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The Polyester Problem: Regulating the Polyester Industry Through the Lens of Environmental Economics

Jo-kel Cornejo Borthwick
Bard College, jb6414@bard.edu

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The Polyester Problem:
Regulating the Polyester Industry Through the Lens of Environmental Economics

Senior Project Submitted to
The Division of Social Studies
of Bard College

by
Jo-kel Cornejo Borthwick

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Introduction

Polyester is just a type of plastic. Polyester fabric is created from tiny polyester fibers that are woven together to create a textile. Polyester is a man-made fiber that is created through a chemical reaction between petroleum, coal, air and water (*NaturalClothing*). In creating this man-made polymer, there is a high level of heat and pressure required to bond the different molecules (*NaturalClothing*). The most common form of polyester is polyethylene terephthalate, abbreviated as PET or PETE. This type of polyester is a thermoplastic, meaning that it can be manipulated easily when heated (*NaturalClothing*). Due to its malleability, polyester can take many forms, fulfilling many different applications.

To begin my project, I will give a brief history on polyester. In 1929, Wallace Carothers, a researcher at DuPont, published a scientific article outlining the creation of polyester (Lowe). Due to some unforeseen difficulties, DuPont decided to focus more on Nylon (Lowe). It took until 1940 for an English researcher working at Imperial Chemical Industries to refine polyester and make it a practical textile for many potential applications (Lowe). After DuPont saw the successful creation of the material, they bought the rights and began to work on commercial production (Lowe). It wasn't until 1953 that DuPont began commercial production of their Dacron Polyester (Lowe).

Upon the initial release of the fabric, polyester was very successful and was described as a "wonder fiber" (Lowe). The general success was due to the fabric's resilience to creases and its easy maintenance. During the 1950's, consumers were used to consistent ironing and meticulous washing techniques required for other materials, but polyester solved this problem (Lowe). Polyester seemed like a solution for the consumers and firms.

Polyester has become the “fiber of choice” for the global apparel industry due to its unique characteristics. Polyesters price, physical characteristics, and versatility aided the fabrics rise in popularity (*Chemical Economics Handbook 2018*). The fabrics physical characteristics include its high durability, wrinkle resistance, moisture wicking and hydrophobic abilities, lack of stretch or shrinkage (*NaturalClothing*). A key characteristic of polyester fibers utility in apparel is its ability to be blended with other fabrics in order to give other fabrics the characteristics of polyester. A common example of this exchange is a cotton poly blend t-shirt (*NaturalClothing*). These other factors have contributed heavily to polyester becoming the most commonly used fiber in the world. 50% of the global fiber market comes from polyester (*Chemical Economics Handbook 2018*). Apparel manufacturing, being the largest proponent of polyester, accounts for 50% of the total demand for polyester. Home furnishing and goods is a somewhat distant second category at 25% of consumption (*ChemicalEconomicsHandbook 2018*). To further clarify the relationship between polyester and the global apparel industry, I will provide a statistical overview of the trends and environmental impact of the industry.

To begin, I ask the question: Is polyester recyclable and sustainable, and if so, to what extent? I found that polyester is recyclable. A big positive of polyester recycling is the decreased consumption of natural resources such as crude oil. Crude oil is a main input in virgin polyester fiber production (van Elven). Another benefit to recycling polyester is the ability to give a second life to non-biodegradable byproducts of society such as PET water bottles (van Elven). It may seem like polyester might be sustainable, since it is recyclable. However, there are significant limitations to polyester recycling. It is far more difficult to recycle polyester when it is blended with other fabrics, which proves to be problematic because a significant amount of polyester goods are blended with other fabrics (van Elven). The process of recycling can

seriously degrade the quality polyester. In order to counteract this degradation, In some cases recycled polyester is mixed with virgin polyester in order to restore its physical integrity (van Elven). While recycled polyester production requires about 40% less energy than virgin polyester, the energy expenditure is still far higher than natural fibers such as cotton (van Elven). Virgin polyester is polyester that has not previously been utilized (van Elven). This decrease in energy expenditure could be meaningless due to the problems that often arise out of the complicated recycling process. The inconsistencies in the color of recycled polyester chips can lead to increased re-dyeing processes which necessitates high energy, water and chemical usage, further contributing to the environmental externalities associated with polyester (van Elven).

The apparel industry is massive in size and impact. In understanding its size and impact, it is essential to have an understanding of the trends in consumption and production and how they have evolved over the years. In 2015, the global apparel industry was valued at just over \$1.3 trillion USD (O'Connell 2019). Although this number is already impressive, the industry is on track to surpass \$1.5 trillion USD by 2020 (O'Connell 2019). When looking at the industry, one of its defining characteristics is its ability to produce and sell an exorbitant level of garments. Globally, in 2016, there were over 107 billion units of clothing sold (*CommonObjective*). To further contextualize this number, this means that each person on earth, on average in 2016, purchased 13 clothing garments (*CommonObjective*). This is simply on average though; in reality some countries participate far more in consumption and which would have a significant impact on the average. An economic giant, the apparel industry shows no signs of slowing down and production is expected to grow at least 13% by 2021 (*CommonObjective*). In terms of employment and the labor force, the apparel industry is flourishing and is predicted to continue on this positive trend. In 2015, it was reported that the global apparel industry employs between

60 to 75 million people (*CleanClothesCampaign*). To put the apparel industry's growth over the past couple decades into perspective, in 2000, the apparel industry employed around 20 million people (*CleanClothesCampaign*). This means that the apparel industry exhibited an almost 300% increase in employment over the time period discussed above. A unique characteristic of the industry and its labor force is the fact that over three fourths of the labor force is female (*CleanClothesCampaign*). Most likely this is a result of clothing and apparel being gendered as feminine.

By further evaluating the growth of consumerism in the global apparel industry, I found research performed by the Mckinsey group that provides logic to the industry's rapid growth and the subsequent rise of fast fashion. The Mckinsey group cites some of the main contributing factors for this 60% increase in consumption since the turn of the century to be the “falling costs, streamlined operations, and rising consumer spending” (Remy 2016). It has been reported that across all subsets of the apparel industry, garments are kept by their owner half as long as they were just 15 years ago. The research concluded that garments are worn eight or less times before the owner discards them (Remy 2016). Fast fashion companies are characterized and defined by their ability to cut costs and streamline production. Due to fast fashion, there has been a significant fall in the relative price of garments compared to other various consumer goods (Remy 2016). Compared to other consumer goods, clothing has withstood price increases and is on average 50% cheaper than what it should be (Remy 2016).

Although much of the information presented seems very positive and exhibits economic success, this economic success comes at a significant environmental cost. The first fact, and often the most shocking, is that the fashion and textile industry contributes an astounding 10% of the global carbon emissions, second only to the Oil industry (Conca 2015). This is largely due to

the manufacturing, production and subsequent transportation of all the garments sold each year (*SustainYourStyle*). The apparel industry significantly pollutes freshwater resources; it is the second most water polluting industry on the planet (Conca 2015). Apparel manufacturing has become excessive, annually there are over 150 billion garments produced. This number is especially astonishing with the context that the world's population as of December 2019 is 7.7 billion (Conca 2015). This excess has led to textiles comprising 5.2% of landfills (*SustainYourStyle*). Another issue is the fact that most of these goods are produced in countries like China, Bangladesh and India which rely on the least environmentally friendly form of energy, coal (*SustainYourStyle*). For each kilogram of fabric produced, over 23 kilogram of greenhouse gases are produced (*SustainYourStyle*). Of these 150 billion garments produced annually, polyester has become the most used fiber (Conca 2015). In my research of the apparel and textile industry, it became abundantly clear that there was a direct relationship between the industry's negative environmental impact and polyester.

Now, I look to evaluate the environmental impacts of the polyester industry. In the first real example of research into microfiber shedding, which serves as truly groundbreaking, scientists at Plymouth University found that for a 6-kilogram wash, 100% polyester garments shed 496,030 microfibers and cotton-poly blend garments shed 137,951 microfibers (Napper 2016, 41). Because of this shedding, 190,000 tons of synthetic microfibers end up in our oceans annually (*SustainYourStyle*). Microfiber shedding is the process by which polyester sheds the tiny fibers it is composed of. Polyester may be recyclable, but it is not biodegradable. Meaning, it can take up to 200 years to decompose naturally (*SustainYourStyle*). Synthetic fibers are not environmentally impactful solely due to the microfibers shed and the chemicals essential to production. Synthetic fibers like polyester are essentially made from fossil fuels. I found this

clear from the fact that “70 million oil barrels are used each year to produce polyester” (*SustainYourStyle*). In 2015, roughly 1.5 trillion pounds of greenhouse gasses were emitted by polyester production for textiles (Drew). This statistical overview highlights the different ways in which polyester is detrimental to the environment.

In presenting the history and utility of polyester fiber we gain a more in depth understanding of why it is such a prominent fabric today. Through the general evaluation of the global apparel industry, we gain valuable insight into the vast size and environmental impact of the entire industry. Presenting the global apparel industry is integral to the discussion of polyester due to their symbiotic relationship. In evaluating the environmental impact and externalities of the polyester industry, attention is brought to the problematic nature of the industry as well as the details of its environmental impact which include; excessive microfiber shedding, intensive use of crude oil in production, as well as significant greenhouse gas emissions. With an industry as powerful as that of polyester, and a global environment clearly on the decline, something clearly needs to be done. This initial research shown in the pages above led me to ask this guiding question for this project: With a nuanced understanding of the polyester industry and environmental economic theory, how can polyester fiber be regulated, and what would that policy entail?

Chapter 1: Delving Deeper into Polyester

To better understand the polyester market, I will now delve into research and raw data in order to highlight nuances of the industry. I will be looking at factors such as global distribution of consumption and production as well as looking at unique trends, relationships and characteristics of the industry. I will begin by presenting graphical data from Statista that highlights the trends of growth and the gravity of the market (*Statista*).

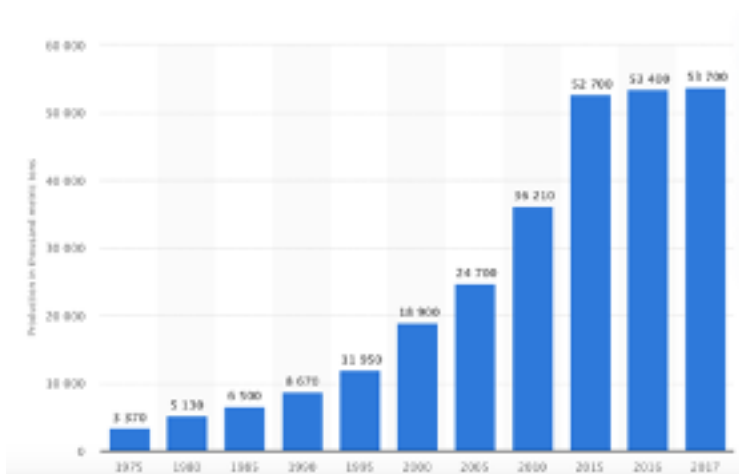


Figure 1

Figure 1 shows the level of polyester fibers produced worldwide from 1975 to 2017 (each unit accounts for 1,000 metric tons) (*Statista*). This highlights the relatively exponential growth that the polyester industry has experienced over the past 40 years. From the mid 70's until now, it is clear through the data that polyesters success cannot solely be associated with scratchy pant suits of the 70's; rather it is one of the most prominent forces within the modern textile industry. In terms of growth, it is clear through the data that within the time period between 2000 to 2015 the industry saw its most significant growth in production.

Why has the polyester industry seen such levels of growth and success? As previously mentioned in the introduction; driving this growth are polyesters defining characteristics, which include its physical properties, price, recyclability and versatility (*Chemical Economics Handbook 2018*). A group of characteristics that are seemingly unmatched by its competition, which has led to a sustained growth in consumption with a rate of 7% yearly (*Chemical Economics Handbook 2018*). Due to these defining characteristics, polyester accounts for half of the global fiber market, not just the man-made fiber market but the global fiber market which includes all natural fibers such as cotton and linen (*Chemical Economics Handbook 2018*). Although polyester has various applications, half of the polyester produced is used directly by the textile apparel industry (*Chemical Economics Handbook 2018*). In terms of production, a defining characteristic of polyester is the low costs associated with said production (*Chemical Economics Handbook 2018*). Due to the low costs associated with polyester production, it has quickly become a substitution for relative materials which has propelled the polyester market to grow faster than the whole fiber market (*Chemical Economics Handbook 2018*).

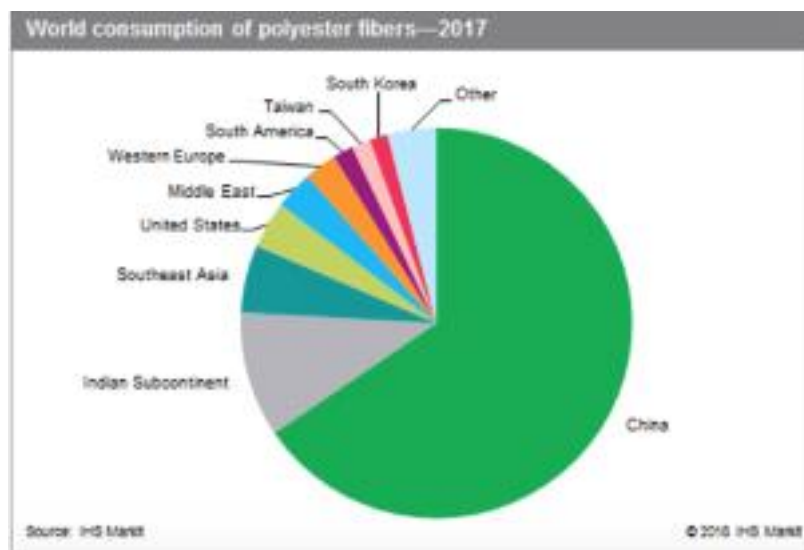


Figure 2

Figure 2, presented above, shows the distribution of the global consumption of polyester based on country (*Chemical Economics Handbook 2018*). From this graphic, it is clear that the main consumers of polyester are China, the Indian subcontinent, Southeast Asian and the United states. China consuming the vast majority of the global supply of polyester comes as no surprise, this is due to the fact that Asia accounts for 94% of the global production capacity (*Chemical Economics Handbook 2018*). The high levels of polyester consumption by China are largely due to their production and exportation of finished goods that require polyester such as apparel, bedding, etc. (*Chemical Economics Handbook 2018*).

The barriers of entry for the Polyester industry are described as being relatively low (*Chemical Economics Handbook 2018*). Because of this, the producer landscape has become very fragmented (*Chemical Economics Handbook 2018*). This is clear through the fact that the 15 largest global producers of polyester only account for 30% of global capacity in 2017 (*Chemical Economics Handbook 2018*). There are over 900 producers in China alone (*Chemical Economics Handbook 2018*).

In terms of relative and competitive goods, cotton has one of the most interesting relationships with polyester. In research published by The World Bank, John Baffes delves into the complexities of this relationship. Within this article, Baffes evaluates the level and nature of price linkages between the dominant synthetic fiber, polyester and the dominant natural fiber, cotton, as well as crude oil which is integral to the equation (Baffes 2005, 1). Baffes looks at the short and long run characteristics of the relationship in order to examine the nuanced relationship.

Baffes presents the general characteristics of the relationship between cotton and polyester. Cotton prices vary much more than polyester for two main reasons:

First, cotton as a primary commodity is subjected to both demand and supply shocks while polyester, an industrial product, is subjected mainly to demand shocks. Second, cotton's price responds quickly to changes in the fundamentals because it is determined in a futures exchange (New York Board of Trade). Prices of polyester, however, are determined through contractual arrangements (Baffes 2005, 7-8).

This unique characteristic of Polyester has definitely contributed to the success the industry has seen in the past few decades. When evaluating the different characteristics of the relationship, Baffes evaluates the long and short run characteristics.

The polyester industry has some pretty unique long run characteristics. In terms of long run, they found through econometric evidence that price changes on polyester has a much more significant effect on the price of cotton as opposed to "Vice Versa" (Baffes 2005, 12). another long run characteristic of the relationship is the fact that the polyester industry is much more sensitive to changes in crude oil prices, compared to the cotton industry (Baffes 2005, 12). When looking at the long run co-movement between polyester and cotton within the context of 18 other highly traded primary commodities, they made some interesting observations. Baffes found that the co-movement between polyester and cotton is much higher than what is observed between the 18 other highly traded primary commodities (Baffes 2005, 12). Posing that this co-movement highlights the factor specific nature of these two markets.

In terms of the short run relationship between cotton and polyester, the main observation is within the context of price signals. Baffe's states that "the speed at which the price signals are transmitted from the polyester market to the cotton market is much higher than vice-versa" (Baffes 2005, 13-14).

Much of the points discussed in the Baffes article are integral to the understanding of the polyester market and its rise to prominence today. Within the context of the apparel and textile industries, the common social perception seems to assume cotton's dominance, but this research highlights the antiquated nature of this perception. Although cotton and polyester account for two thirds of global fiber consumption, in recent history we have seen cotton shares weakening and “during the last 4 decades, cotton’s market share has declined from 68 percent to 40 percent” (Baffes 2005, 14). This statistic highlights the weakening marketing share of the cotton industry in relation to polyester, a trend that is predicted to continue. The research does not just highlight polyesters increasing share but rather its increasing power in terms of market dynamics.

To better understand what the future holds for the polyester industry, I will look at some current research forecasting the industries growth and characteristics. In a recent article published in December 2019 by Global Market Insights, they predict significant growth for the polyester industry in the coming years. The polyester industry’s annual revenue is predicted to surpass \$190 billion USD by 2026 due to an 8%> compound annual growth rate or CAGR (Pulidindi 2019). Figure 3 presents visualizations of the predicted growth of PET and PCDT (the two most common forms of polyester) over the next 4 years. This level of growth is pretty shocking considering the market was valued at 100 Billion in 2018, meaning that it should almost double in size in the coming years (Pulidindi 2019).

There are a plethora of reasons and factors that have and will contribute to the exponential growth we are predicted to see in the coming years. Two of the main driving forces that account for this growth are the apparel and home goods sectors. Within the context of the apparel industry, the growth of the apparel industry and the polyester industry have become inextricably tied due to polyesters vast applications and popularity within the industry. When

thinking about the global distribution of the polyester industry, especially in terms of potential growth, it is essential to discuss the Asia Pacific polyester market. Over the forecasted timeline, the Asia Pacific region is expected to exhibit an 8.5% compound annual growth rate, which is .5% higher than the rest of the polyester industry (Pulidindi 2019). This is largely due to a significant rise in housing development projects which leads to significant furnishing (Pulidindi 2019). Another main driving force for this predicted growth is the soaring demand for apparel and fast fashion (Pulidindi 2019).

The exponential growth exhibited by the polyester industry over the past 40 years highlights the industry's power and consistent growth. Clear through the forecasted 8%+ CAGR, this growth is going to continue, showing the strength and stay power of the industry (Pulidindi 2019). Global Market Insights further reinforce the fact that fast fashion serves as a key driver of the polyester industry (Pulidindi 2019). The strength of the industry is equally present in the majority share of the global fiber market, at 50% (*Chemical Economics Handbook 2018*). Baffes evaluation of the relationship between cotton and polyester show the power of polyester in terms of market dynamics. Baffe's points out a key weakness of the polyester industry, due to crude oil being the main input in production, the industry is extremely sensitive to changes in crude oil prices (Baffes 2005, 12). This evaluation of the polyester industry and market establishes polyesters prominence in the fiber market. In combination with the previously established understanding of polyester's vast negative environmental externalities, I believe that the only way to mitigate the effects of polyester is through regulation.

Du Pont, the original creator of polyester fiber, has a new contribution to the eco fiber market, Apexa resin, which in collaboration with Ichimura Sangyo is used to create ECOFACE polyester (*Ichimura Co.*). This new form of polyester is described as "...an eco-friendly

compostable polyester fiber...” (*Ichimura Co.*) . In an experiment performed by Fusako Kawai at the Kyoto Institute of Technology, testing the composability of PET polyester and ECOFACE polyester, they found that ECOFACE polyester was far more biodegradable than common PET polyester (Kawai 2013, 1). They found that ECOFACE polyester saw a 90% decrease in molecular weight, this level of decomposition occurred at 3 months for normal thickness fabric, and 4.5 months for thicker examples (Kawai 2013, 1). In comparison to PET polyester, which saw less than a 50% decrease in molecular weight in 6 months, ECOFACE polyester is far more biodegradable (Kawai 2013,1). Another key finding is the fragmentation, essential to the decomposition process, exhibited by ECOFACE polyester once the molecular weight had decreased by 90% (Kawai 2013,1). This fragmentation was not present in the PET polyester decomposition observed (Kawai 2013,1).

This research interested me for a few reasons. For a fiber that has seen minimal innovation or change since its introduction, ECOFACE polyester shows that there is potential for innovation in the product and processes of polyester fiber. In my research of ECOFACE polyester it seems that information on its price, market share, and utilization is non-existent. I am left to assume that ECOFACE polyester is more expensive than PET polyester due to the costs associated with research and development of such an innovative product. Due to the likelihood of a higher price in comparison to PET polyester, could it be competitive in such a competitive and fragmented industry? How could we further incentivize the use of ECOFACE polyester and those alike due to the likelihood of a price discrepancy?

Chapter Two: Environmental Economics and Policy

In evaluating the polyester fiber industry, it is essential to have a historical and contemporary understanding of environmental policy and economic instruments. The *Environmental Economics* book by Stephen Smith successfully highlights different examples of policy and the impact they've had. In *Environmental Economics*, they highlight two main policy instruments of significance; the environmental tax system and an emissions trading system. These forms of policy instruments have one main goal; to create financial incentives to reduce emissions and polluting behavior which in turn coerces actors within the market to adopt more environmentally conscious practices (Smith 2011, 42). The emissions tax system in most cases is done by taxing firms for every ton of carbon emitted. Taxing based on the exact level of emissions is considered a Pigovian Tax which is a tax related to behavior that creates negative externalities such as pollution (Kagan 2019). This is very effective in coercing firms to adopt better practices and reduce emissions because they can lower the level of taxes they are required to pay. The second and more complex instrument is an emissions trading system. In this case, firms are given emissions allowances for a certain amount of pollution (Smith 2011, 42-43). When they go over this allowance they are required to purchase more. Firms can save money by reducing emissions and selling their allowances in a secondary market for these credits (Smith 2011, 42-43).

There are key benefits and disadvantages to both these systems. The most important and obvious benefit that both systems share is their ability to change a firms' behavior through economic costs and or benefits (Smith 2011, 43). Another shared benefit is the fact that the responsibility is placed primarily on the firms and producers. Although the costs of such reform

is felt by the consumer, it places an emphasis on how these firms act within the market. Because of all the new costs incurred from the existing unsustainable practices, it provokes technological innovations that help minimize environmental impact and streamlining processes (Smith 2011, 45). These systems have also been proven to be far more efficient and effective compared to the command and control models that “on average across these studies, efficient allocation of abatement could achieve the same environmental quality as uniform command-and-control, at only one-sixth of the cost” (Smith 2011, 46). Command and Control models of regulation typically set a standard or a ceiling on the use of a particular goods or on the level of allowable emissions for example. The problem that arises from CAC models is that when firms reach the standard, they have no incentive to further better their polluting behavior, leading to complacency. To further contextualize within the context of polyester fiber, with the goal of reducing polyester utilization, if I forced firms to cap their polyester fiber usage at 1 ton annually, they would simply use that 1-ton allowance with no incentive to further reduce their polyester fiber utilization.

When it comes to the disadvantages of emissions tax and emissions trading systems, the main issue arises out of the measurement problem (Smith 2011, 51). Although the concept is pretty simple, in practice constant emissions testing is very expensive and time consuming (Smith 2011, 51). To make these systems more viable, we would need to make more technological innovations (Smith 2011, 51). Thankfully there are some innovations regarding emission measurement, but they are not widely accessible yet (Smith 2011, 51). Although these systems make a lot of sense in theory, I want to delve into some examples of more commonly used tax systems.

In practice, most taxes related to environmental pollution are not based on direct levels of pollution, rather they levied on the sale of commodities related to pollution. Because of this, they are not considered strict Pigovian taxes, rather they are tax surrogates. A very common example of this is the automotive gasoline industry. This tax is done in the belief that an increase in price will further deter the use of such a high environmentally polluting substance (Smith 2011, 51). On the other hand, goods that are better for the environment are taxed less heavily such as lead-free petrol (Smith 2011, 51). This is done in an effort to shift consumer behavior (Smith 2011, 51). A prime example of taxing the sale of a good is the Irish plastic bag levy of 2002 (Smith 2011, 38). This is a very famous example of a simple yet effective tax to minimize consumption of something as simple as plastic bags. In this case, the Irish government decided to impose a 15-cent tax on single use plastic bags due to the fact that they were heavily polluting the area (Smith 2011, 38). Although the tax was small, it was enough to make people think twice about their consumption which made it very effective. This almost immediately led to a 90% decrease in the consumption of plastic bags (Smith 2011, 38). This example shows the extreme effectiveness of taxes and other incentive-based policies in shifting consumer behavior (Smith 2011, 39). Some might suggest that an outright ban would make more sense and be more effective but with policy like the plastic bag tax, it gives the consumer the choice to adopt more sustainable practices without being burdened with the possibility of not being able to get a plastic bag if they are truly in need (Smith 2011, 39). It is also common knowledge that policy such as this is far more effective and socially accepted when consumers have the choice and are not being forced to adopt particular practices. Smith highlights the importance of properly targeted incentives and he presents an anecdote about the issues that arise out of improper targeting and execution (Smith 2011, 51). In this example he brings attention to the implementation of an experiment created by

Norwegian economist Agnar Sandmo, which the government charges for trash bags or tags for said trash bags in order to reduce waste (Smith 2011, 51-52). Although this was effective in reducing the levels of waste, the concept never reached its true potential due to the loopholes citizens found (Smith 2011, 52-53). The main loophole used was the compression and compaction of trash in order to fit more into each bag and reduce the costs incurred by the bags (Smith 2011, 53). This anecdote presents some important implications when it comes to properly implementing policy and incentive structures, showing what can happen when there is poor incentive targeting (Smith 2011, 53). The failure of this policy presents an important lesson; the issue arises out of the fact that they charged for the bag rather than the direct level of waste (Smith 2011, 53). This example speaks to a significant issue we see in environmental policy choice, Smith states that "...Taxing transactions may be straightforward, but will not target the incentives for environmental improvement as accurately as can be achieved when measured emissions are taxed directly" (Smith 2011, 53). The intricacies of these types of tax and incentive structures and their implementation is a topic I will delve deeper into later in my project.

When implementing these types of tax systems, consumer acceptance plays a key role in their level of success. An effective way to achieve said success is through tax relationships (Smith 2011, 53). In the context of environmental taxes, tax relationships can achieve significant tax reform through the large revenue stream created by environmental taxes (Smith 2011, 53). Smith presents two main examples of environmental taxes that had a direct positive effect on other tax burdens (Smith 2011, 53). The first is the UK landfill tax of 1996 (Smith 2011, 53). In this example, the revenue from this tax was almost completely returned to the UK's citizens through a decrease in employers National Insurance Contributions (Smith 2011, 53). Another example is from the carbon tax of 1991 in Sweden (Smith 2011, 53). In this case, the revenue

from the carbon tax directly financed a decrease in income tax rates (Smith 2011, 53). These were both very successful in gaining public acceptance through creating a very clear cost and benefit relationship, helping the consumer and the environment simultaneously (Smith 2011, 53). I look to apply these types of tax relationships to my regulation of polyester fiber industry.

Although the synopsis presented by Stephen Smith provides a valuable overview of environmental economics, the relevant tools, and examples in history, it lacks the depth necessary to inform an approach to an industry such as that of polyester. Rather, the value lies in its ability to set the foundation and context for the evaluation of more insightful and theoretical work such as that of Michael Porter and Claas Van Der Lin.

In 1995 Michael Porter was one of the first economists to highlight the positive relationship between regulation and economic growth through the now famous and well known “Porter Hypothesis”. Porter's contribution to the topic was groundbreaking and set the foundation for much of the subsequent research (Lanoie 2010, 20). The Porter Hypothesis, developed by Michael Porter and Claas Van Der Lin in 1995, provided valuable and insightful research into the economic relationship between environmental regulation, policy, and growth. One of the initial and foundational observations made by Porter and Van Der Lin is the fact that pollution is commonly a waste of resources and a reduction in this behavior would lead to increased productivity of resources (Lanoie 2010, 2).

Within the first subsection, “The Link From Regulation to Promoting Innovation”, Porter and Van Der Lin discuss “ the possibility that regulation might act as a spur to innovation arises because the world does not fit the Panglossian belief that firms always make optimal choices” (Porter 1995, 99). Despite the obvious value of the proposition of a relationship between innovation and regulation, the value of this statement equally lies in their critique of a commonly

held classical assumption within the school of economics. This critique highlights the misguided nature of many classical economic models that forgo an understanding of nuance within a given economic setting and opt to utilize blanket assumptions that are often not representative, such as the assumption of optimal decision making presented above. Porter and Van Der Lin pose that:

the actual process of dynamic competition is characterized by changing technological opportunities coupled with highly incomplete information, organizational inertia and control problems reflecting the difficulty of aligning individual, group and corporate incentives (Porter 1995, 99).

Within this statement they highlight the complex and site-specific nature of the issue at hand. A somewhat groundbreaking understanding in the world of environmental economics.

Porter and Van Der Lin bring attention to six main purposes that well-crafted environmental regulation can serve. First, “regulation signals companies about likely resource inefficiencies and potential technological improvements” (Porter 1995, 99). They go on to express that this is due to companies' lack of experience in measuring discharges as well as a lack of understanding of the costs incurred by poor utilization of resources (Porter 1995, 99). They also highlight the fact that companies lack the ability to “conceive” new ways of limiting discharges and or hazardous materials (Porter 1995, 99). As a result of these factors, “regulation rivets attention on this area of potential innovation” (Porter 1995, 100). “Second, regulation focused on information gathering can achieve major benefits by raising corporate awareness” (Porter 1995, 100). Porter and Van Der Lin pose that a strong information base “leads to environmental improvements without mandating pollution reductions, sometimes even lower costs” (Porter 1995, 100). Third, “regulation reduces the uncertainty that investments to address the environment will be valuable. Greater certainty “encourages investment in any area” (Porter 1995, 100). Although straight forward, this aspect is very important because investment or lack thereof can be a driving or limiting force. When the goals and benefits of investing are clear

through regulation, it creates certainty in the value of the investment. Fourth, “regulation creates pressure that motivates innovation and progress” (Porter 1995, 100). They pose that exogenous pressure brought on by regulation can be equivalent to the endogenous pressure brought on by strong competition (Porter 1995, 100). Fifth, “regulation levels the transitional playing field. During the transition period to innovation-based solutions, regulation ensures that one company cannot opportunistically gain position by avoiding environmental investments” (Porter 1995, 100). In leveling the playing field, it maintains the competitiveness of the market and prevents market failures such as monopolistic behavior. Sixth, “regulation is needed in the case of incomplete offsets” (Porter 1995, 100). Porter and Van Der Lin acknowledge the fact that this is not a perfect science and “innovation cannot always completely offset the cost of compliance, especially in the short term...” (Porter 1995, 100).

This section highlights the clear purpose of meaningful regulation and can be simply recontextualized within the context of the polyester industry. In implementing regulation on the polyester industry, it would signal companies to its problematic nature and, through standards created by regulation, provoke the right innovative processes as opposed to leaving companies to their own devices. Although there is widespread data highlighting the serious negative environmental externalities of the polyester industry, which include the microfibers entering the ocean, the emissions created during production, and the intensive crude oil usage, it is still not commonly held knowledge. Regulation with a strong information base would force the industry to acknowledge the issue which is foundational to combating the issue. The concept that regulation, exogenous to the industry, provokes progress and innovation has some interesting potential implications within the polyester industry. In highlighting and regulating the high levels of resource expenditure by the industry, the pressure could provoke the creation and

implementation of more environmentally sustainable and resource efficient processes that require a lower level of harmful inputs such as crude oil which is essential to polyester production.

Similarly, if pressure is focused on the negative effects of synthetic microfiber release, regulation could help promote the invention of polyester with better microfiber retention when it comes to washing.

Porter and Van Der Lin propose that the innovation that occurs from regulation takes two broad forms. The first form “is that companies simply get smarter about how to deal with pollution once it occurs...” (Porter 1995, 100-101) this includes reducing the expenditure of emissions and toxic materials as well as innovation and improvement in the processes related to secondary treatment (Porter 1995, 101). The second general “form of innovation addresses environmental impacts while simultaneously improving the affected product itself and/or related processes” (Porter 1995, 101). They propose that in some cases “innovation offsets” surpass the costs associated with compliance, this proposition is central to their implication that regulation can promote and provoke industrial competitiveness (Porter 1995, 101). They divided these “innovation offsets” into two groups: product and process offsets (Porter 1995, 101). They describe product offsets as regulation leading to “better performing or higher quality products, safer products, lower product costs...”, not just decreased pollution (Porter 1995, 101). Similarly, process offsets are when environmental regulation leads to a decrease in pollution as well as:

higher resource productivity such as higher process yields, less downtime through more careful monitoring and maintenance, materials savings (due to substitution, reuse or recycling of production inputs), better utilization of by-products, lower energy consumption during the production process, reduced material storage and handling costs, conversion of waste into valuable forms, reduced waste disposal costs or safer workplace conditions (Porter 1995, 101).

They pose that these innovation offsets are heavily related, and success in one area can often trigger others (Porter 1995, 101). The second form of innovation that occurs from regulation

seems more in line with the goals of regulating the polyester industry. The goal of regulating the polyester industry is to address the externalities of the industry while provoking improvement.

The next section of the Porter Hypothesis, integral to my approach to regulating the polyester industry, is titled: “*Designing Environmental Regulation to Encourage Innovation*” (Porter 1995,110).They propose that if the regulation is meant to provoke innovation and the relevant offsets, they must follow 3 main principles:

“First, they must create the maximum opportunity for innovation, leaving the approach to innovation to industry and not the standard-setting agency.

Second, regulations should foster continuous improvement, rather than locking in any particular technology.

Third, the regulatory process should leave as little room as possible for uncertainty at every stage” (Porter 1995, 110).

With these principles in mind, Porter and Van Der Lin evaluate and critique the US’s approach to environmental regulation. They emphasize the significance of “*Clear Goals, Flexible Approaches*” (Porter 1995, 110). To prescribe a particular technological innovation would act as a limiting force on the potential of the industry, rather regulation should provoke new innovative approaches (Porter 1995, 110). With that, regulation should encourage changes in the “product and process” as opposed to “end-of-pipe or secondary treatment, which is almost always more costly” (Porter 1995, 111). Moving forward, they discuss “*Seeding and Spreading Environmental Innovations*”. In this section they emphasize the importance of existing environmental policy instruments that focus on creating incentives such as tradable permits, deposit refund schemes, and pollution taxes (Porter 1995, 111). As discussed previously, these types of incentive-based tools have been successful in reaching goals while maintaining flexibility. In concluding this section, Porter emphasizes the importance of *Regulatory Coordination* and the role it plays in meaningful regulation. They pose that we need to improve

coordination between: “industry and regulators, between regulators at different levels and places in government, and between U.S. regulators and their international counterparts” (Porter 1995, 113). Within this they highlight the importance of industry participation and collaboration, especially at the beginning of the transition (Porter 1995, 113). A key aspect of this is the commitment by industry and particularly regulators to create lasting standards that provoke meaningful innovation as opposed to quick fixes (Porter 1995, 113). In terms of coordination between regulators and other levels of government, there needs to be consolidation and organization in order to prevent unnecessary complications (Porter 1995, 113).

The Porter Hypothesis was very successful in provoking the world of environmental economics. One of the central reasons for its popularity was its ability to shift the perception on sustainability in economics (Lanoie 2010, 3). Contrary to the prominent belief of the time, Porter showed that environmentally sustainable behavior didn’t have to be an economic burden (Lanoie 2010, 3). This was very successful in shifting the “business communities” perception of the matter and getting actors to participate in regulation (Lanoie 2010, 3). This was the first time an economic framework predicted a win-win scenario for economic profitability and environmental sustainability.

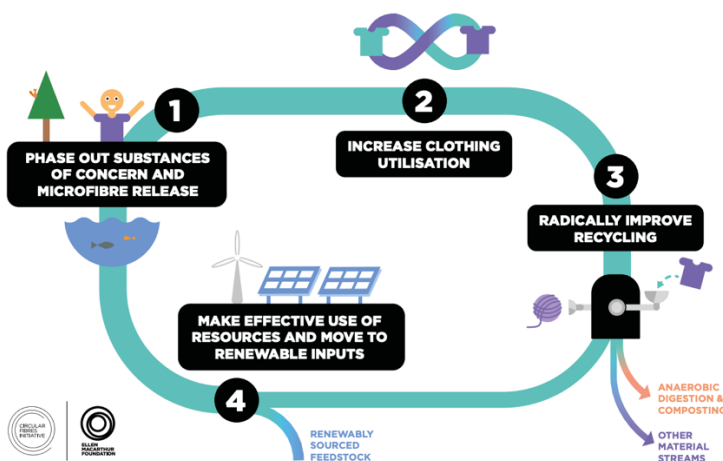
The value of the Porter Hypothesis is not solely in its contents, but rather in its ability to provoke the world of economic thought. The Porter Hypothesis was the catalyst for a plethora of insightful economic research within the context of regulation and environmental sustainability. In the empirical research of the Porter Hypothesis performed by economists since its release, there are two main versions that have developed, the “weak” and “strong” hypotheses (Lanoie 2010, 7-9). The “weak” version of the porter hypothesis evaluates the relationship between the stringency of environmental regulation and the innovation that occurs (Lanoie 2010, 7). In their

assessment of the vast research that has attempted to apply the PH, they found that the “weak” version (“stricter regulation leads to more innovation”) is empirically substantiated (Lanoie 2010, 16). The “strong” version of the Porter Hypothesis evaluates the effects of regulation on business’s performance (Lanoie 2010, 8). In their evaluation of the present empirical evidence relevant to the “strong” Porter Hypothesis (“stricter regulation enhances business performance”), they found that the proof of the relationship was more varied than the “weak” Porter Hypothesis, but there is clearly still a positive correlation which has been strengthened in the most recent examples of research (Lanoie 2010, 16).

The principles presented by Porter and Van Der Lin provide valuable insight on how to approach the creation of meaningful regulation in the polyester industry. The principle of “*Clear Goals, Flexible Approaches*” will be foundational to my regulatory approach (Porter 1995, 110). Equally foundational is the principle of “*Regulatory Coordination*” (Porter 1995, 113). When discussing “*Seeding and Spreading Environmental Innovations*”, Porter brings attention to the importance of the utilization of existing regulatory instruments such as pollution taxes and tradable permits (Porter 1995, 111). In applying these regulatory instruments to the polyester industry, a pollution tax seems to be the most fitting. In applying the work performed by Lanoie, the goals of my regulatory approach are in line with the “weak” version of the Porter Hypothesis. While I believe there will be increased business performance provoked by my regulatory approach, the main goal is to perpetuate more innovative and environmentally sustainable practices.

When thinking about current and relevant work and research coming out of the industry, I would be remiss if I failed to present the work coming out of the Ellen Macarthur Foundation.

The Macarthur foundation has long championed a general circular economy model, but as of recent years, they've set their sights on the fashion and textile industry. The significance of this work lies in its collaborative nature between industry and intellectuals, amassing contributions from a wide array of individuals from senior partners at McKinsey & Company, the leading firm in business consulting, to the directors of marketing, strategy and sustainability at Adidas, one of the most powerful names in the apparel and sportswear industries. Although the focus of the model is on the fashion and textile industry as a whole, it places an insightful emphasis on the use of synthetic fibers such as polyester and the negative impact they have.



Although the Macarthur Foundations model consists of the 4 steps presented in the graphic above, my main point of interest is the first step due to its focus on microfibers. In phasing out the use of microfibers such as polyester, they propose 2 main actions that should hypothetically lead to a successful transition. The first action posed is to “align industry efforts and coordinate innovation to create safe material cycles” (*Ellen MacArthur Foundation*, 23). In their elaboration of the point, they highlight some key factors such as the necessity to eliminate these substances in order to set the foundation for large scale recycling of textiles and to eliminate the negative

effects of the substances of focus (*Ellen MacArthur Foundation, 23*). They continue by highlighting the importance of “improved transparency along the value chain, a robust evidence base, and common standards...” in phasing out microfibers (*Ellen MacArthur Foundation, 23*). Although many of the impactful substances could be eliminated quickly, innovation is integral in creating new processes, inputs and materials that should completely phase out microfibers and other problematic substances (*Ellen MacArthur Foundation, 23*). The second action proposed it to “drastically reduce plastic microfiber release” with the use of new processes and materials that minimize the shedding of microfibers. Just as integral, scalable technologies that work to “capture those that do still shed...” (*Ellen MacArthur Foundation, 23*). Finally, they pose that a better understanding and awareness of microfiber shedding will help inform future solutions (*Ellen MacArthur Foundation, 23*).

In assessing the work presented by the MacArthur foundation, we are able to gain valuable insight into the industry's evaluation and understanding of the issue at hand. The work presented and paraphrased above is well rounded, highlighting many valuable facets of ameliorating the issue such as greater industry alignment and coordination, innovation in production processes and inputs, and technological innovations in monitoring to prevent future microfiber shedding. Although I am in agreement with the integral nature of these factors in combating the issue of polyester and other microfiber shedding materials, they have clearly neglected the paramount importance of policy and government intervention. The importance and utilization of policy is mentioned in later sections, but it is often treated as an afterthought, secondary to the prescriptions given. The simple fact that they failed to present policy initially, highlights their negligence common economic theory.

In evaluating the MacArthur Foundation's model, I want to highlight some of their assumptions I picked up on and found quite dangerous. The assumption of collaboration and unity in combating the issue feels misguided and naïve due to the simple nature of competitive markets, especially one as competitive as the textile market. Similarly, the assumption of the market being able to self-regulate and create standards is far-fetched, with the prominence of sweat shops and child labor in the textile industry, it is clear that morality is lacking so it is more than likely that less morally inclined firms would pick up the slack created by those opting to forgo the use and propagation of these materials. The MacArthur Foundations model assumes that innovation of technological processes serves as a precursor to regulation, this is the opposite of what Porter and Van Der Lin's theory proposes.

Historical examples of regulation of polyester are nonexistent, but there are a few recent examples of bills coming out of California attempting to address the micro-fiber externality. The first example is California legislature's SB1263 bill, which was passed in September of 2018, with the goal of creating awareness around plastic microfiber release and creating a "statewide microplastics strategy". Towards the end of the summary of the bill, they state that: "The bill would require the council, subject to the availability of funding, to submit the Statewide Microplastics Strategy to the Legislature on or before December 31, 2021, and to report to the Legislature on the implementation and findings of the Statewide Microplastics Strategy, and on recommendations for policy changes or additional research, on or before December 31, 2025" (SB1263). The goal of this strategy is to "increase the understanding of the scale and risks of microplastic materials on the marine environment and identify proposed solutions to address the impacts of microplastic materials, to the extent feasible" (SB1263). From the gained

understanding from this risk assessment research, they will “evaluate options, including source reduction and product stewardship techniques, barriers, costs, and benefits” (SB1263). SB1263 was a good first step in attempting to grapple with the growing issue of microfiber pollution, it was equally valuable in its ability to provoke further regulatory action such as AB2379 and AB129. AB2379 states that after January 2020, all clothing made with over 50% synthetic materials must bear a warning label highlighting the environmental impact of microfibers (AB2379). The main goals of the legislature as proposed in the bill are to “(1) Recognize the emerging threat that microfibers pose to the environment and water quality and provide information to the general public about the sources of microfiber pollution. (2) Reduce the amount of microfiber that enters the environment and is subsequently consumed by wildlife” (AB2379). Although the goals are nothing groundbreaking, they are valuable in that they attempt to further create awareness around the issue. Through this increased awareness, there is potential to shift consumer behavior, potentially diverting the more environmentally inclined from purchasing goods that bear the warning label. Despite the confusing nature of the California legislature’s website, I am pretty sure that this bill was passed and is currently being implemented. Building off of the goals set forth by AB2379, AB129 was a recently proposed bill out of California that took, what could be considered, a more extreme approach to the issue. The technical summary is as follows:

This bill would require the state board to take specified actions relating to microfiber pollution on or before July 1, 2020, and would require the state board to identify best practices for clothing manufacturers to reduce the amount of microfibers released into the environment. The bill would require, on or before January 1, 2020, a public entity that uses a laundry system, and a private entity that contracts with a state agency for laundry services, to install a filtration system to capture microfibers that are shed during washing. The bill would require, on or before January 1, 2021, a private entity that uses an industrial or commercial laundry system to install a filtration system to capture microfibers. By requiring a public entity, which is defined to include specified local government entities, to install microfiber filtration systems, the bill would impose a state-mandated local program.

To reiterate the points presented above; the intentions of the bill are to get the state board to identify the best practices for clothing manufactures, require all public and private(if contracted

by the public) entity's using industrial washers to install a filtration system, and by 2021 all private industrial or commercial washers to install a microfiber filtration system (AB129).

Are these attempts at regulation actually meaningful, particularly within the context of the Porter Hypothesis? In evaluating California Legislature's SB1263 bill, it is generally positive and is for the most part consistent with the prescription set forth by the Porter hypothesis. The call for collaboration between government entities such as the Office of Environmental Health Hazard Assessment and private institutions such as Stanford University, is directly consistent with Porter's call for "Regulatory Coordination" (Porter 1995, 113) (SB1263). Even though the initial goals and intentions are set forth and implemented by 2021, they allow for 4 years of research before policy recommendations are made. Although the relationship to Porter's prescription of "Clear Goals, Flexible Approaches" is less direct than the connection to "Regulatory Coordination" made above, they share the same sentiment (Porter 1995, 110).

California legislature's AB2379 bill, although subtle in its effects, serves as the best example of existing regulation, consistent with principles set forth by Porter. In mandating warning labels, this regulation will undoubtedly create better consumer and corporate awareness around the issue, potentially shifting consumer and corporate preferences away from the good. AB 2379 is consistent with the idea that regulation should serve the purpose of riveting attention to potential innovation (Porter 1995, 100). One critique I do have of this bill is the decision to only label clothing composed of 50%+ Polyester. One of Polyester's most common applications is as a complementary agent to other fibers such as cotton in order to blend the characteristics, meaning that a significant level of clothing that includes polyester, are composed of less than 50% polyester. This lack of understanding of the nuances of polyester's applications will undoubtedly limit the effectiveness of this bill.

California legislature's AB129 bill, within the context of the Porter Hypothesis, is easily the most misguided attempt at regulation presented. In forcing public and private entities that use industrial or commercial washers to install a specific prescribed filtration system, the bill defies the two of the three principles set forth by Porter in his section "Designing Environmental Regulation to Encourage Innovation" (Porter 1995, 110). In forcing a particular innovation, they are limiting the potential opportunity for innovation as well as defying the principle that the approach to innovation should be left "to industry and not the standard-setting agency" (Porter 1995, 110). I question the fact that the standard setting process was left to the state board and not the industry? In locking in a particular filtration technology, they are defying the second principle that states: "regulations should foster continuous improvement, rather than locking in any particular technology" (Porter 1995, 110). Porter would describe these types of regulations as "end-of-pipe or secondary treatment", which are often more costly than meaningful regulation that provokes "product and process changes to better utilize resources and avoid pollution early" (Porter 1995, 111). In evaluating these bills, I question if Porter would consider all these bills "end-of-pipe" treatments? Although not a direct connection to the principles set forth by Porter, I believe there is potential for a more theoretical connection. In solely attempting to ameliorate the microfiber externality, they neglect the opportunity to regulate the root of the issue; polyester. I believe Porter would consider this misguided regulatory targeting as an "end-of-pipe" treatment (Porter 1995, 111).

Conclusion: The Final Policy Proposal

Goal: Reduce the environmental impact of the polyester fiber industry through innovation in product and processes provoked by well-crafted regulation.

Issue:

Over the past few decades, Polyester fiber has grown to be the most used fiber in the world. Although there are many benefits to the utilization of polyester fiber, it comes at a significant environmental cost. The environmental impacts of the polyester industry include: microfiber shedding, high fossil fuel expenditure, and a high level of greenhouse gas emissions.

Solution:

1. All finished goods, intending to be sold in the US, made with 25% or more polyester fiber will be required to bare a warning label, clearly visible to consumers and corporations, that highlights the different ways polyester fiber impacts the environment.
 - a. As opposed to AB2379 which only required goods with 50% or more poly to be labeled, this proposal poses that labeling at 25%+ better reflects the nuances of polyester fiber's utilization as blending agent (polyester fiber often contributing less than 50% of a good).
2. Emissions tax on the sale of products that include polyester fiber. Recycled polyester will be taxed at half the rate of virgin polyester. Biodegradable forms of polyester, like ECOFACE polyester, will not be affected by the tax.
 - a. The level of tax will be directly relative to the percentage of polyester fiber weight within the good.
I. Example: if a t-shirt weighs 10 oz's and is comprised of 50% virgin polyester, at a hypothetical tax rate of \$1 per an oz of polyester, the t-shirt would have a \$5 tax. Similarly, if the same t-shirt was made from recycled polyester instead of virgin, it would have a \$2.50 tax associated.
 - b. The EPA will be tasked with calculating an appropriate tax rate that reflects the environmental costs of polyester utilization. Once created, the EPA will seek the collaboration and consultation of the industry in order to create a fair yet affective tax rate.
 - c. All tax revenue will go to the EPA to fund initiatives that work to ameliorate the environmental damage that has been done.

In designing this policy proposal that reflects the nuances of the polyester fiber industry and the nuances of environmental economic theory and implementation, I believe that if this policy was implemented, it has the potential to significantly reduce the environmental impact, internalizing the externalities, of polyester fiber as well as provoke a more sustainable and innovative industry. I will now analyze the different parts of the policy, explaining the main theory that went into each.

I will discuss part 1 of the policy; the warning label. Although a relatively simple form of regulation, it is essential. Part 1 of the regulation is inspired by the purposes that properly crafted regulation can serve as presented by the PH, as well as the ideas presented in the AB2379 bill. (Porter 1995, 99). The implementation of a warning label signals consumers and companies to the problems associated with polyester fiber usage. In terms of consumers, the education brought on by the warning label has the potential to shift consumer preferences away from goods containing a high density of virgin polyester fiber. Although the intentions of AB2379 were good, it lacked understanding of the nuances of polyester's implementation which would have seriously limited the effectiveness of the bill. In changing the threshold of products affected from 50% to 25%, the regulation better reflects polyester's utilization as a blending product. A key distinction that will undoubtedly increase the effectiveness of the regulation over that proposed by AB2379.

Part 2 of the policy; emissions tax on the sale of final products that include polyester fiber. I acknowledge that although this may not be a strict emissions tax by definition, my implementation holds the same sentiment, implementing a tax meant to reflect the environmental costs associated with polyester fiber. As opposed to part one which places emphasis on pressuring consumers and firms, part 2 places all the emphasis on firms and producers. The goal

of this tax is to disincentivize the use of polyester fiber, particularly virgin polyester fiber, and incentivize the creation and utilization of more innovative products and processes such as recycled polyester and biodegradable equivalents like ECOFACE polyester. With this, the emissions tax works to internalize the costly environmental externalities of the polyester industry, within said industry. In order to incentivize the use of recycled polyester, I have decided to tax recycled polyester at half the rate of virgin polyester. Although the process of recycling polyester is far from perfect and often inconsistent, in some cases leading to environmental externalities similar to that of virgin polyester (as discussed in chapter 1), in making recycled polyester more economically viable than virgin polyester, it will create the pressure necessary to innovate and streamline the relevant processes, creating more consistent and sustainable practices.

The intuition and intention of this regulation is based in, and consistent with, the principle set forth by Porter. The principle of “*Seeding and Spreading Environmental Innovations*” presented by Porter was essential to the choice to implement a tax that reflects the costs of emissions (Porter 1995, 111). This policy proposed has the potential to create the product and process offsets described earlier by Porter (Porter 1995, 101). In designing this policy proposal, it was critical that I followed the principle of “*Clear Goals, Flexible Approaches*” (Porter 1995, 110). In applying this, I was diligent to avoid locking in a particular innovation or technology, such as ECOFACE polyester, because doing so would undoubtedly limit the policy’s effectiveness. Rather, the incentive structure should lead to an increase in the creation, viability, and utilization of environmentally sustainable products like ECOFACE polyester, but not limited to ECOFACE polyester. If I was negligent to this nuance and simply said “ECOFACE polyester will not be affected by the tax”, I would be providing the ECOFACE brand with significant

market power that could lead to monopolistic characteristics. This would also remove any incentive to innovate and create similar products. Porter emphasizes the importance of “*Regulatory Coordination*”, I agree strongly that in order for regulation to properly reflect the industry affected, there has to be collaboration, hence my call for collaboration between the EPA and the industry (Porter 1995, 113). In sending the tax dollars to the EPA, creating a tax relationship, firms and consumers will be able to see where their tax dollars, perpetuating corporate and consumer acceptance.

Through my research, I have designed an environmental policy that reflects the nuances of both the polyester industry and environmental economic theory. If this policy was to be implemented, I believe it would successfully internalize the environmentally costly externalities within the industry, while creating maximum opportunity for innovation, leading to a more environmentally and economically sustainable polyester industry of the future.

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