Attachment 2

Economic Analysis of California's Green Chemistry Regulations for Safer Consumer Products

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Biography

Matthew E. Kahn is a Professor at the UCLA Institute of the Environment, the Department of Economics, the Department of Public Policy, the Anderson School of Management and the UCLA Law School. He is a research associate at the National Bureau of Economic Research. Before joining the UCLA faculty in January 2007, he taught at Columbia and the Fletcher School at Tufts University. He has served as a Visiting Professor at Harvard and Stanford. He holds a Ph.D. in Economics from the University of Chicago. He is a member of the California Air Resources Board's Research Screening Committee. He has served as the co-editor of the Review of Environmental Economics and Policy and serves on the editorial board of the Journal of Environmental Economics and Management and the Journal of Urban Economics. He has published three books and over 80 peer reviewed journal papers.

LIST OF ACRONYMS

Acronym	Definition
AA	Alternatives Assessment
AB	Assembly Bill
CAPA	California Administrative Procedure Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CGE	Computable General Equilibrium
CEX	Consumer Expenditure Survey
CAFE	Corporate Average Fuel Economy
DTSC	Department of Toxic Substances Control
NAICS	North American Industry Classification System
OPEC	Organization of Petroleum Exporting Countries
REACH	Registration, Evaluation, Authorization and Restriction of Chemical Substances
R&D	Research & Development
RCRA	Resource Conservation and Recovery Act
SB	Senate Bill
TFP	Total Factor Productivity
TURA	Toxics Use Reduction Act

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Executive Summary

The California Administrative Procedure Act (CAPA) mandates that State agencies perform an economic analysis of the "adverse economic impact on California business enterprises and individuals" when engaged in rule making. This assessment includes consideration of the impact on the ability of California businesses to compete with businesses in other states. Another provision of the CAPA calls for assessment of the extent to which the proposed regulations will lead to the creation or elimination of businesses and jobs in California.

This report provides a prospective economic analysis of the draft new Safer Consumer Product regulations. The regulations intend to improve public health and environmental quality by introducing a set of rules that will create a discovery process that will change how manufacturers produce their products and generate new information about the chemical content of products. Once the assessment is completed, firms may manufacture an alternative product if it meets prescribed conditions. Failing this, DTSC may issue a regulatory response mandating several possible actions by the firm, ranging from engaging in further research, providing product information, adopting an identified alternative, to banning products from the California marketplace.

The economic approach for determining the benefits of such new public policies hinges on whether there are significant societal costs associated with the status quo. Today, producers, workers and California consumers know too little about the content of products. The Safer Consumer Products regulations will rectify this information gap and create incentives to encourage product makers to produce safer products. This mitigation effort demonstrates the regulation's potentially large societal benefits of protecting human health and the environment. Economists stress the importance of considering tradeoffs between benefits and costs. Manufacturers and consumers will incur some costs to comply with these regulations. One of the key goals in this economic analysis of public policy is to correctly describe this *tradeoff*. Throughout this report, we pay careful attention to identifying the factors that determine both the short run and long run costs of these regulations and its likely benefits.

Responsible entities will bear real costs as a result of these regulations. To evaluate these costs, this report begins by developing a causal framework within which the effects of these regulations on firms' costs can be evaluated. The focal types of costs include: 1) testing products for Chemicals of Concern, 2) undertaking an alternatives assessment, 3) implementing a chosen alternative and 4) complying with various regulatory mandates. Because of a lack of empirical information, this report will not provide empirical estimates of these costs. Rather, for each type of cost, this report identifies those factors that will determine the likely size of the cost borne by responsible entities.

Throughout this report, we are careful to highlight which links in the supply chain will be affected by these regulations. Retailers of products are unlikely to be significantly affected by these regulations because they can substitute and sell products that have not been regulated by the DTSC. In an extreme case in which entire product lines are banned, then retailers can import products designed in other countries such as Europe that are likely to meet DTSC's regulatory

requirements. If no such products exist, then retailers will have the option of substituting and selling other products that do not face DTSC regulation. Access to this broad set of options protects retailers from suffering significant profit losses due to these regulations.

The revised regulations state that worker exposure is a prioritization factor. A benefit of this provision is that the regulation is likely to reduce worker exposure to chemicals of concern.

Short-run costs in the California context

To place these impacts in context, this report presents information on household expenditures on chemical products and recent California trends in job growth in the chemical industry. Given the importance of protecting California jobs, we pay careful attention to the employment impacts of these regulations. We present evidence on the health of the chemical industry for California. Because households' share of expenditures on the likely set of affected products is small, there are likely to be small impacts on households' budgets. Since most product manufacturing takes place outside of California, we expect the direct short-run California employment impacts to be minimal. There are scenarios under which there could be employment growth if greener California manufacturers gain in market share.

Incentives for innovation and eliminating barriers to market efficiency

Taken together, the proposed regulation will create incentives to innovate toward safer products. Manufacturers that are found to produce products that contain Chemicals of Concern are likely to suffer sales losses when this information becomes public knowledge. However, claims that such losses represent social costs of these regulations are false since this shifting consumer demand represents a transfer to other firms that produce safer alternatives and will gain sales as consumers substitute toward safer products. We believe that California firms have an edge in gaining such market share. Such greener alternatives developed in California could enjoy a substantial export market given the phase in of Europe's REACH regulation. Europe's new regulations create an export market for California manufacturers. Furthermore, this regulatory proposal sends a credible signal to risk averse innovators that investments of their scarce time in designing green products will offer a high rate of return.

Long-run regulatory costs are likely to fall

Next, this report explains why firms are likely to overestimate the long-run costs of these regulations. We believe that firms will respond to the change in the "rules of the game" by making investments to investigate alternative ways to design their products and establishing new relationships with intermediate input suppliers so that their supply chains evolve. Unlike in the short run, in the long run manufacturers can make many adjustments in response to these regulations. The net effect of this enhanced "flexibility" is that long run regulatory compliance costs are likely to be much lower than short run costs. Manufacturing firms will engage in research and development, experimentation, and will benefit from competition in the intermediate input market, as these regulations will stimulate new ways for designing consumer products. We anticipate that some firms producing similar products will form industry research consortia to work together to achieve common regulatory goals. The combination of these factors

lowers the cost of compliance. A review of past regulatory examples for lead and chlorine emissions supports these claims. Firms that have trouble adapting to the new regulatory environment exit the market and are replaced by new or expanding firms that are more nimble in complying with the regulatory code. In short, the time allowed for firms to adapt to the proposed regulations provides the average firm in the industry the opportunity to face lower regulatory compliance costs. Historic environmental regulations (i.e. The Clean Air Act) and Europe's REACH regulation provide direct empirical support of this claim.

The size and determinants of social benefits

The final section of this report identifies the types of societal benefits and those factors affecting their size. The size of these benefits will depend upon 1) how effectively DTSC prioritizes Chemicals of Concern and priority products, 2) how motivated firms are to test their products and adopt alternatives, and 3) how quickly consumers will access information and exercise choice that will shift demand toward safer consumer products.

If DTSC focuses on Chemicals of Concern for which the population has a high exposure, then the health benefits of these regulations could be large. The size of such benefits hinges on how many people are exposed to the priority chemical, how intense in their individual exposure, and how sensitive is their health to such exposure. A major and early benefit of these regulations is providing direct credible information to consumers. Armed with this new information, consumers will make healthier choices. In the long term, these regulations create both market and regulatory incentives for firms to discover and adopt safer production methods and safer products.

A tool for advancing environmental justice

Currently only consumers with the time, information, expertise, and resources to identify safe and unsafe products can make welfare-improving market choices. There are other Californians who simply assume that all products are "safe" and seek out the cheapest product at the store. Low-income populations are more likely to be over-represented in this group and will thus gain the greatest health benefits from these regulations. These regulations address this inequity in two ways. First, by increasing access and reducing the cost of obtaining this information, these regulations empowers all consumers to make better market choices. Second, over time the set of products offered in the market should become safer.

Known Unknowns

These regulations create a new set of "rules of the game" that encourage product makers to invest time and effort into understanding their supply chains. In any setting featuring learning and experimentation, there is uncertainty concerning what will be discovered and how costly it will be to seek out substitutes. Firms will learn about the risks that their products may pose and will learn about alternative methods for producing safer products. DTSC will learn about the ability of existing firms and new firms to produce such products. It is quite reasonable to assume that significant "learning by doing" will take place here. Firms will acquire the expertise

to investigate alternatives. As there is increased demand for alternatives assessment, well-trained workers will choose to specialize in this field. Their specialized human capital will mean that the quality of assessments will improve and this will lead to larger medium term public health benefits from these regulations.

In addition to there being uncertainty about how producers will respond to these regulations, there is also uncertainty about how consumers will respond. An active research agenda in the new field of behavioral economics has argued that consumers can be overwhelmed with information and this can lead them to "tune out". While economists are quite optimistic that information regulation does influence consumer behavior, it is likely that different consumers will respond differently to the information that DTSC will post to its website and to new product labels. Anticipating such heterogeneous responses will increase the likelihood that these new regulations offer public health benefits to all of California's consumers.

1. Introduction

This report provides an economic analysis of California's draft Green Chemistry Regulations for Safer Consumer Products. These regulations intend to improve public health by introducing a set of rules that will affect how manufacturers produce their products and that generates new information about the chemical content of products. The economic approach for judging the benefits of such new public policies hinges on whether there are significant social costs associated with the status quo. This Safer Consumer Products regulation helps to mitigate a significant information problem. Today, both producers and California consumers know too little about the chemical content of products. These regulations will rectify this information gap and create incentives to encourage product makers to produce safer products. This point highlights that these regulations offer potentially large social benefits. But, economists stress the importance of considering tradeoffs. Manufacturers and consumers will bear costs to comply with these regulations. One of the key goals in this economic analysis of public policy is to correctly describe this *tradeoff*. Throughout this report, we pay careful attention to identifying the factors that determine both the short run and long run costs of these regulations and their likely benefits.

The California Administrative Procedure Act (CAPA) mandates that State agencies perform an economic analysis of the "adverse economic impact on California business enterprises and individuals" when engaged in rule making. This assessment includes consideration of the impact on the ability of California businesses to compete with businesses in other states. Another provision of the CAPA calls for assessment of the extent to which the proposed regulations will lead to the creation or elimination of businesses and jobs in California. Where accurate or meaningful quantification is not possible, DTSC must "present a matrix of all reasonably foreseeable positive and negative impacts of the regulation."[1]

This report will address each of these key issues. We devote special attention to identifying those types of product makers who will face the highest costs of these regulations. We use economic theory to assess how California's businesses and workers will fare in the presence of this new regulation.

We will study in detail how California firms are likely to cope and adapt in the face of this new regulatory regime. These regulations will unleash a dynamic process of learning and technological change. It will provide firms with strong incentives to take a new look at their supply chains and production processes to try to reduce the quantity of priority products that are used to produce the final product. Given the diversity of firms and the multitude of possible innovations that each firm could discover through trial and error, there is no way for anyone to foresee what will transpire. The net effect of this dynamic discovery process is that the long run costs of compliance with these regulations will be much lower than the costs of compliance in the short run. This optimistic claim is backed up by thirty years of experience with

[1] California EPA, *Economic Analysis Requirements for the Adoption of Administrative Regulations* (December 9, 1996).

environmental regulations. Below, we will discuss several salient examples. [2] The unifying theme across these examples is that firms adapt to the new "rules of the game". Due to our workforce's educational attainment, world-class universities, and access to capital, California's firms are likely to among the most nimble in responding and thriving in the new regulatory environment. In capitalist competition, they will be rewarded for their innovative production strategies.

1.1 Overview of cost impacts & firm adaptation

This report studies these regulations' short run and the long run impacts on product makers and chemical makers. We will argue that the short run costs of compliance are likely to overstate the long run costs of compliance. We emphasize the importance of recognizing firm heterogeneity as a key assumption. More nimble firms who seek a "green niche" are likely to gain market share from these regulations at the expense of firms who are locked into "old ways" of producing products. Using basic concepts from microeconomic theory, we pinpoint the conditions such that firms can adapt to the new regulations.

AB 1879 (Feuer, 2008) and SB 509 (Simitian, 2008) require DTSC to develop a regulatory process in which firms, consumers, and the government will all learn about the chemicals embodied in consumer products. The regulations create a new set of "rules of the game" that will create a discovery and disclosure process, providing incentives for firms to produce safer products. The regulations provide firms with time to adapt to the new rules. Firms first have a chance to see if any of the chemicals embodied in their products are prioritized. Firms will also be granted time to research the feasibility of introducing an alternative. This explicit "cushion" highlights that DTSC recognizes that product adjustments costs that some manufacturers will face. The net result will be increased consumer confidence in products sold in California and reduced population exposure to harmful chemicals.

1.2 Regulations effects on product quality and public health

These regulations will raise the quality of products sold in California. Products containing chemicals known to be truly dangerous for which there are viable economically feasible alternatives are likely to be banned. The regulations will push companies to take steps to reduce Californians' exposure to harmful chemicals. This will build trust among consumers and lower the likelihood of long run health consequences from using key products. Firms will take a new

[2] Examples include; Kerr, S. and R.G. Newell, 2000. "Policy-Induced Technology Adoption: Evidence from the U.S. Lead Phasedown", Resources for the Future Discussion Paper 01-14, Resources for the Future, Washington, DC. And Snyder L, Miller N, Stavins R., 2003. The effects of environmental regulation on technology diffusion: the case of chlorine manufacturing," *Am. Econ. Rev*. 93:431–35, Popp, David. 2003, "Pollution Control Innovations and the Clean Air Act of 1990", *Journal of Policy Analysis and Management*, 22(4), 641-660. , Popp, David. 2006, "International Innovation and Diffusion of Air Pollution Control Technologies: The Effects of NOX and SO2 Regulation in the US, Japan, and Germany", *Journal of Environmental Economics and Management*, 51(1), 46-71.

look at their global supply chains and take pro-active steps to improve the safety of their products.

Ultimately, these regulations can only improve the public's health if it reduces Californians' exposure to dangerous chemicals. These regulations can achieve this goal through focusing its regulatory efforts on identifying such chemicals, making sure that companies that currently produce products using these chemicals are alerted about this fact, and using the regulatory tools at its disposal to encourage such firms which produce "priority products" to minimize population exposure to these chemicals. This requires that firms identify cost-effective alternatives to minimize exposure to dangerous chemicals such as substituting safer chemicals, reducing the given chemical's use, or minimizing the possibility of the chemical's release.

Our study will also present a detailed logic chain for why these regulations offer significant social benefits. Today there is a fundamental asymmetry of information; consumers are unaware of potential chemical exposure when they buy a product. Some producers may also be unaware of what chemicals are contained in their products. Such firms may have settled upon a production process and product formulation years ago before current knowledge became available. If the consumer had more information about each product's toxicity would he or she make a "healthier" choice? We believe that the answer in many cases is "yes". This view is based on a major ongoing research program in environmental economics. Leading scholars have documented how people change their behavior when provided with new trusted information.[3] While the Surgeon General's 1964 Report on Smoking and Health that linked smoking and cancer risk is the most famous example, there are several more recent examples that we discuss below. High quality new information provided by a trusted government regulator can offer significant social benefits through encouraging consumer substitution and purchases of "greener" products. Below, we will argue that these regulations could have significant environmental justice benefits as the low income populations, who may not be environmentally conscious, are the most likely to change their product consumption and hence exposure thanks to these regulations. As households change their product choices, the toxicity level of garbage in landfills will decline. This will translate into reduced chemical exposure for the residential community living near landfills.

1.3 Methods

Most prospective analyses of new regulation's likely consequences rely on one of two possible methodologies for generating an exact prediction. The first are computable general equilibrium models. Such models make strong assumptions about the cost of production for firms and household product preferences. The payoff of such a framework is that it yields precise predictions concerning the consequences of the regulation. But, by the very nature of these

[3] Examples include; Jin, Ginger & Phillip Leslie, 2003. "The Effect Of Information On Product Quality: Evidence From Restaurant Hygiene Grade Cards," *The Quarterly Journal of Economics*, MIT Press, 118:409-451 and Shimshack, Jay P. & Ward, Michael B. & Beatty, Timothy K.M., 2007. "Mercury advisories: Information, education, and fish consumption," *Journal of Environmental Economics and Management*, Elsevier, 53(2): 158-179.

regulations' emphasis on information discovery, learning, and firms' evolutionary adaptive responses, we view any attempt to offer precise predictions of these regulations' costs and benefits to be highly speculative and perhaps even foolhardy.

There are two key reasons why we do not believe that an explicit computable general equilibrium (CGE) modeling effort would be useful for predicting the consequences of these regulations. Today, economists simply do not know diverse firms' short run and long run cost of compliance with these regulations. Without knowing each firm's cost of production, we cannot determine how these regulations will affect each firm's labor demand or its output production. In the medium term and long term, we do not know what will be the production capabilities of new firms who will enter the product market to compete against incumbents. Just as Microsoft did not anticipate the impact that Google would have on how we use computers, we acknowledge that we cannot foresee such industry dynamics. But, without such foresight there is no way to make precise quantitative predictions about these regulations' medium term and long term impact on jobs, profits and consumer prices in product markets.

In addition to not knowing precise details about the costs of production for different products, we also do not know the true shapes of product demand curves. If consumer demand for products is highly inelastic, then these regulations will mainly affect final consumer prices for these products. In contrast, if aggregate demand for a specific product is highly elastic (i.e., higher prices will sharply lower quantity demanded), then firms whose cost of production goes up because of these regulations will respond by reducing their employment and output production. While economists have estimated the elasticity of demand for many products such as gasoline and food, we know of little research investigating the specific elasticities of demand for extremely narrowly defined products (such as a Blackberry cellular phone).

A second approach for generating predictions about a new regulatory program is to use statistical estimates of the effects of similar past regulatory efforts to extrapolate about the consequences of this new regulation. Unfortunately, from a research perspective, the draft AB 1879 regulations represent a unique law that has not been implemented elsewhere. While Europe started its REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulations in 2007, we do not have a sufficiently long history of regulatory compliance with these types of regulations to be able to statistically estimate how different firms adapt to similar regulations. We have carefully searched for relevant past cases, and we will below discuss examples that we believe speak to the likely consequences of these regulations but we are not aware of any regulatory actions that are closely similar to this specific regulatory action.

These regulations create new "rules of the game" and there is ample evidence from the industrial organization literature that through a competitive process firms adapt to the new circumstances that they face (Nelson and Winters 1982). The firms that emerge from such a competition may not be the same set of incumbents who thrived before the regulation was enacted. After all, one firm's challenge represents another firm's opportunity. In the 1970s, the Nobel Laureate Robert E. Lucas published his famous Lucas Critique arguing that one cannot naively extrapolate from

past data on how optimizing decision makers will respond when the rules of the game change.[4] His focus was on how consumers would respond to changes in government policy such as a tax cut. In this case, we seek to understand how diverse firms across many different industries will respond to the new regulations. Every firm even within narrowly defined industries will find itself facing a different set of economic circumstances depending on its physical capital stock and the ability of its managers. No economist can claim to know how so many decentralized decision makers will respond. The implication of the Lucas Critique in this setting is that it is nearly impossible to write down a predictive model to anticipate how diverse industries and different types of firms within industries will be affected by this new regulation. In the year 1990, nobody could have anticipated the role that Google and Facebook would play in California's economy in the year 2012. This same logic applies in the case of DTSC's regulations. By mandating that product makers take a close look at their products, these regulations will induce an industrial shake up that will lead to some firms losing market share and other more nimble firms gaining market share. While "naming names" of those firms who will thrive under these new rules is not possible, we can be confident that technical challenges create new opportunities for those firms who have the human capital, financial capital and the luck to adapt and find cost effective solutions. By a law of large numbers, if enough firms try to innovate to find solutions then some will succeed and these companies will be rewarded for their ability to make safe products that meet consumers end goals.

While we do not construct a formal economic model of supply and demand for products nor do we use econometrics to estimate a forecasting model, we devote special attention to describing the key cases and underlying economic parameters that will determine the size of the costs and benefits of these regulations. This taxonomy is useful for predicting how different types of products will compete in the face of these regulations and for judging how California's firms will fare in both the short run and the long run.

Our overall assessment, despite the fundamental uncertainties, is that these regulations will offer California significant net benefits. This bottom line is based on three key facts. First, there is a historical record that the ex-ante predicted regulatory costs of compliance overstate the ex-post true regulatory costs of compliance. Second, California's firms are uniquely suited to thrive under this new regulatory environment. Such firms have access to a skilled workforce and leading research universities. California firms have past experience in working to comply with stringent environmental regulations. Third, informed consumers make better choices. DTSC's actions to implement the AB 1879 regulations will generate valuable information for consumers. Once informed based on this discovery process, consumers are highly likely to make different choices over product purchases. The net effect of such choices will be an improvement in household health.

[4] For some technical discussion see http://www.nobelprize.org/nobel_prizes/economics/laureates/1995/back.html

2. The Regulatory Process

The *Safer Consumer Product Regulation*, authorized by Assembly Bill 1879 and Senate Bill 509 gives the Department of Toxic Substances Control (DTSC) the responsibility to devise a new consumer product chemicals regulation. These regulations sets out procedures and standards in four basic steps:

1) identifying and prioritizing the chemicals of greatest concern;
2) identifying products that contain those Chemicals of Concern,
3) performing assessments that compare health, environmental and economic trade-offs of those chemicals and relevant alternative chemicals, and
4) selecting regulatory responses, ranging from outright bans to no action at all and everything in between that create incentives for firms to adopt alternative consumer products.

3. Direct Costs of these regulations

Here we examine the types of costs that Safer Consumer Products Regulations may impose on California firms in the short run. For each step in Regulations chain, we will first explain how the regulations create new costs for the firm, illuminate the nature of those costs and then explain what factors will determine the magnitude of those costs. While there are several stages in determining the costs that different firms will face from these regulations, it is important to keep in mind the key conceptual point that the ultimate cost of these regulations will be paid by firms, workers and consumers. The exact "cost sharing" depends on key economic parameters that we discuss below. DTSC will also incur costs as it develops the Priority Product listing but it is anticipated that DTSC will ameliorate these costs by using existing scientific data.

3.1 Cost of testing and reporting for Priority Products

A firm's cost of testing products will vary with a number of factors. First, the total ***number of products*** a firm produces will influence its aggregate testing costs, with the greater the number of products the larger the firm's expected costs. Second, increases in the ***number of product components or chemicals*** involved in producing each product will likely increase the firm's aggregate costs

Third, the firm's ***prior knowledge of the chemicals*** used in it products will vary with several factors. Firms that already have investigated what chemicals are contained in their product will encounter very low costs for this step of the regulations. This may include firms who sell products in markets such as Europe. These firms may already have conducted the required testing. In addition, firms using chemicals that are regulated by TSCA or state laws may already have foreknowledge of certain chemicals. Finally, "green" firms who seek to target and re-assure green consumers are likely to have prior knowledge of the chemicals they utilize and the levels of these chemicals in their products.

Fourth, the ***structure of the firm's supply chain*** may affect its cost of testing chemicals in products. Vertically integrated firms that produce all of their own components and chemicals will generally face lower testing costs, all other factors held constant.

In contrast, manufacturing firms who contract out for components and inputs from other companies may face higher costs of determining what chemicals are contained in their entire product. The informational challenges associated with contracting increase when supply chains cross national boundaries. In response to these regulations, firms which source inputs from outside vendors will likely place a higher value on verified information of product contents. This will support the growth of ISO 14040 firms outside of California firms which verify the chemical components of product inputs which are imported into the state. In the draft regulations, there is no requirement for a manufacturer/responsible entity to know the chemical composition of every component or a product as a whole. A responsible entity must know enough about its product to know if it contains selected chemical/product pairings for which an alternative analysis is required.

Product testing as a fixed cost. Product testing for Chemicals of Concern represents a fixed business cost. Once the firm has incurred this cost, its average fixed cost declines with the scale of its production. A firm that sells two cars per year will face a higher average fixed cost from testing this product for chemicals than a firm that sells 5,000 cars per year. If small firms do sell a smaller volume of output, then they are likely to face higher average fixed costs of compliance. If DTSC expands the list of chemicals that must be tested for, then companies will incur new testing costs.

3.4 Costs of Alternatives Analysis

Once DTSC has identified a priority product, the firm must undertake an alternatives analysis. The cost of undertaking these analyses depends upon many factors.

First, the ***role of the Chemical of Concern in the product*** will matter. The costs of conducting these alternatives analysis will likely depend on the role the Chemical of Concern plays in the production and performance of these products. A continuum of possibilities may result from the alternatives analysis; from a new chemical *input*, to a new *production* process, or an *entirely* new product. If a firm can substitute an alternative chemical to fill the same role in the product or production process, then the fixed costs of transitioning to the alternative chemical will be minimal. If the firm is unable to substitute an alternative chemical, it may seek an imperfect substitute which could require product redesign or new production equipment and processes, and the firm would need to make fixed investments in order to identify and adopt the preferred alternative.

Second, the ***number of alternatives considered and thoroughness of each analysis*** will impact costs. Each alternative must be evaluated along several dimensions: health, environment, product performance and economic impacts. Costs will clearly vary with the standards of evaluation for each of these and how difficult it is to achieve those standards. If an alternative contains no Chemicals of Concern, it may be less costly to consider than an alternative that contains a Chemical of Concern, which would be subject to more testing to determine potential harm versus the status quo product.

Third, variations in firms' ***in-house research & development capacity*** will likely affect the costs identifying and assessing alternatives**.** Firms will differ with respect to their research and development capacity. Some firms may have already explored different ways to produce their product or have next-generation products under development. This is likely to be especially true for products with high rates of obsolescence and innovation. Generally speaking, larger firms in markets with a history of product innovation are more likely than smaller firms to have this in-house R&D capacity.

Fourth, the ***research capacity of the firm's trade or industry association*** may influence its costs. Firms' costs may fall if they belong to an industry association that assists in their alternatives analysis. Trade association research is most likely to reduce alternatives analyses costs when firms use common production technologies and products are made up of similar ingredients. A group of firms who produce similar products could contribute money to a collective pot to finance the overall analysis. For example, if there are ten firms in the collective, and they agree to share the cost of hiring a certified assessor, then each would face 10% of the total cost.

Fifth, firm's cost will also depend upon the ***degree of market competition among assessors.*** The assessor is expected to work with the firm who produces a priority product to identify alternative methods for mitigating the public health and environmental challenge. The costs of undertaking these analyses will fall as more trained professionals choose to enter this field.

Initially, the market could experience a shortage of accredited third-party assessors, as the onset of the regulations will suddenly and substantially increase the demand for ISO 14040 firms and skilled workers. If there are insufficient assessor/verifiers to meet the industry-wide demand for alternatives analyses by the regulatory deadline, then a scarcity exists and these firms will be able to charge high fees and attain high profits for their services. The effects of this initial shortage can be mitigated if alternative analysis firms know training requirements in advance and firms believe they will be able to recoup investment in capacity expansion when the regulations takes effect. In the long run, firms and individuals seeking profits will attain the accreditation necessary to perform alternative analysis. Such investments in specific human capital will mean that the quality of the third party efforts will improve and quality adjusted prices for hiring these consultants will decline due to market entry.

Trade Secrets and Intellectual Property Theft

Requiring companies to reveal their "secret sauce" is a necessary step for discovering what chemicals are embodied in the products but the transfer of this information raises the possibility of firms losing valuable trade secrets. This is surely a low probability event but it would be very costly for those firms who have made enormous up front R&D investments to design a product that competes with similar differentiated products. If such blue prints could be accessed, then other producers could easily enter that firm's product niche. Anticipating this low probability risk, DTSC has built into the regulations substantial trade secret protections to limit the likelihood that a costly information leakage could happen.

3.5 Regulatory costs resulting from DTSC regulatory responses

Regulatory uncertainty. The firm can incur costs in complying with a regulatory response if it takes significant time for DTSC to issue a regulatory response. Firms who produce a priority product may delay investments until a response is issued. These firms face uncertainty about the response outcome, and in light of this uncertainty will delay or suspend investments such as building or retooling a factory related to the priority product until they receive the DTSC regulatory response. In addition to the effect this delay will have on firm productivity, the firm may face financing costs for money borrowed in support of a suspended investment project.

For products that are submitted to the DTSC for a regulatory response, DTSC has many options at its disposal. It could require that a firm take no action or require additional information, or choose the minimal cost alternative. Additionally, the DTSC could require product labeling. While changing the product packaging to include the labeling would be low cost, it would result in additional consumers being aware of the product's potentially harmful nature than when the product was listed on the DTSC web site, and could result in additional loss of sales. If the DTSC restricts or prohibits a product's usage, this could result in substantial costs to the firm.

3.6 Regulatory response costs associated with implementing an alternative product

The cost to firms of actually deploying a new alternative will depend, in the first instance, on whether it requires a change in chemical used, changes to an existing production technology or a new production technology or the adoption of an entirely new product supply chain. The firm hires workers, purchases raw materials, develops production technology, and uses corporate knowledge to produce output. Implementing an alternative could involve several changes in production, the costs of which are not going to be well known ex-ante.

Substituting one chemical input for a safer chemical input. Alternatives that involve only switching of one chemical for another are likely to be among the least complex and perhaps the cheapest. For example, in the production of electronics equipment manufacturers could substitute tin-copper solder for tin-lead solder.

Changes in input contracts for components. An alternative for some firms will be to change the product components that they use by changing their contracts with suppliers. The costs of this option cannot be known ex ante. Firms have an incentive to identify "green" alternatives to Chemicals of Concern and engage in long-term contracts early, as firms that are late to contract for components may find a shortage of acceptable alternatives. However, assuming that the firm does not have to change their production technology processes or fixed capital, this option is likely to be less costly than the following two alternatives.

Drop-in or Add-on technologies. Rather than re-engineering their entire production process, this alternative would require a firm to change only one segment of the production process. For example, a firm that uses a Chemical of Concern to condition input materials such as metals or plastics may seek to use an alternative chemical plus new machinery at that stage of the production process in order to eliminate the Chemical of Concern residue in the finished product.

Changes in fixed capital costs. This case would require the firm to change significant portions of its production technology to implement a new alternative. Probably the most expensive, this would require significant new capital investments, labor retraining and significant modification to existing components subcontracting. If product characteristics change enough it may also require new patent and marketing costs.

Length of phase-in period. Once DTSC makes a ruling, the actual impact on a firm will hinge on how much time the firm has to meet the requirement. The cost of adjustment will be lower if the firm has more time to adapt.

Macro-economic factors. Aggregate product demand trends will likely play an important role in determining the cost of implementing the alternatives analysis. In the case of products such as cell phones for which there is rising demand over time, producers anticipate that they will need to build new factories. Many of these factories are just in the planning stage. If these production facilities have not been built yet, then the firm will have access to many more options for how to design the new factory in order to be compliant with the AB 1879 draft regulations. In contrast, for a product whose market is shrinking or stagnant, there is little reason to build new factories. Producers will use existing capacity and may not even be paying to reduce depreciation of the capital stock. For such declining industries, these regulations could even lead to product exit. The CEOs of such firms may reason that the irreversible investment required to comply with the regulations will not be recouped by selling a product already facing declining sales.

Firm Product Investment Cycles. Within broad product categories, product makers will differ with respect to their ability to comply with different regulatory mandates. Some firms will be more nimble in responding to regulatory changes. Such firms may have an innovative leadership. These firms may have recently invested in constructing a new production facility or have a flexibility in their contracting that allows them to substitute input providers without breaking long term contracts.

Past experience with major regulations such as the Corporate Average Fuel Economy (CAFE) standards for vehicles highlights that different firms at a point in time face different costs in complying with regulations. In the CAFE standards case, Chrysler was much better situated to comply with the 27.5 MPG standard than Ford or General Motors because it had made past investments to build more fuel efficient vehicles. Chrysler President Harold R. Sperlich told a U.S. House subcommittee in September 1985 that “Chrysler will meet the standard because, even when we were going broke a few years back, we invested heavily in a corporate strategy geared to satisfying the market while meeting the fuel-economy law. Our compliance with the

Corporate Average Fuel Economy (CAFE) standard is proof that the 27.5 mpg standard is technologically feasible and that other manufacturers could have met the law as well."[5]

The Porter Hypotheses and Production Costs Dynamics. In certain limited cases, these regulations could lower a firm's production cost. This counter-intuitive claim has been called the "Porter Hypothesis" named after the Harvard Business School Professor named Michael Porter.

Porter and van der Linde (1995) outline five different reasons why regulations can have this effect. First, regulations signal companies about likely resource inefficiencies and potential technological improvements. Second, regulations focused on information gathering can achieve major benefits by raising corporate awareness. Third, regulations reduce the uncertainty that investments to address the environment will be valuable. Fourth, regulations create pressure that motivates innovation and progress. Fifth, regulations level the transitional playing field.

The Porter Hypothesis posits that regulations can have *negative costs* as they force firms to engage in a re-evaluation of their business practices. Implicit in the Porter Hypothesis is the view that firms suffer from inertia and face organizational costs for making their businesses "cutting edge". Under the Porter logic, established firms (think of Microsoft or General Motors) have become locked into "old ways" of production and have not devoted sufficient thought to adopting new methods of production. Proponents of the Porter Hypothesis claim that regulations such as the AB 1879 draft regulations can "wake up" a firm and allow it to discover cost savings that it would have ignored otherwise. Recent research conducted by David Popp (2003, 2006) has documented that firms regulated under the Clean Air Act increased their investments in patents to help them innovate to better adapt to regulatory requirements. Whether the Porter Hypothesis applies in the case of these regulations is an open question.

Will Large Firms Have a Cost Advantage in Complying?

Manufacturers who sell products in several nations are likely to have "in house" expertise in designing and improving their products. Such a company will want to sell products in California and in Europe. Facing the REACH regulations and anticipating the introduction of DTSC regulations, such a firm will produce in sufficient scale that the average fixed cost (defined as upfront cost divided by total sales) of researching alternatives is likely to be low. Such a firm will recognize that an expensive upfront investment in considering alternatives will be subsequently spread across millions of sales in various international markets. Large product making firms are likely to have the scale and revenue to hire highly specialized engineers to work for the firm. Such firms are better equipped to adapt to the new regulatory rules than smaller firms.

[5] Chrysler President Harold R. Sperlich testimony before the House Subcommittee on Energy Conservation and Power, September 19, 1985

In contrast, smaller firms will be less likely to have this internal research capacity.
Some small firms may face financial constraints in implementing an alternatives analysis. Small firms may not have sufficient cash available to pay such a consulting firm. Such firms are unlikely to have a research staff or established relationships with consultants who can advise them on handling these issues. The 2009 Nobel Prize in Economics was awarded to Oliver Williamson in part for his work on transaction cost economics.[6] His work has focused on transactions that firms engage in within the boundaries of the firm (i.e. in-house) versus those that take place using markets (i.e. a firm hiring another firm as a consultant). There are cases in which there are significant cost savings from having "in house" experts working on the problem. In cases where there is *specificity* of knowledge, an external consultant may not have sufficient expertise about the nitty gritty details of a particular product to be able to cost effectively evaluate it relative to alternatives.

Concerns about higher costs for small firms is partially mitigated if these firms produce roughly similar products and can overcome transaction costs to work together and form a club or trade association that allows them to pool their resources to hire qualified AA assessors. Examples of transaction costs include; the geographic distance between firms (as this reduces the ability to cheaply meet and co-ordinate), a lack of social networks so that small firm bosses face costs setting up a group meeting to co-ordinate group decisions related to the AA.

4. Regulation's Effects on California Consumers and Workers

In the previous section, we presented a detailed discussion of what types of firms are likely to face higher costs of production due to these regulations. When a manufacturing firm's cost of production increases, there will be general equilibrium consequences in both the product markets and the input markets. In the product market, the manufacturing firm will earn less profit if it chooses to discontinue selling the product or if it is unable to pass along the regulatory costs to final consumers. The impact of the regulations on the manufacturing firm's profits will hinge on what products it now focuses on producing. Retailers may choose to discontinue selling a Chemical of Concern laden product. The impact on their firm's sales from no longer selling such a product will hinge on whether there is a close substitute product that does not embody a Priority Chemical. If this is the case, then consumers will continue to shop at the store and the retailer will experience no significant change in its economic performance. In the input markets, the manufacturing firm that now faces DTSC regulations may now choose to hire fewer workers. Such a firm is likely to reduce its production of specific priority products and facing less demand for such a production, this firm will reduce its workforce. This section examines how these regulations will affect the well being of the consumers who buy the product, firm's shareholders, and workers and consumers.

Our starting point is the basic economic theory of regulatory incidence. If a firm's cost of doing business increases as a result of these regulations, will it pass on this regulatory cost to consumers or will it cut back on its production and thus reduce its employment? If a firm can

[6] http://www.nobelprize.org/nobel_prizes/economics/laureates/2009/press.html#

fully pass on the regulatory cost to final consumers then neither the firm's profits nor its employment will change. A firm's ability to pass the new regulatory cost to consumers hinges on the elasticity of demand. If demand for the final products is completely inelastic (i.e., price insensitive), then any regulation-induced cost increases will be passed on to final consumers and final consumer prices will rise. In this case, the firm will continue to produce its original level of output and not lay off any workers. For any specific manufacturing firm, the elasticity of demand will hinge on whether there are close substitutes for the specific product. Imagine a case in which one product such as paint has a Chemical of Concern embodied in it while a similar competitor's product does not. The first paint maker might recognize that the elasticity of demand is extremely high (perhaps 30) such that the slightest increase in price leads all of its customers to substitute to its rival.[7] In this case, the paint company would not be able to pass on its regulatory costs to consumers and this firm would suffer a profit loss. It is important to note that this product maker would not lose profit if the alternatives analysis yields a safer alternative that the firm can cheaply substitute to.

4.1 Effects on Consumers

Product price increases have their largest impact on our standard of living on households that spend a large share their budget on such products. If a household spends 50% of its disposable income on food and the price of food doubles, then the household's real purchasing power has declined by 25% even if its nominal income has not changed.

With this logic in mind, we have examined data from the United States Consumer Expenditure Survey (CEX), the leading data set economists use to study household consumption behavior. An analysis of the overall budget information based on data from 2008 indicates that that households spend a very small share of their income on these products.[8] Data from the 2008 CEX indicates that the average household spends 1.4% of its income on housekeeping supplies, and 3.4% of its expenditure on household furnishings. In contrast, it spends 17.6% of its expenditure on transportation. If DTSC focuses its regulatory efforts on products that are used within the home, then these average budget shares suggest that the new DTSC regulation will affect products that only represent a small share of overall household expenditure.[9] This means that consumers are unlikely to suffer a significant loss in real purchasing power from any product price increases caused by these regulations.

International competition protects California consumers from facing higher prices for products. In capitalism, firms will enter markets where they can earn a profit. In extreme cases where only one producer is cleared to sell a product for which there are no substitutes in California, this producer could seek to exert its monopoly power by charging higher prices. In this age of globalization, such a monopoly could not persist even in the short run. Companies that sell products on the Europe REACH market are likely to be able to meet the AB 1879 draft regulations' requirements. These firms are likely to begin to export to California if they sense

[7] An elasticity of demand equal to 30 means that a 1% increase in a product's price would reduce demand by 30%.
[8] from ftp://ftp.bls.gov/pub/special.requests/ce/share/2008/cucomp.txt
[9] It is relevant to note that DTSC may identify priority products that are not common household products.

that they can earn a profit from entering the market. This potential entry threat encourages incumbent firms to not "price gouge" and this protects California consumers.

In the aftermath of new costly regulations, product prices can only rise sharply if aggregate demand is highly inelastic. These would have to be products for which there is no substitute. While in competitive capitalism there are very few cases in which consumers have no choice across products, we can imagine cases in which all of the leading products are produced using a Chemical of Concern. In this case, consumers would not have access to a "safe product" substitute. All of the firms that produce this product would face the same challenges in dealing with DTSC's regulatory choice. If DTSC decides to ban the chemical and/or priority product, then consumers in the short run are likely to bear the cost of these regulations through higher product prices. In the medium term and long run, new firms using new production techniques that economize on this Chemical of Concern could enter this product market and consumers would enjoy reduced prices. If DTSC determines that there is no safer alternative to the Chemical of Concern, then there would be no required substitution of chemicals and market prices would not be affected.

For many products such as a Dell computer, one or more close substitutes exist (an IBM computer). In these cases, there are many close substitutes for any one product. In such a competitive market, a company that tried to raise its prices to cover the new regulatory costs would lose many buyers. Consumers who stop buying a "priority product" will seek out other products whose combination of quality, price, and regulatory stamp of being "safe" make them a more attractive choice. This consumer substitution will create new sales opportunities for existing green companies and will encourage market entry to fill this niche. If there are low barriers to entry for competing in this industry, then consumers will not experience sharp price increases for products as the "green" firms scale up their production.

All regulations induce unintended consequences. It is possible that these regulations will encourage some producers to divert products of concern to be sold on the black market. Such products would likely sell for a deep discount in price and would be attractive to the poor and those who do not believe that their health is likely to be injured by consuming these products. As we learned from the case of alcohol prohibition in the 1920s, it is very difficult to enforce such black markets. If community organizers find that such products of concern being sold in their communities, then DTSC could consider introducing retail store audits and credible punishments for those stores caught carrying such banned brands.

4.2 Regulation's impact on existing California employment

Given the fundamental uncertainty about the details of how DTSC will implement the regulations in terms of choosing priority products and the decisions it will make in the alternatives analysis, it is impossible to offer precise predictions concerning how California jobs will be affected. In this section, we first sketch the overall economic picture for the chemical manufacturing industry both over time for the nation and for California. After setting up the basic facts about this industry, we return to the question of how these regulations are likely to affect diverse firms. We recognize that these regulations will also affect product manufacturers and we will present data on employment trends for many different manufacturing industries

within California. We devote special attention to the chemical manufacturers because their core business will be directly affected by these regulations. For many product manufacturers who use such chemicals as an input of production, these producers will have significantly more flexibility in substituting inputs. For example, a company that sells a household cleaning product could contract with input suppliers who are currently selling to firms in Europe and thus satisfy the REACH regulations' requirements. This example highlights that many product makers can shield themselves from significant regulatory impacts by contracting with international input suppliers who are able to comply with DTSC regulation.

We focus on statistics about the chemical industry because this industry will face the most stringent costs from the AB 1879 draft regulations. This industry sells the key chemicals used by product makers to produce final consumer products. It is important to note that raw chemical manufacturers will both produce Chemicals of Concern and the same firms may also produce alternatives to these chemicals. This point highlights the nuanced effects introduced by these regulations.

The U.S Census County Business Patterns (CBP) employment data is useful for examining California employment trends by industry.[10] In 2009, the top five California manufacturing industries (at the 6 digit NAICS level) based on employment counts are: All Other Plastics Product Manufacturing 27,638 jobs, Commercial Lithographic Printing 25,554 jobs, Women's, Girls', and Infants' Cut and Sew Apparel Contractors 25,520 jobs, Wineries 22,561 jobs and Commercial Bakeries employing 15,206. Given that roughly 39 million people live in California, these job counts highlight how small an industry manufacturing is in the state's economy.

We take the CBP data in 2003 and 2009 to examine trends at the six-digit NAICS level for chemical manufacturing.[11] Table One reports some facts for 34 six-digit NAICS industries. For each industry, we report the count of employment in California and the rest of the nation in 2003 and 2009. This allows for a comparison of whether California has a major share of the nation's employment and whether California's specific industries experience differential employment growth relative to the rest of the nation. The table also reports the average worker count per establishment in California versus the rest of the nation in 2003 and 2009. These facts provide a sense of whether the typical establishment is small.

Across the 34 industries in 2009, California employed more than 1,000 workers in only 14 and the major employers were in pharmaceuticals (NAICS code 325412), which are not covered by these regulations. Between 2003 and 2009, there has been a large reduction in California employment in Paint and coating manufacturing (NAICS code 325510), Soap and other detergent manufacturing (NAICS code 325611) and Photographic Film (NAICS code 325992) but even for these three industries the total job reduction adds up to roughly 5,000 jobs. In an economy featuring roughly 39 million people, this appears to be a very small number. The

[10] http://www.census.gov/econ/cbp/download/index.htm

[11] We choose 2003 as the start date because the industries are reported as SIC codes before that year.

general conclusion based on these trend data is that that the California chemical manufacturing industry is not in decline and is a relatively small share of the state's overall economy.

It is relevant to note that manufacturers outside the chemical industry could be affected if their product contains a Chemical of Concern. In focusing on the recent employment dynamics for the chemical industry, we are assuming that California's non-chemical manufacturing industries will be able to identify alternative methods for producing their products and thus are unlikely to suffer employment losses due to these regulations. We recognize that many California producers may use chemicals that are priority products in producing their final products. The employment impacts on such firms hinge on their ability to substitute safer alternatives in producing their final products.

4.3 The Economic Incidence of the Regulations

As jobs involving chemical exposure become safer, basic labor economics predicts that real wages will fall in these industries because firms will no longer have to pay "combat pay" to attract workers. This prediction is based on the assumption that the workers are aware of the risks of chemical exposure that they face in the work place and that labor markets are competitive. In this case, workers have an alternative to choose from and will only work in a risky environment if they receive pay compensation for this additional risk. If the regulations lower this risk, then more workers will seek these jobs and this will lower the real wage that workers earn.

If firms had to pay significant wage premiums to attract workers to work in the high chemical exposure areas, then such firms would have an incentive to seek out alternatives to clean up the work place even if there were no DTSC regulations. If such firms could have cleaned up their own work place, then they could have attracted workers without paying the wage premium.

The DTSC regulations offers workers the greatest benefits in those cases in which workers were not informed about the risks they were being exposed to, or were unaware of the long term consequences of their exposure or in cases in which the firm had monopoly power in the labor market so that workers had no other employment alternatives.

4.4 Past lessons from the California employment effects of the Clean Air Act

Recently, environmental economists have studied whether the enforcement of the Clean Air Act has deflected manufacturing jobs away from highly regulated areas (i.e., polluted big cities) toward more rural, less regulated areas within the United States. This empirical work has documented that high polluting industries whose final output is cheap to ship back to final consumers have been migrating to counties that have been assigned to low regulation "Attainment Status" under the Clean Air Act (Becker and Henderson 2000, Greenstone 2002, Kahn and Mansur 2011). At first glance, this suggests that the AB 1879 draft regulations will be costly because industry will leave California. But, this logic is false. The Clean Air Act

regulations apply to where production takes place. These DTSC regulations apply to where consumption takes place. Regardless of where the factory is located, the product maker will face the same "priority product" issue if the producers seek to sell the product in California.

The oil refining industry offers a relevant case study on the impact of the Clean Air Act on California manufacturing employment. There is a lot of refining activity in California such in the coastal areas of Contra Costa County and the South Bay of Los Angeles County. Recent detailed micro econometric research conducted a "before/after" comparison to investigate how these regulations affect job growth for regulated industries. As analyzed by Berman and Bui (2001), the Clean Air Act has mandated multi-million dollar regulatory costs for oil refineries to lower their ambient air emissions. They conducted an empirical investigation comparing employment dynamics at California's oil refineries (who faced a significant increase in regulation costs) relative to employment dynamics at Texas oil refineries (the control group which did not face such regulations). They reject the hypothesis that California's regulations caused job loss. They attribute this negligible effect of regulations on the California firms' employment decisions to the fact that the oil refineries are highly capital intensive plants. This means that they use high levels of capital per worker in producing their output. This case study of how the California oil refining industry has adapted to regulation is very relevant because the chemical industry is also highly capital intensive. Using the latest national data from 2005 for 473 different NAICS industries, the industries that comprise the NAICS 325 chemical industry feature a capital to labor ratio that is significantly higher (by two standard deviations) than the average industry.

4.5 Regulations' impact on future job creation in California

California's edge in producing "greener" products is threefold. First, producers will recognize that California's ***green conscious consumers*** will value such products and will be willing to pay a price premium for such quality. The typical California consumer's "green focus" means that many of the state's producers are uniquely suited to compete in a marketplace in which priority products will face greater regulator scrutiny. In terms of head-to-head competition, these regulations should aid many of California's producers. This conclusion is tentative but based on our belief that California has a comparative advantage in designing "green products" and these regulations will shift consumer demand away from products that contain Chemicals of Concern and towards "green" products. California is well known for its consumer environmentalism. There are more Toyota Priuses and solar panels bought in this state than in any other part of the United States. California has a proven track record of "green job" creation even in the absence of these regulations. The National Green American Directory highlights the share of California's listing of businesses that have made firm commitments to green products. This directory lists 2,333 companies and 633 of them (over 25%) are located in California.[12]

Second, California's ***access to venture capital*** means that local producers will have an easier time raising the funds to finance new potentially high-risk, high-reward efforts at producing new products that comply with these regulations. Finally, ***California's universities and skilled***

[12] www.greenamericatoday.org/pubs/greenpages

workforce guarantee new firms a pipeline of employees who can be trained regarding or are familiar with alternatives analysis and new manufacturing processes.

There are, of course, scenarios in which California could lose jobs. Under the AB 1879 draft regulations, some firms could face a product ban. This severe outcome would mean that demand for their product would fall sharply as Californians would no longer be buying their product. In addition, as the rest of the nation (and world) learns about California's DTSC action, aggregate demand for the product would decline. Such product demand declines would mean that such firms are likely to fire workers unless they increase their sales in countries that do not pass such regulations (such as developing countries). It is important to note that this extreme outcome would only take place for firms whose products are "priority products" that are produced in California, and DTSC rules for a ban, **and** the firm is unable or unwilling to redesign the product or identify alternative inputs to substitute out for the chemicals or properties that led to the ban. We believe that very few firms will experience this outcome. When firms submit their alternatives analysis, they will submit information about their costs of compliance. DTSC will balance perceived economic harm to companies with the "good" caused by choosing a specific alternative.

5. The Dynamics of a Firm's Regulatory Compliance Costs

This section will focus on firm and industry level dynamics that will result in lower long-run compliance costs. In the short run, firms have fewer ways to cope with the new regulatory environment. In the long run, firms have many more available strategies that help them to compete according to the new "rules of the game".

In the long run, new firms will enter the market, and they will be better equipped to compete. Within any industry, firms face evolutionary pressures. If they do not adapt to changing circumstances, they are likely to respond by no longer selling a product. Retailers will replace such products with new products that meet the regulatory standard. We envision this dynamic playing out in industries affected by the AB 1879 draft regulations. Firms whose products have been designated as "priority products" will have strong dynamic incentives to invest in modifying their product. Such products are likely to face new competition from industry entrants featuring products that are similar in quality but have not been labeled "priority products". The net effect of this competition will be a safer typical product for consumers to purchase.

5.1 Research & development lower regulatory costs

With the introduction of the AB 1879 draft regulations, firms will have incentives to minimize their use of Chemicals of Concern in their production processes. Facing this new requirement, such firms will engage in directed technological change to achieve these goals. In recent years, empirical research conducted by environmental economists has documented an important fact that suggests firms can lower their regulatory compliance costs. When the price of a production input such as electricity goes up in price, firms engage in directed "endogenous technological change" to enable them to use less electricity. Intuitive examples of this phenomenon include

improvements to air conditioners and automobiles. When the price of electricity increases, manufacturers subsequently produce energy efficient air conditioners (Newell, Jafee, and Stavins 1999). When the price of gasoline increases, auto manufacturers subsequently produce more fuel-efficient vehicles. This matters in the case of the AB 1879 draft regulations because these regulations will effectively raise the price of using Chemicals of Concern. This will provide firms with a strong incentive to seek out alternatives. Whether individual firms will pursue their own substitutes or work together in trade associations to identify group solutions remains to be seen.

We recognize that such basic research can be costly; however the average fixed cost can be low if the firm sells many units over time. The global market for products offers large sales volume opportunities and thus the average fixed costs of such R&D investments could be quite low given the number of years a firm will exist. As written into AB 1879, one of the alternatives that DTSC can choose from is a requirement that firms contribute to a Research & Development fund under the green chemistry challenge grant. The funds raised from such firms can be used to help smaller firms finance innovation.

5.2 Learning by doing

Another trend that portends declining compliance costs is rising demand for safer chemicals. As product makers seek out "safe chemicals" (to minimize their DTSC regulatory exposure), profit-maximizing chemical firms will have strong incentives to conduct research to design and scale up their production of such chemicals. With any new product, there is significant learning over time. Research examining the dynamics of the "green economy" has highlighted that the average cost of producing "green power" (i.e., solar panels and wind turbines) has declined over time (Wiser et. al 2006). At the heart of learning by doing is the intuitive idea that "practice makes perfect". The new generation of hybrid vehicles and electric vehicles are of much higher quality than the early prototypes.

This regulatory mandate represents a type of commitment device such that innovators are now certain that there is a market demand for "safe chemicals". In the absence of such a government guarantee, risk averse innovators may devote their effort on other projects. The Safer Consumer Product regulations send a credible signal to such innovators that their investment of their scarce time in designing "green chemicals" will offer a high rate of return. While we cannot predict which of these innovators will succeed, we are confident that several of these efforts will payout and product manufacturers will benefit from being able to purchase new chemical inputs that allow them to comply with the DTSC regulation.

5.3 Compliance costs fall as new input markets become competitive

As described in Section 3 of this report, firms will face costs from testing their products, engaging in alternatives analysis, and implementing DTSC's orders. In the medium term, each of these costs will decline due to market forces. For example, consider a product maker's cost of hiring an alternatives assessor. In the short run soon after the AB 1879 draft regulations are implemented, there could be a scarcity of environmental consultants ready to work with firms

through the alternatives analysis. In this case, product makers may in the short run pay a high price for such consulting services. But in the medium term, new university graduates and unemployed or underemployed workers will seek compliance with ISO 14040 standards and assessor accreditation to help firms comply with the AB 1879 draft regulations. We foresee new degree programs opening up where MBA business students train in joint degrees in sustainability to have the skills for conducting life-cycle analysis and for understanding how to integrate life cycle assessment into product design and marketing. Such training of the next generation of workers will lead to lower "input prices" for product firms.

The DTSC can reduce the costs of the regulations to industry by accepting verification information which has been passed through a product's supply chain, or chain of custody. The regulations create new value on verified information of product contents. In the absence of the regulations, industry would respond to this new value by producing verified information at the lowest cost point of the supply chain. For the inputs included in many finished products, the lowest cost stage to produce verified information may be at a primary or intermediate stage – where inputs are less complex and produced in higher volumes. If the supplier firm can have the products tested by a DTSC accredited firm and pass this verified information on to its customers, then firms which create products from many verified inputs may be able to use this information in lieu of performing tests on its finished product, which may be produced in lower volumes than its inputs. This would reduce the testing costs for the firm that produces the finished product without compromising available information about product contents.

The Maturing AA Market

As the demand for alternatives analysis increases, this will affect human capital and educational investments by people. More workers will choose to specialize in fields that allow them to conduct alternatives analysis. The net effect of this new set of "green jobs" will be that the quality of assessments will improve and the price of conducting such audits will decline.

The DTSC can play a role here as a "market maker" by creating a webpage that allows assessors to list their expertise and their contact information. By reducing transaction and search costs, demanders of assessments will be matched with qualified suppliers of such services. The DTSC has anticipated that the regulated firms and the regulator may not have aligned incentives. The DTSC will hope that firms hire the best assessor in judging the firm's options. In contrast, the firm may seek out consultants who are low cost and have a reputation for embracing the firm's agenda. The regulations introduce checks and balances on certified assessors and an audit function is expressly established in Article 9 of the regulations.

In informal comments on early drafts of the DTSC regulations, numerous parties have voiced the concern that the assessment timeline is too short. This raises the concern that mistakes will be made due to a rushed review cycle. While this is a very real concern, one can be confident that there will be learning by doing among product assessors. As these assessors gain experience, they will be able to complete assessments in a more timely fashion.

5.4 Market share shifts: transfers vs. costs

Short run

Once DTSC announces information on a public website, this information may spread by television, newspapers, and the Internet to consumers. If consumers use this new information to make more informed choices, this new information may lead to distributional effects across firms who compete for product sales. Firms whose products are listed as "priority products" will suffer lost sales and competitor firms whose products are not listed are likely to gain new sales. This claim rests on the assumption that within any product class, such as cell phones or household cleaners, there are both "priority products" and competing products that do not contain Chemicals of Concern.

As consumers substitute to safer products, the firms who produce those products will gain market share. This transfer of sales from a "brown" firm to a "green" firm represents a financial transfer rather than a social cost of the regulations. In fact, this transfer actually represents a benefit to consumers because the regulations have resolved an important information asymmetry, reducing consumer uncertainty about product safety.

From California's perspective this is likely to mean that these regulations offer the benefit of higher demand for California products. Given California's business profile, California may garner a large share of these financial transfers. These regulations will encourage consumers to purchase products from "green firms" who produce products that are not listed as "priority products". California has an edge in being the home of many such firms because of its environmentally conscious consumer market, skilled workforce capable of enhancing products, and the environmentalist leadership.

Consumers who are unable to find a viable substitute for a "priority product" may choose what they consider to be an inferior product, or may choose not to buy a substitute at all. Both cases will negatively impact consumer welfare, which would be considered a cost of the regulations. Additionally, if the consumer chooses not to purchase a substitute product, industry will bear an actual cost of the regulations in the form of an aggregate sales decrease for a product class. It is important to note that the consumers who change their consumption choices because of the regulations will enjoy a health benefit from not being exposed to potentially dangerous products. In Section Six, we will elaborate on this point.

Long run

Over time these regulations will shake up product markets as some product makers find that they have trouble complying with these regulations while other firms will find that they can thrive in this regulatory environment. Such industry dynamics is nothing new. In the auto industry in the 1960s, General Motors, Ford and Chrysler sold millions of cars while international firms such as Toyota exported very few vehicles to the United States. The domestic "Big Three" specialized in producing large gas-guzzlers. A consequence of the OPEC oil shocks was that the Big Three's sales fell as imports of fuel-efficient Japanese vehicles skyrocketed. This example highlights the evolutionary dynamics of a mature product market (cars) in the face of shocks to

inputs (in this case the price of gasoline). Today, we see the fuel efficient Toyota Prius' sales soar when gas prices go up and we see a growing nascent movement in California to design zero carbon electric vehicles.

Why are some firms so nimble in the face of new regulations while others engage in sluggish responses? Understanding the sources of this within industry diversity is a frontier research question in modern economics. Here, we offer a few insights. At any point in time, a firm's production process depends on its past investments in its workforce and its factory. A firm that has designed a flexible production plant that can produce different varieties of a product will be better able to respond to new regulatory mandates. A firm that hires more expensive nimble managers who have broad skills will be better able to cope under the new regulatory rules. Different firms may also have different business strategies. In the case of the car industry, Detroit's Big Three made a bet that Americans would keep driving big, fuel inefficient vehicles. They under-estimated the impact of gasoline price spikes (and the probability that such OPEC oil price shocks could occur) on the demand for their products. In the case of chemical industry and the push for "green chemistry", some chemical manufacturers are likely to seek out a market niche as an industry leader in providing "green chemicals". The rise of Europe's REACH regulations indicates that there is a growing market to supply to.

We foresee the Safer Consumer Products regulations leading to dynamic evolutionary process so that some products that cannot compete under the new rules of the game exit the retail stores and new products produced by nimble firms replace them. If Europe's REACH regulatory efforts and the DTSC regulations become the world's "green" product standard, then firms will have incentive to design compliant products to compete for market share.

In this dynamic competition, some companies may merge to take advantage of superior corporate know-how in designing the next generation of "green" products. Such companies can merge with other companies that have production facilities but lack the human capital and knowledge to thrive in the new regulatory environment. In this sense, both through organizational change and free market competition; the "green firms" are likely to enjoy a growing market share. This will mean that the average product sold by the industry will be "greener", and the average cost of regulatory compliance will decline.

5.5 Evidence of dynamic responses induced by past toxics regulations

In this section, we describe what is known about industrial responses to three major regulations all affecting chemicals users. The three cases we discuss are the Massachusetts Toxics Use Reduction Act (TURA), the lead emissions phase out for oil refineries and the regulations of chlorine.

Toxics Use Reduction Act

TURA was enacted in 1989. It uses information disclosure and mandatory planning to promote 'voluntary' industry innovations focused on toxic chemical use reductions. "TURA has been able to motivate industry to reduce toxics use through two mechanisms: mandatory planning and

learning support. Forcing firms to better understand their processes (and the costs of these processes) and helping them identify options for pollution prevention through training, case studies of leading firms and publications, has led to an atmosphere of innovation and learning in the state which helps even reluctant firms change" (O'Rourke and Lee, 2004).

O'Rourke and Lee (2004) argue that the TURA regulations have acted as a commitment device requiring "companies to create planning teams, to conduct assessments of production, to engage workers in these discussions and to assess the financial costs and benefits of production changes . … TURA quite simply helps get managers' attention and focuses them on toxics reduction." We anticipate that the Safer Consumer Products regulations will have a similar impact.

Much past environmental regulations such as the Clean Air Act rely on a "top down" approach that features the regulator providing specific emissions levels that the firm must achieve. In contrast, in the case of TURA, O'Rourke and Lee (2004) emphasize the symbiotic relationship between the regulator and the regulated firms. "Relationships between regulators and industry are transformed, implementation occurs not through command but through joint exploration and information sharing, and uncertainty is acknowledged and accepted as a reality of problem solving. TURA provides a more flexible process, ripe with dialogue and learning, that encourages technical innovation."

The TURA case is an important precedent for the AB 1879 draft regulations. It provides a blueprint for how firms and the regulator can work together in an evolutionary, learning process that yields higher quality, safer products at low social cost.

Lead Regulations

Starting in the 1970s, there has been a major U.S effort to reduce the lead content of gasoline and this has affected the refining industry. Kerr and Newell (2002) study the consequences of the lead phase-out for innovation at petroleum refineries. In this specific regulatory case, a pollution permit market was created to allow petroleum refineries to buy the right to release lead emissions. As the lead standard was tightened over time, the aggregate quantity of lead that such refineries could release declined. In economics terminology, this meant that the supply of pollution permits declined and from simple supply and demand theory, the price of a permit increased.[13] Kerr and Newell document that increased regulatory stringency (which raised the effective price of emitting lead) encouraged greater adoption of lead-reducing technology. They also document heterogeneous responses to the regulations in that larger more technically sophisticated refineries were more likely to adopt the new technology. One key lesson from this specific case is that manufacturers have demonstrated an ability to change their production process when faced with new regulatory rules.

Chlorine Manufacturing

The third case is the regulation of chlorine manufacturing. "In 1972, a widely publicized incident of mercury poisoning in Minamata Bay, Japan led the Japanese government to

[13] Policy-Induced Technology Adoption: Evidence from the U.S. Lead Phasedown

prohibit the use of mercury cells for chlorine production. The United States soon imposed more stringent environmental constraints on mercury cell units during the early 1970s. Subsequently, chlorine manufacturing became subject to increased regulation under the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), popularly known as Superfund. In addition, chlorine manufacturing became subject to public disclosure requirements under the Toxics Release Inventory." (Snyder, Miller and Stavins 2003).

Snyder, Miller and Stavins (2002) argue that environmental regulations did affect technological change. It did so by reducing the demand for chlorine and hence encouraging the shutdown of facilities using environmentally inferior options. Their study highlights the role that firm heterogeneity plays. They highlight that firms that were not nimble in responding to the regulations were more likely to leave the industry. Thus, the regulations caused the industry average pollution level to decline due to the exit of "dirty firms" and the entry of firms better able to perform under the new regulatory code.

This case highlights how regulations encourage environmentally friendly production techniques. It is also relevant to note that the authors demonstrate that the new firms who entered this industry after the regulations were enacted were better suited to compete under the new rules. Both individual incumbent firms learning by doing, and the entry of low cost firms into the regulated industry are micro-foundations for how the long run costs of production under the regulations can be lower than short run costs.

6. Social Benefits of the Regulations

The social benefits of the regulations accrue as people's exposure to a dangerous chemical falls, thereby enhancing their health and extending their life spans. The regulations may affect people's exposures to unsafe products in two different ways. First, it may provide consumers with information that enables them to avert their exposures to existing unsafe products through safer market choices. Second, through the alternatives analysis process, it may reduce the actual number of unsafe products available on the market at any one time. The size of the social benefits that result from these regulations cannot be known in advance but are likely to depend upon four general factors: 1) how well DTSC prioritizes chemicals, 2) how many Priority Products DTSC identifies and how quickly it performs these identifications, 3) how motivated firms are to both test their products as well as to develop and implement safer alternatives and, 4) whether consumers are able to use new risk information to avert their own exposure.

6. 1 DTSC's Prioritization of Chemicals of Concern

The benefits from these regulations will be larger if DTSC prioritizes those chemicals that cause the greatest health problems for exposed people and for which many people are exposed. The regulations will provide DTSC with the information it needs to make this determination.

Reducing chemical exposure to substances deemed to affect children's long run development, IQ, and non-cognitive skills will yield large social benefits. Public health literature has documented the benefits in terms of cognitive and non-cognitive skills of not being exposed to lead and other toxics. The Nobel Laureate James Heckman has convincingly documented the dynamic complementarities in how a child grows up to be a productive adult. Put simply, "learning begets learning and skill begets skill". A child who is healthy is more likely to achieve a higher level of skill development. There are other sensitive populations who will also benefit greatly from these regulations.

In terms of life-cycle analysis, there will also be social benefits from these regulations if DTSC prioritizes chemicals that can cause significant damage once disposed of in landfills. When products that contain harmful chemicals are disposed, they often end up in landfills. Some of these landfills are located near populated areas. The AB 1879 draft regulations will reduce the amount of harmful chemicals that end up in California landfills. The benefits of reduced landfill toxicity depend on the concentration of population near the landfill, the probability of waste leakage from the landfill, and the effects of this leakage on the nearby population. Accurate measurement of these factors would require detailed geographical information and the results will vary on a case-by-case basis.

6.2 Firm Response Times for Product Testing and Alternatives Adoption

These regulations will offer larger social benefits if firms quickly take action to 1) release information on their products and 2) reduce the possible chemical exposure associated with purchases of priority products. As we discussed in sections 3 and 5, firms will engage in a host of short run and long run decisions such as substituting inputs in production and changing their supply chains in order to comply with the regulations. The benefits of these regulations will be larger if this transition to "greener" products can take place more quickly. We anticipate that the transition period will require more time for firms who learn in the alternative analysis stage that there are not readily available substitutes that do not feature Chemicals of Concern. In these cases, ongoing consumers of these products are less likely to enjoy short-term benefits from these regulations.

6.3 The Public Web Site Providing New Product Information Triggers Consumer Learning

The social benefits will be larger if these regulations accurately change consumers' perceptions of safety of products that they may purchase in California. Once DTSC posts its listing of priority products, this information will be available to all consumers. The benefits of these regulations will be larger if this product list becomes common knowledge.

The social benefits of providing this information can take many forms. Retailers are likely to change their product mix and focus on selling products that DTSC has not deemed to be priority products.

A major benefit of the AB 1879 draft regulations will be its role in providing trusted information that will change consumer behavior. Consumers purchase a product if the benefits they perceive they gain from consuming it exceed the costs, as measured by the purchase price. These regulations will provide them with valuable new information that will allow them to make "better" choices. Before these regulations, it has been very costly for consumers to know with certainty what chemicals were embodied in many products. These regulations substantially lower a consumer's cost of knowing which products are safe and this improves their well-being.

It is important to note that until DTSC has completed its prioritization of chemicals and products that there will continue to be incomplete consumer information. In the middle of the testing regime, products not labeled as a Priority Product could be safe or unsafe but whose true status has not yet been discovered.

In the absence of these regulations, there has been a fundamental asymmetry of information. Producers know more about the chemicals embodied in the products than consumers. These regulations will "level the playing field" and make California's consumers more confident about the quality of the products they are buying. This "peace of mind" offers significant intangible benefits to risk averse consumers who may have wondered about what they are exposing their families to in buying day-to-day household products. Economists define "risk aversion" as the willingness to pay money to avoid uncertainty. Consider a person who prefers to be paid $100 for sure rather than having a 50% chance of earning $300 and a 50% chance of earning $0. The second scenario has an expected value of $150, which is greater than $100, but many people do prefer the "sure thing". Economists call such people "risk averse" and the market demand for homes and life insurance and disability insurance highlights our taste for avoiding risk. If before the AB 1879 draft regulations consumers knew that they did not know the quality of products they were consuming, this would cause discomfort due to the uncertainty. Economists have documented that household willingness to pay to avoid risk rises with income (Costa and Kahn 2004). Over time, as California's economy grows richer, the value Californians place on the regulations' effects to increase information and reduce product risk will increase, and the total benefit of the regulations will increase.

6.4 Three Examples of the Benefits of Information Regulations

Recent environmental economics literature has documented the significant benefits of information regulations. Such regulations protect public health by changing household behavior and allow such households to make healthier choices. Information is costly to acquire, and the government has a cost advantage in collecting and distributing such information. Recent research has highlighted how consumers respond to this "new news". Here we offer three examples of the health benefits of information regulations.

In the case of Los Angeles Public Health Report Cards, restaurants must prominently display simple to understand report cards grades "A, B, C" that signal a restaurant's performance in its latest public health inspection (Jin and Leslie 2003). The introduction of this trusted information has changed consumer behavior as they have avoided such "C" grade restaurants. In

the short run, this improves public health and in the medium term and long term it pushes restaurants to invest in basic hygiene.

A second example is the introduction of California's "Spare the Air" Days.

> "The Spare the Air Program was established by the Bay Area Air Quality Management District to educate people about air pollution and to encourage them to change their behavior to improve air quality …. The 2010 Spare the Air ozone season runs from May 3 through the end of September. During these summer months when ground-level ozone, or "smog," becomes a pollution problem, the Air District issues Spare the Air Smog Alerts for days on which air quality is forecast to be unhealthy. On these Spare the Air days, we urge residents to cut back on any activities that cause pollution - such as driving, using oil-based paints, gasoline-powered lawn mowers, or household aerosol products like hair sprays. People who are sensitive to unhealthy air are advised to limit their time outdoors, particularly in the afternoon hours."[14]

Matthew Neidell (2009) has documented how people change their behavior and avoid parts of Los Angeles that are the most extremely polluted on those days. His empirical strategy focused on collecting daily attendance data at the Los Angeles Zoo and the Botanical Gardens. These two places are located inland and thus are exposed to high ozone levels relative to coastal locations. He documented on that on Spare the Air days that attendance at the Zoo and at the Gardens was lower than on similar days during the same months when it was not a Spare the Air day. His study factored in the daily outdoor temperature. Intuitively, he compared attendance at the Zoo on hot summer days in which the smog levels were not high enough for a Spare the Air day to be triggered versus similar days when the smog was bad enough for a Spare the Air day announcement. This "twins" comparison allowed him to isolate the effect of information on household daily locational choice. His results highlight that the Los Angeles population reduces its exposure to high outdoor pollution when provided with trusted environmental information.

A final example of the value of information regulations comes from mercury advisory warnings. Shimshack, Ward and Beatty (2007) examine responses to a US national FDA advisory that urged at-risk individuals to limit store-bought fish consumption due to the dangers of methyl-mercury. They find that some targeted consumers significantly reduced canned fish purchases as a result of the advisory. Education and newspaper readership were important determinants of response, suggesting that information acquisition and assimilation are key factors for risk avoidance. Each of these three empirical case studies document the same point, many consumers (once informed about new risks), respond by changing their behavior.

While we have emphasized the beneficial effects of information provision, there is a psychology and economics literature that emphasizes that households can be "overloaded" with too much information and that government messages lose their salience. Going back to the early research of the Nobel Laureate Herbert Simon (1959, 1986), some economists have argued that people are boundedly rational so that it takes time and effort to process information. If information is too complex to digest, then people may choose to ignore it.

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[14] http://www.sparetheair.org/

6.5 Environmental justice benefits from these regulations

These regulations will serve environmental justice goals by disproportionately reducing the chemical exposure of the poor. Information can only have value if it is "new news". Put simply, you would never buy a newspaper if you already knew all of the information in it. California's households are diverse. Today, there are sophisticated environmentalist consumers in cities such as Berkeley who actively use websites such as UC Berkeley Professor Dara O'Rourke's GoodGuide.[15] GoodGuide allows users to access information on a product's toxicity and other dimensions of "greenness" using a web interface or iPhone application. However, not everyone is aware of this service, has time or motivation to seek additional product information, or has the tools (web access or iPhone) needed to access the information.

Households who do not or cannot use existing informational services will gain most from these regulations. Households who are poor, and do not speak English will be the ones who are likely to gain the most from having government protecting them or informing them about potentially harmful chemical exposure. In contrast, if environmentally aware households are already protecting themselves from exposure to toxics, then they will gain less from active government policy to minimize exposure. While some California households have invested time and effort into discovering which products are safe, government clearly has an edge in providing such information and removing the informational asymmetry between firms and all segments of consumers.

6.6 Ex-post torts do not sufficiently protect the population from dangerous products

The economic approach for determining the benefits of these regulations hinges on the counter-factual of whether firms would have sold products embodying dangerous chemicals in the absence of these regulations. In the absence of the AB 1879 draft regulations, firms have not had sufficient incentives to reduce the chemical content from their products. They are not being held accountable for producing dangerous products. The AB 1879 draft regulations focus on reducing the chemical content of products before they are purchased. Such "ex-ante" precautions are more valuable to society in cases when "ex-post" after the fact remedies are unlikely to work.

Product makers who produce defective, risky products face the prospects of a liability, or torts, lawsuit. Ideally, a company will anticipate that if it makes potentially harmful products and if somebody suffers from using such a product (such as a defective vehicle) then the company will later be sued. In this case, a company might preemptively produce high quality products to minimize the torts risk of facing future liability lawsuits. If this were the case, then ex-ante product regulations would be less socially valuable because of the incentive effect introduced by the desire to avoid costly torts cases.

Ideally, society can hold firms accountable for producing bad products but there are at least two reasons why we discount this possibility. First is the issue of latency and multiple exposure

[15] http://www.goodguide.com/

pathways. A victim of chemical exposure may not suffer symptoms for years. This person will only recognize that she has suffered when the symptoms appear. Once the symptoms are apparent, it will be quite difficult to establish which product caused the disease. Over the course of one's life, one is exposed to many products and environmental hazards; these multiple exposures create a fundamental attribution problem. It is nearly impossible to find the source of the exposure and this limits the accountability of the polluter. Without this clear mapping from product to disease, the producer is less likely to be held accountable for its misdeeds. This creates very bad incentives for producers to produce quality products and increases the social benefits of adopting ex-ante regulations that force firms to minimize their use of proven toxics.

The second reason why we are skeptical that ex-post liability measures can be used to punish firms that produce dangerous products is that economists have documented that chemical companies strategically use bankruptcy as a strategy to protect themselves against ex-post liability. If a firm configures itself in ways that protects itself against liability lawsuits then it is less likely to be held accountable when it is found liable for harm. Ringleb and Wiggins (1990) conclude that chemical companies are taking pro-active steps to protect their assets from anticipated future liability costs associated with product risk. Large firms have an incentive to divest risky activities and minimize the exposure of assets to potential liability claims. Using data from 1967 to 1980, Ringleb and Wiggins show that changes in potential liability are closely linked to substantial increases in the number of small firms operating in hazardous sectors. These small firms do not have the assets to cover large liability damage awards. They conclude; "Hence liability may not lead to large damage awards in the long run equilibrium, but instead may simply lead to a restructuring of enterprises to avoid damage payments (Ringleb and Wiggins 1990, page 576)."[16]

Their paper highlights that the chemical industry has taken steps to reduce its ex-post liability risk. This fact is crucial for evaluating the benefits of the AB 1879 draft regulations. The AB 1879 draft regulations are ex-ante risk mitigation that will make products less risky. The benefits of such regulations are higher if traditional legal liability recourse measures that take place after harmful impacts are not available. Put simply, ex-ante precautionary regulation is more valuable when ex-post punishment of firms who knowingly or unknowingly sell harmful products is not credible.

We acknowledge that the Ringleb and Wiggins paper is based on historical data (covering the years 1967 to 1980) but it highlights that profit-maximizing firms will take pro-active actions to protect themselves from costly litigation. If the lawyers for such firms are successful in fending off liability lawsuits, then the victims who have been exposed to dangerous products will never receive compensation. The Safer Consumer Products regulations will offer significant benefits

[16] Legal actions involving torts cases could be used as an ex-post strategy for encouraging companies to design safe products. Time lags in litigation and the challenge of establishing causal effects (i.e. that product j caused a certain illness) would reduce the deterrence effect and would mean that product making firms might expect a lower present discounted value of expected costs of dangerous products and this expectation would reduce their incentive to engage in ex-ante precautionary investments.

because this unjust scenario cannot play out if the regulations have pro-actively pushed manufacturers to phase out priority products.

6.7 Other Social Benefits

In discussing the benefits of these regulations, we have focused mainly on the health impacts for the household that purchases the product but society will also gain benefits in the product production and product disposal stage. Under these regulations, in the production stage, workers are less likely to be exposed to dangerous substances. When products with chemicals embodied in them are disposed of, they end up in landfills. Some of these landfills are located in geographical areas that place the surrounding community at exposure risk. The AB 1879 draft regulations reduce the likelihood of local communities near landfills suffering from toxic pollution. The benefits of reduction in the toxicity of landfills hinges on how many people live close to such landfills, what is the probability of leakage of toxic waste from such a landfill, and how much each "downstream" household is affected when such leakage occurs. Another potentially significant social benefit of these regulations is reducing municipal costs of water treatment as fewer chemicals are disposed of.

7.0 Conclusion

These regulations create a new set of "rules of the game" that encourage product makers to invest time and effort into understanding their supply chains. In any setting featuring learning and experimentation, there is uncertainty concerning what will be discovered and how costly it will be to seek out substitutes. Firms will learn about the risks that their products may pose and will learn about alternative methods for producing safer products. DTSC will learn about the ability of existing firms and new firms to produce such products. It is quite reasonable to assume that significant "learning by doing" will take place here. Firms will acquire the expertise to investigate alternatives. As there is increased demand for alternatives analysis, well-trained workers will choose to specialize in this field. Their specialized human capital will mean that the quality of assessments will improve and this will lead to larger medium term public health benefits from these regulations.

In addition to there being uncertainty about how producers will respond to these regulations, there is also uncertainty about how consumers will respond. While economists are quite optimistic that information regulations do influence consumer behavior, it is likely that different consumers will respond differently to the information that DTSC will post to its website. Anticipating such heterogeneous responses will increase the likelihood that these new regulations offer public health benefits to all of California's consumers.

References

Becker R, Henderson V. 2000. “Effects of air quality regulations on polluting industries,” *J. Polit. Econ.* 108:379–421.

Berman E, Bui LTM. 2001. Environmental regulation and labor demand: evidence from the South Coast Air Basin. *J. Public Econ.* 79:265–95.

Berman, E. and L. Bui, 2001. “Environmental Regulation and Productivity: Evidence from Oil Refineries”, *Review of Economics and Statistics* 83(3):498–510.

Cañón-de-Francia, Joaquin and Concepción Garcés-Ayerbe and Marisa Ramírez-Alesón, 2007. “Are More Innovative Firms Less Vulnerable to New Environmental Regulation?” *Environmental and Resource Economics*, 36:295- 311.

Costa, Dora L. & Matthew E. Kahn, 2004. "Changes in the Value of Life, 1940--1980," *Journal of Risk and Uncertainty*, Springer, 29(2):159-18.

Greenstone Michael., 2002. “The impacts of environmental regulations on industrial activity: evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures.” *J. Polit. Econ.* 110:1175–219

Heckman, James, 2006. “The Technology and Neuroscience of Capacity Formation.” Proceedings of the National Academy of Science, http://jenni.uchicago.edu/human-inequality/papers/tech-skill-pnas_2col_all_2007-03-22a_mms.pdf

Jaffe A, Newell RG, Stavins RN., 2003. “Technological change and the environment1.” In *Handbook of Environmental Economics*, ed. K Ma¨ ler, J Vincent, 1:461–516. Amsterdam: Elsevier.

Jin, Ginger & Phillip Leslie, 2003. "The Effect Of Information On Product Quality: Evidence From Restaurant Hygiene Grade Cards," *The Quarterly Journal of Economics*, MIT Press, 118:409-451.

Kahn, Matthew E., 2001. “The Beneficiaries of Clean Air Act Legislation,” *Regulation*. 24: 34-39. 2001.

Kerr, S. and R.G. Newell, 2000. “Policy-Induced Technology Adoption: Evidence from the U.S. Lead Phasedown”, Resources for the Future Discussion Paper 01-14, Resources for the Future, Washington, DC.

Neidell, Matthew, 2009. “Information, Avoidance Behavior, and Health: The Effect of Ozone on Asthma Hospitalizations,” *Journal of Human Resources*, 44(2):450-478.

Nelson, Richard and Sidney Winters, 1982. An Evolutionary Theory of Economic Change. Harvard University Press

Newell, R.G, A.B. Jaffe and R.N. Stavins, 1999. "The Induced Innovation Hypothesis and Energy-Saving Technological Change", *The Quarterly Journal of Economics* 114:941-75.

O'Rourke, Dara and Eungkyoon Lee, 2004. "Mandatory Planning for Environmental Innovation: Evaluating Regulatory Mechanisms for Toxics Use Reduction," *Journal of Environmental Planning and Management*,47(2):181–200.

Popp, David., 2001. "The Effect of New Technology on Energy Consumption", *Resource and Energy Economics* 23(4):215-239.

Popp, David., 2002. "Induced Innovation and Energy Prices", *American Economic Review*, 92(1):160-180.

Popp, David. 2003, "Pollution Control Innovations and the Clean Air Act of 1990", *Journal of Policy Analysis and Management*, 22(4), 641-660.

Popp, David. 2006, "International Innovation and Diffusion of Air Pollution Control Technologies: The Effects of NOX and SO2 Regulation in the US, Japan, and Germany", *Journal of Environmental Economics and Management*, 51(1), 46-71.

Porter, Michael E. and Claas van der Linde, 1995. "Toward a New Conception of the Environment-Competitiveness Relationship." *Journal of Economic Perspectives*, 9(4):97-118.

Reyes, Jessica Wolpaw (2007) "Environmental Policy as Social Policy? The Impact of Childhood Lead Exposure on Crime," *The B.E. Journal of Economic Analysis & Policy*: Vol. 7 : Iss. 1 (Contributions), Article 51.

Ringleb, Al and Steven N. Wiggins, 1990. "Liability and Large-Scale, Long-Term Hazards," *The Journal of Political Economy*, 98(3): 574-595.

Shimshack, Jay P. & Ward, Michael B. & Beatty, Timothy K.M., 2007. "Mercury advisories: Information, education, and fish consumption," *Journal of Environmental Economics and Management*, Elsevier, 53(2): 158-179.

Simon H. 1959. Theories of Decision-Making in Economics and Behavioral Science. American Economic Review 49: 253–83

Simon H. 1986. Rationality in Psychology and Economics. Journal of Business 59: 209–24

Snyder L, Miller N, Stavins R., 2002. The effects of environmental regulation on technology diffusion: the case of chlorine manufacturing," *Harvard University, Kennedy School Working Paper.*

Snyder L, Miller N, Stavins R., 2003. The effects of environmental regulation on technology diffusion: the case of chlorine manufacturing," *Am. Econ. Rev*. 93:431–35

Wiser, Ryan, Mark Bolinger, Peter Cappers and Robert Margolis. 2006, Letting the Sun Shine on Solar Costs: An Empirical Investigation of Photovoltaic Cost Trends in California. LBL National Lab Working Paper.

Appendix One: Suggested New Data Collection Efforts for Measuring the Cost of Regulatory Compliance over Time

Measuring the costs of compliance with environmental regulation has posed a major challenge to environmental economists. In this appendix, we discuss some alternative relatively low cost methods for ascertaining whether these regulations impose significant costs on California consumers and producers. Since the DTSC regulation has not been implemented yet, such data does not exist but such data will exist soon after the regulation is implemented.

It is relevant to note that environmental economists have continued to investigate alternative methods for quantifying how the costs that firms face due to environmental regulation change over time. In the 1980s and 1990s, the U.S Environmental Protection Agency invested in created the Pollution Abatement Cost Expenditure (PACE) survey to quantify this exact question. This data set has been discontinued as researchers learned that diverse firms answered the same survey questions in different ways. The interviewees had trouble distinguishing what costs they had incurred because of the new regulation versus what were normal business costs. If the interviewees could not make such distinctions, then the resulting data is of little research or policy value. The key unknown here is what would have been each regulated firm's cost of production in the absence of the regulation.

With any new piece of regulation, there is uncertainty concerning how producers and consumers will respond. There are scenarios under which these regulations could cause unintended consequences that affect California producer profitability, worker employment prospects and the prices that California consumers pay for products they need on a daily basis. While this report has highlighted the scenarios where these impacts could happen, as these regulations is rolled out there are important empirical benchmarks that can be tracked to document in real time how California's firms and consumers are faring due to these regulations.

One low cost indicator of how companies are responding to regulatory rulings is to study stock price dynamics. Such daily data exist for publicly traded companies. At any point in time, a stock's price provides information about the market's best guess of the expected present discounted value of future corporate earnings. If new regulation is anticipated to sharply raise a firm's costs, then this would be reflected in a change in the company's stock price. The basic logic here is that regulation induced increases in costs means that the firm's profits will be lower each year. The fundamental theory of stock valuation predicts that a stock's rate of return moves in lock step with "new news" about the financial health of the company. The theory predicts that stock prices will rise if there is new news about profit increases and that the stock price will fall as there is new news about unanticipated increases in costs or reductions in revenue. Consider the example of the April 2010 British Petroleum oil spill. This publicly traded company's stock price has fallen sharply since the event as investors have grown concerned about the liability this company will face from anticipated lawsuit settlements and cleanup costs. This salient example highlights that today's stock price is a leading indicator of the market's collected wisdom about the expected future profitability of a firm.

A common technique used in financial economics is to conduct an *event study* in which the researcher collects data on the stock price trends over time before and after an event takes place. In the case of these DTSC regulations, this would be major DTSC regulatory response. In recent research studying the impact of Europe's REACH regulation, researchers have documented that companies who have made greater past investments in technological capital and hence are more innovative companies experienced less of a market value reduction when this new regulation was announced (Canon-de-Francia, Garces-Ayerbe, and Ramirez-Aleson 2007).

It is important to note that many California product producers are small privately held firms. In these cases, there is no asset market data for tracking their performance. To assess the financial health of these small firms requires a different strategy. At UCLA and UC Berkeley, there are Census Data Centers where unique confidential micro data can be analyzed.

"The California Census Research Data Centers (CCRDCs) at UCLA and UC Berkeley are two of nine Research Data Centers (RDCs) established by the Center for Economic Studies (CES) of the U.S. Bureau of the Census in order to provide secure physical locations for researchers to study non-public microdata collected by the Census Bureau. These microdata files contain data that cannot be released publicly because they contain detailed information on geographic location and/or other characteristics about the firms or households that could disclose their identities." [17]

UC researchers could use confidential employment files at the establishment level to track the employment dynamics of firms being regulated by the DTSC. Such analysis of micro data would allow the DTSC to observe how small firms versus large firms in different geographic areas across California are coping with the new regulations. Unlike the aggregate "macro data" reported in Table One above, such establishment level data would allow the DTSC to track how its regulation is affecting the local economy. The only downside of using such data is that it is produced on a lag so that in the year 2012 researchers would be able to access data for 2010 and perhaps part of 2011. If sought more up to date data, the DTSC could supplement these data with a survey of "at risk" establishments.

For establishments that shut down in California and reopen elsewhere, the DTSC could construct a mechanism to conduct an "exit interview" to learn about why the establishment made this decision.

Data can also be collected on how consumers are affected by these regulations. The Bureau of Labor Statistics constructs the consumer price index (CPI) to track the inflation rate.[18] This index seeks to measure how much money is required to purchase the same market basket over time. If this basket becomes more expensive then this indicates that the purchasing power of money is declining or that inflation is taking place. In a similar spirit, the DTSC could construct a CPI for California consumers focused on products regulated by these regulations. If this subset CPI increases more quickly than the nation's overall CPI then this would be evidence that these regulations are adversely affecting consumers.

[17] Source http://www.ccrdc.ucla.edu/.

[18] http://www.bls.gov/cpi/cpifaq.htm

Table One: Employment Trends in the Chemical Manufacturing Industry

		2003				2009			
		California		Rest of Nation		California		Rest of Nation	
Industry	Naics	Jobs	Firm Size	Jobs	Firm Size	Jobs	Firm Size	Jobs	Firm Size
Petrochemical Manufacturing	325110	2.5	2.5	8808.5	151.9	17	8.5	8025	167.2
Industrial Gas Manufacturing	325120	966.5	19.7	10540.5	20.2	1264.5	26.9	9691	21.7
Inorganic Dye and Pigment Manufacturing	325131	417.5	59.6	7907.5	102.7	466.5	51.8	6048	77.5
Synthetic Organic Dye and Pigment Manufacturing	325132	57	9.5	8395.5	75.6	66.5	13.3	4846	56.3
Alkalies and Chlorine Manufacturing	325181	42	21.0	5845.5	146.1	42	21.0	6518.5	155.2
Carbon Black Manufacturing	325182	14.5	14.5	2083.5	83.3	22	11.0	1572.5	54.2
All Other Basic Inorganic Chemical Manufacturing	325188	1881.5	38.4	39910.5	68.9	1682.5	39.1	31096.5	52.4
Gum and Wood Chemical Manufacturing	325191	10	5.0	2294	44.1	461.5	92.3	2421.5	45.7
Cyclic Crude and Intermediate Manufacturing	325192	74.5	74.5	4086	113.5			3077.5	99.3
Ethyl Alcohol Manufacturing	325193	231	57.8	2759.5	37.8	390	39.0	8447.5	38.2
All Other Basic Organic Chemical Manufacturing	325199	1303.5	31.8	66208	107.3	1239	29.5	63266.5	92.1
Plastics Material and Resin Manufacturing	325211	3035	35.3	62457	87.2	3773.5	38.1	62077.5	66.3
Synthetic Rubber Manufacturing	325212	825.5	35.9	10511	81.5	909	45.5	8684.5	72.4
Cellulosic Organic Fiber Manufacturing	325221			2237.5	159.8	2.5	2.5	1726.5	101.6
Noncellulosic Organic Fiber Manufacturing	325222	14.5	14.5	23432	260.4	39.5	13.2	13645.5	133.8
Nitrogenous Fertilizer Manufacturing	325311	189.5	10.0	5241	41.6	382.5	18.2	4795.5	36.6
Phosphatic Fertilizer Manufacturing	325312	270.5	38.6	5831.5	157.6	185.5	37.1	6428.5	94.5
Fertilizer (Mixing Only) Manufacturing	325314	1046.5	26.8	8818.5	19.6	756.5	20.4	8493.5	21.6

Pesticide and Other Agricultural Chemical Manufacturing	325320	620	22.1	12054	58.0	803	26.8	11984	61.5
Medicinal and Botanical Manufacturing	325411	3088.5	50.6	21281.5	70.9	4824	76.6	20814.5	64.8
Pharmaceutical Preparation Manufacturing	325412	14944.5	106.7	111720	145.7	16658	102.2	101407	125.0
In-Vitro Diagnostic Substance Manufacturing	325413	7036.5	108.3	18154.5	112.1	7849.5	113.8	18609	106.3
Biological Product (except Diagnostic) Manufacturing	325414	5002.5	102.1	21688.5	77.2	6375.5	159.4	30242	108.0
Paint and Coating Manufacturing	325510	4763.5	28.5	48328.5	40.1	2689	17.7	38326.5	34.6
Adhesive Manufacturing	325520	2246.5	34.6	20876.5	39.6	2183.5	37.0	21549	43.3
Soap and Other Detergent Manufacturing	325611	2428.5	30.7	24839	39.2	1116.5	16.7	25275.5	42.0
Polish and Other Sanitation Good Manufacturing	325612	1292	17.9	19877	38.3	1175.5	19.9	15469.5	33.9
Surface Active Agent Manufacturing	325613	296	18.5	7041.5	46.6	287.5	16.9	6441	46.0
Toilet Preparation Manufacturing	325620	8408	48.3	52071	78.5	8476	44.6	47487.5	76.3
Printing Ink Manufacturing	325910	1547	27.6	12866.5	27.3	4226	75.5	15161.5	34.8
Explosives Manufacturing	325920	233.5	46.7	5745.5	68.4	355	59.2	6688	91.6
Custom Compounding of Purchased Resins	325991	1476.5	24.2	24880.5	42.4	1119	25.4	18489.5	40.8
Photographic Film, Paper, Plate, and Chemical Manufacturing	325992	2745	38.1	15962	47.2	1246	27.1	13342	43.9
All Other Miscellaneous Chemical Product and Preparation Manufacturing	325998	2844	20.9	36158.5	35.6	2677.5	24.6	35677.5	33.7