatives vary from one firm to another. Numan-Parsons et al. (2011), suggest that understanding firms' responses to carbon pricing initiatives is very important to determine the potential outcomes or aggregate emission reductions of the initiatives.

1. Shifting cost to consumers

Shifting cost to consumers is one of the straight forward options available to the firms. However, Henderson et al. (2017), explains that the firms' ability to pass the cost to consumer will depend on the price elasticities of demand and supply of a particular good. In a market where the elasticities of demand and supply is low for a particular product, the proportionate change of demand and supply in relation to a change in price is smaller (Sorrell and Sijm 2003). Hence, it will be easy for firms to transfer additional cost of carbon pricing in to consumers when the price elasticity is low. Moreover, bargaining power of a firm over its consumers is also critical in firms' ability to shift the additional costs to consumers through price adjustments.

2. Shifting cost to suppliers

Firms have the option of passing the cost of carbon pricing to suppliers by negotiating supplier prices (Henderson et al. 2017). However, again, the firms' ability to influence suppliers will be dependent on the bargaining power of a firm over its suppliers. A superior bargaining power of firms will ensure that the additional costs are passed on to the suppliers.

3. Adjusting inputs, outputs or production processes

Firms have the option to respond to cost increase due to carbon pricing by adjusting its inputs, outputs and production processes (Wang et al. 2016). According to Bumpus (2014), firms could either avoid high carbon intensive inputs or cease to produce high carbon intensive outputs. Neuhoff (2010) suggests that deep decarbonisations are achievable by shifting to low carbon inputs and products with low life-cycle emissions. Moreover, following low carbon production process also assist in minimising the carbon emissions attached to the production process (Numan-Parsons et al. 2011).

4. Absorbing the additional costs

As explained earlier, for firms, the price elasticities of their products will determine to a large extent whether they can easily transfer their tax burden to consumers or not. Hence, sectors producing higher price elasticity products and less bargaining power may have to absorb the tax burden (Wang et al. 2016). However, Hoffman (2005) explains that, some firms consider carbon pricing mechanisms as a compliance cost rather than an opportunity to innovate and adopt low carbon technologies.

5. Investing in new technologies

This is the most aspired outcome of implementing a carbon pricing instrument, as it ensures long-term emission reductions (Neuhoff 2010). However, usually, low carbon high efficient energy retrofits are considered as massive investments (Bumpus 2014). Moreover, Martin and Rice (2010) identify low-carbon investments as high-risk options due to the uncertainties attached with the climate policies.

7. Conceptual Framework

The conceptual framework (figure 1) indicates the emergence of emission reduction policy instruments from the principles of environmental economics and international agreements on climate change. The main focus of this study is on price based market instruments under which carbon tax and ETS emerged. As outcomes of pricing instruments response of firms and revenue utilisation is indicated.

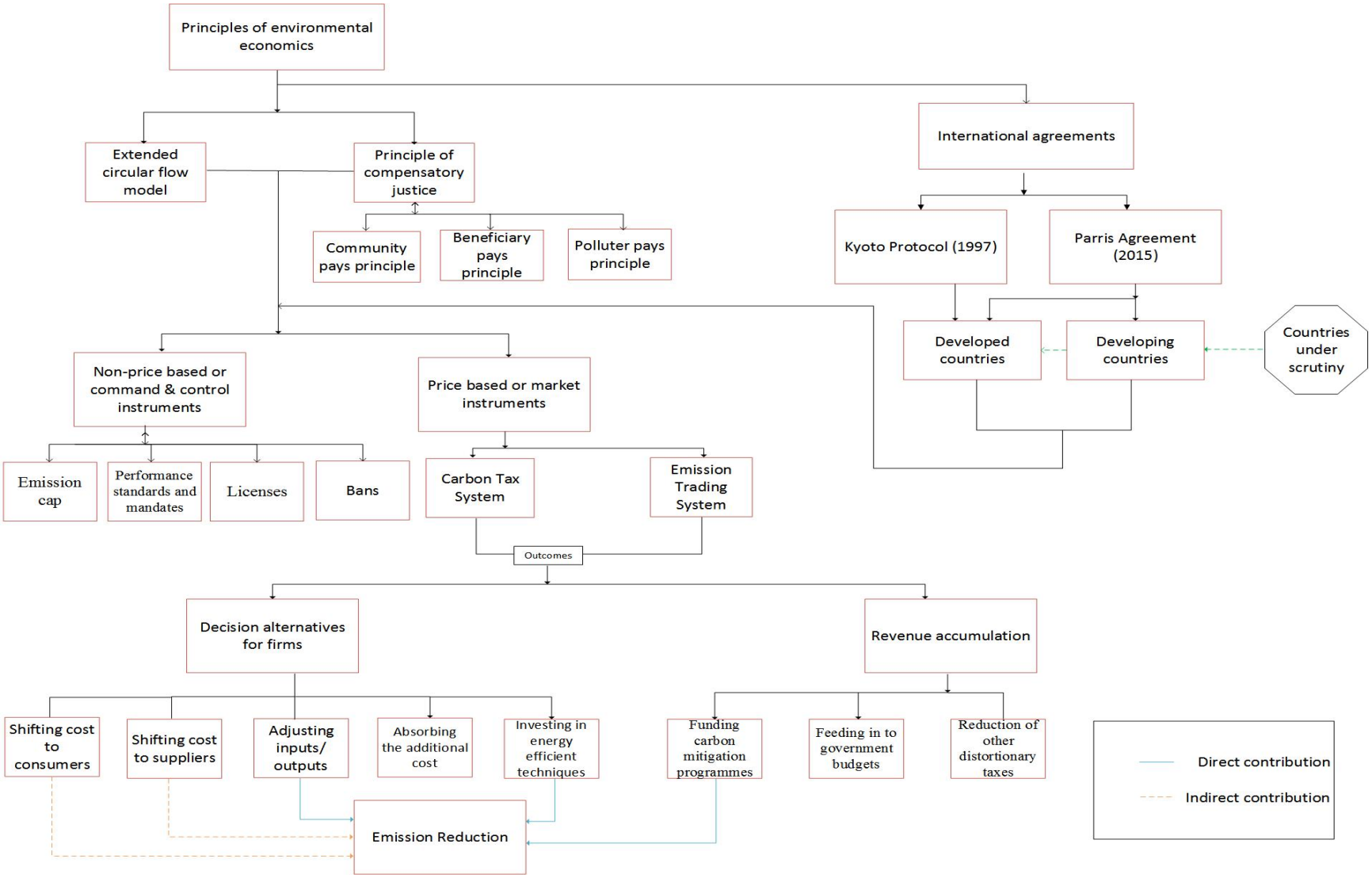

Figure 1: Conceptual Framework

8. Decision Criteria for Apparel Firms When Responding to Carbon Pricing Instruments

Responding to an increase in production cost of a firm is not straight forward. It was found that firms evaluate the available response options under several decision making criteria. In order to establish the decision making criteria, which is applicable for apparel firms in Sri Lanka, expert interviews were conducted with three experts having knowledge and experience in the industry. The respondent's profile is indicated in table 2.

Table 2: Respondent Profile

Current Designation	**Experience in the industry**
Manager	12 years
Assistant Manager	7 years
Freelance Consultant	25 years

The respondents have indicated three criteria as important when making decisions in response to a carbon pricing instrument. In fact, these three criteria are considered for any increase of production cost.

1. Profit margin

Profit margin is highly important for Sri Lankan apparel firms, as they compete with other firms from all around the world. Hence, when the production cost increases, the firms respond to it by considering the impacts on profit margin in long- term and short-term.

2. Customer retention

Sri Lankan apparel firms produce mainly for international customers. The bargaining power of these international apparel brands are massive over Sri Lankan apparel firms. Hence, the apparel firms need to ensure that the requirements of the customers are not impacted when taking decisions in response to carbon pricing instruments.

3. Corporate image

Firms need to maintain the corporate image in terms of ethical values and corporate social responsibility, as it can influence the purchasing decision of end users. The firms have a responsibility to minimise the contribution to global warming, Hence, the way the firms respond to carbon pricing instrument will indicate how firms take on the responsibility to minimising global warming, which eventually will influence the corporate image of the organisation.

9. Analytical Hierarchy Process (AHP)

According to Golden et al. (1989), AHP is a data analyzing technique which can be used to rank decision alternatives based on both qualitative and quantitative factors. Further to the authors, AHP can be used to rank, evaluate, select and predict decision problems. As the objective of this study, which is to evaluate the selection of decision alternatives of apparel firms in response to carbon pricing instruments is complicated by the existence of multiple decision criteria, AHP is considered as the most appropriate method. As part of AHP process, the hierarchical structure for decision making is developed by using literature and expert interview findings. According to Saaty (2008) the decision should decompose into four steps in order to make the result in an organized way to generate priorities as indicate in figure 2.

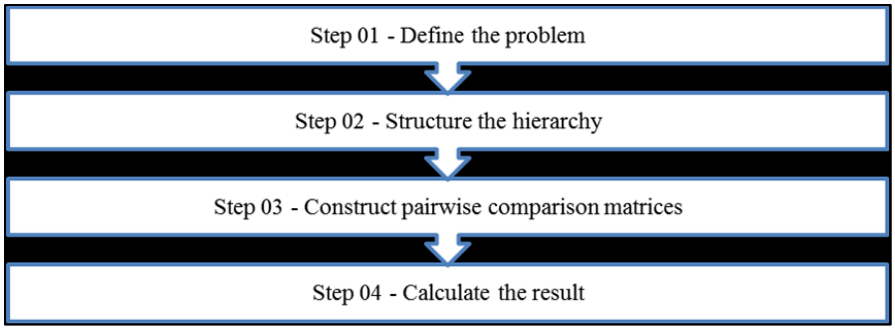

Figure 2: Analytical Hierarchy Process (AHP)

This paper presents the hierarchy structure of AHP developed this study by using the literature findings and the expert survey findings.

10. AHP Hierarchy Structure

Hierarchical arrangement in AHP contains goal of the decision at the top, then the objectives in distinction to a broad perspective through the intermediate levels (subsequent elements depending on the situation) to the lowest level (Saaty 2008). The developed hierarchy structure to evaluate the response of firms to carbon pricing instruments is depicted in figure 3.

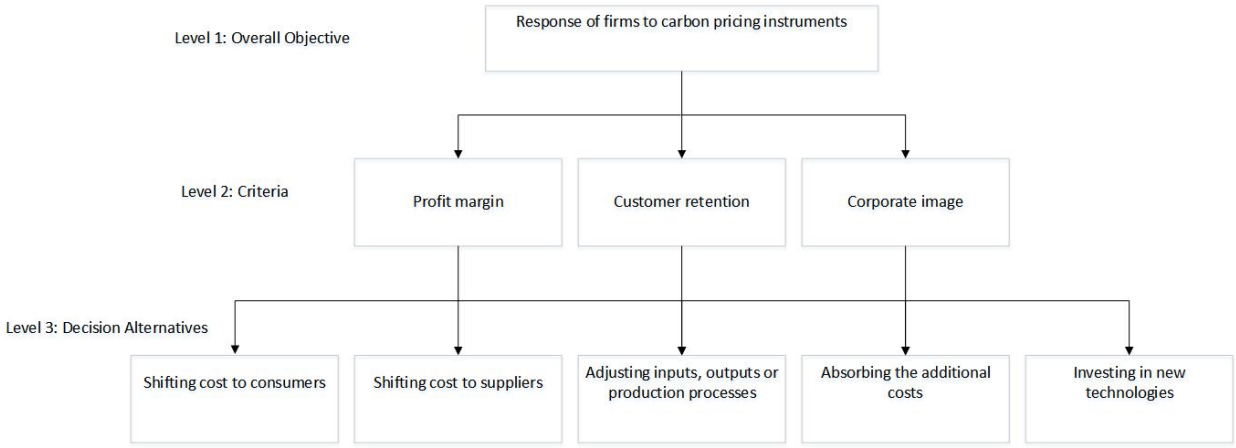

Figure 3: Hierarchy Structure of AHP

11. Conclusion

With the identification of principles of environmental economics, various international agreements were introduced to control emissions while maintaining economic growth. Carbon pricing is identified as an effective mechanism in controlling global emissions. The benefits generated by carbon pricing are two-way.

However, the success of a carbon pricing instrument heavily depends on the way firms respond to it. There are various decision alternatives available for firms as response for carbon pricing instruments. The response of firms varies from one firm to another based on the capacities of the firms. However, selecting response decision is not a straight forward task for firms as it is governed by multiple criteria. The applicable decision criteria are identified through expert interviews. AHP was selected as the method to evaluate the response of firms, due to the complexity of decision making with the existence of multiple criteria. Hence, by using the

available decision alternatives and the applicable decision making criteria, the hierarchical structure for overall objective of "response of firms to carbon pricing instruments" was developed.

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Biographies

T.L.W. Karunaratne is a research assistant at the Department of Building Economics, currently reading for M.Sc by research. He has obtained his first degree in B.Sc (Hons) in Facilities Management with a first class from University of Moratuwa.

T.S. Jayawaickrama is a senior lecturer at the Department of Building Economics. She has obtained her first degree in B.Sc (Hons) in Quantity Surveying from University of Moratuwa. She has also completed her PhD. in National University of Singapore.