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Did the Invisible Hand Need a Regulatory Glove to Develop a Green Thumb? Some Historical Perspective on Market Incentives, Win-Win Innovations and the Porter Hypothesis.

Abstract:

The idea that properly designed environmental regulations can improve a firm's competitiveness while simultaneously contributing to a cleaner environment through the development of so-called 'win-win' innovations (i.e., that reduce environmental damage while simultaneously increasing profits) is usually credited to Porter (1991). Numerous studies have since attempted to assess the validity of the concept, with mixed results. This paper contributes to this debate by surveying a nearly forgotten body of literature written in the late nineteenth and early twentieth century that discussed the impact of market incentives on the development of valuable by-products out of industrial waste. Based on the opinions held by several industrial chemists, engineers, technical journalists and economists, the development of 'win-win' manufacturing practices seems to have been primarily the result of the profit motive, although actual or potential legal actions based on private property rights and/or government regulations occasionally triggered this process. After reviewing some important historical writings on the latter issue, a suggestion is made that perhaps the best way to craft 'well-designed' environmental regulations is to return to a private property rights approach to mitigating pollution problems whenever possible.

Keywords: Porter Hypothesis; By-Products; Private Property Rights; Common Law; Win-Win Innovation.

JEL Codes: L21; O18; Q53; Q55; Q56; R11

Introduction

Much controversy surrounds the impact of environmental regulations on the economic performance of firms (Fiorino 2006; Press 2007). Drawing upon an argument now typically credited to Harvard University professor Michael Porter (1991) - but which had been anticipated a few years before by other authors (Ashford 2000) - some academics and regulators have suggested that ‘properly designed and enforced’ regulations that actually mitigate environmental harm could trigger innovative responses that would not only fully offset compliance costs, but also result in additional profits, or so-called ‘win-win’ innovations. Proponents of the ‘Porter Hypothesis’ (henceforth PH) have typically supported their argument with recent case evidence, but several econometric studies using various indicators have yielded inconclusive, though generally negative, results.

This paper contributes to this debate by surveying a nearly forgotten body of literature written in the late nineteenth and early twentieth century that discussed the impact of market incentives, including both the profit motive and legal constraints, on the development of valuable by-products out of industrial waste. It is structured as follows: The first section introduces the main arguments and controversies surrounding the PH. Next is a survey of the work of several analysts who, from the middle of the nineteenth century onward, argued that the search for increased profitability promoted a widespread ‘greening’ of industrial practices through the development of by-products from previously polluting residual matter and emissions. This process was gradual, of course, and was never capable of eliminating the environmental impact of industrial activities in their entirety, but these non-mandated reductions were hardly insignificant.

After providing some legal background, I then summarize the analysis of the core PH insight found in the work of three authors who devoted much thought to the issue: the French engineer and politician Charles de Freycinet (1828-1923), the British chemical engineer John Baker Cannington Kershaw (1861-1943) and the German-born American economist Erich Zimmermann (1888-1961). While they supported the notion that actual or potential legal actions based on private property rights and/or government regulations did occasionally result in the development of ‘greener’ practices, they did not contradict

the assessment of the vast majority of other writers on the subject who gave much more credit to the profit motive in this respect.

Finally, this essay suggests that if indeed by-product development has always been a widespread – probably even fundamental – feature of market economies, it is unrealistic to expect environmental regulations to generate widespread ‘win-win’ innovations in an economic context that doesn’t feature the widespread existence of ‘slack’ required to make the PH a plausible proposition. This is not to say that, today as in the past, scenarios in which the PH hypothesis appears to be compatible with observed reality do not occur. While this conclusion can be interpreted as supporting the arguments made by some of Porter’s critiques, I further suggest that a return to common law principles might provide a better means to craft ‘properly designed’ environmental regulations.

1. The Porter Hypothesis Debate¹

The PH suggests that ‘well-designed’ and ‘well-enforced’ environmental regulations will encourage firms to reduce waste, increase efficiency, and utilize newer and more efficient production technologies. Through incentives that otherwise don’t exist in a market economy, managers and engineers will be compelled to examine their operations more closely, discover inefficiencies in and eventually improve upon production activities. As a result, they will more than fully offset compliance costs, become more competitive and profitable than non-regulated rivals, and reduce their environmental impact. Furthermore, the PH puts forth the idea the environmental regulations can trigger the development of a cutting edge pollution control technology industry with significant export potential.

The belief that regulations are needed for business people to undertake what are ultimately profitable actions rests on a number of perceived market failures ranging from a lack of information and innovative stamina among private sector actors to insufficient incentives to invest in financially risky R&D. For example, it is argued that the benefits of R&D investments might later be appropriated by competitors at little or no cost,

¹ This section is based on the following more detailed and technical accounts of this debate: Anex (2000), Hemmelskamp et al. (2000), Jaffe et al. (2002), Levinson et al. (2006), Roediger-Schluga (2002) and Wagner (2003).

thereby diluting the incentive to invest in such activities in the first place. In the words of Jaffe et al. (2002: 45): “If firms are not optimizing, a logical consequence of the evolutionary model is that it cannot be presumed that the imposition of a new external constraint (for example, a new environmental rule) necessarily reduces profits.” As Porter and van der Linde (1995: 99) argue, the current “transitional phase of industrial history” is characterized by companies that “are still inexperienced in dealing creatively with environmental issues,” where the environment “has not been a principal area of corporate or technological emphasis,” and where “knowledge about environmental impacts is still rudimentary in many firms and industries, elevating uncertainty about innovation benefits.” Regardless of whether or not knowledge about environmental impacts is still ‘rudimentary,’ numerous firms have been able to increase profitability in recent years by reducing production costs and polluting emissions.

PH sceptics argue that self-interest serves as a sufficiently strong incentive for corporate executives to invest in innovations that benefit both their bottom-line and the environment. According to this perspective, although scenarios that appear to vindicate the Porter hypothesis may exist, it is doubtful that business people would remain systematically oblivious to profit opportunities that can be realized through the adoption of less-polluting practices/technologies. Furthermore, most econometric studies on the topic have yielded inconclusive, though generally negative, results on the validity of Porter’s idea (Jaffe et al. 2002; Mohr 2002; Smith and Walsh 2000). In addition, phone inquiries revealed that most of the cases originally singled out by Porter to back up his argument had little to do, if anything, with governmental regulations (Palmer et al. 1995). Of course, measuring the specific impact of environmental regulations on the development of win-win innovations is a difficult endeavor because environmental regulations are but one of many factors that operate alongside the profit motive to induce innovative behavior. Some of the other factors include, but are not restricted to, government-run grant-giving programs for R&D and subsidies for certain technologies over others.

While no side in this debate has thought it worthwhile to look for historical precedents and earlier discussions of these issues, the development of ‘win-win’ innovations in the form of by-product development has been documented in some detail for nearly two hundred years – long before the advent of ‘properly designed’ environmental regulations of the type favored by PH proponents. In fact, as will be illustrated, the core of the PH argument has been debated since at least the middle of the nineteenth century. Despite the limitations of Porter’s critics, this essay will seek to illustrate why their alternative explanations might in fact represent a stronger argument than the one put forth by his followers.

2. Economic Growth and the Environment: The Case of By-Product Development.

It is entirely possible that many past managers, engineers and technicians, especially in successful firms, were comfortably ensconced in their production routines and had become complacent about the need to improve environmentally damageable practices. However, there is significant evidence that suggests that several private sector actors relentlessly looked for new ways of extracting more valuable outputs from their inputs and for developing lucrative by-products out of their polluting wastes and emissions. While the evidence of increased efficiency over time in the production of primary outputs is well documented (Rosenberg 1994a; Ausubel 1998; Simpson 1999), the same cannot be said of by-product development. Because of the latter issue’s arguably greater importance in terms of the direct environmental impact of manufacturing activities, this paper will concentrate on factors having promoted it. The remainder of this section will briefly survey the very different perspectives on the topic held by current and past generations of economists and other analysts.

By-Product Development in Recent Economic Thought

In their review essay on the interface between economics and industrial ecology, a perspective which promotes the reduction of the environmental impact of industrial activity through learning from an analogy with natural ecosystems in which the discarded matter produced by one species/firm is consumed by another (Ayres and Ayres 2002),²

² Industrial ecologists are by and large academics based in engineering and business school programs.

van den Bergh and Janssen (2004b: 31) observe that the “economic analysis of [industrial waste] recycling is still underdeveloped within environmental economics, possibly because recycling and processing of waste are not considered standard categories of economic production.”³

In a typical discussion of the issue, Ethridge (1973) compares the marginal cost of using by-products instead of virgin materials and argues that the distinction between by- and waste products is economic in nature. In short, by-products can be recovered economically until the marginal returns from recovery equal the marginal costs of recovery, while waste products cannot. But although the author briefly hints at the opportunity of increased by-product recovery that might in principle result from new user charges on waste discharge, his analysis omits the impact of traditional market incentives and institutions on the processes leading to the transformation of industrial waste into wealth. While reiterating the basic argument on the economic nature of industrial residuals, Turner (2000: 710) further suggests that certain physical characteristics of waste flows, such as “high mass, relatively low contamination, good homogeneity and concentrated location” facilitate their profitable recovery. One example of an industry in which all three of these criteria is satisfied is the ‘secondary’ sector of the chemical and allied industries where “reprocessed chemicals are usually sent back to the original waste-generating plant or sold to other plants capable of utilizing the recovered and often degraded chemical.” On the other hand, “lower-grade recyclable materials arising in small amounts in scattered locations and with only limited end uses” offer much less interesting perspectives and the financial loss incurred in attempts to recover them might not be offset by the environmental gains claimed by recycling advocates (*idem*).

Jaffe et al. (2005: 166) suggest that innovations such as cleaner production methods, new pollution control equipment or new substitutes for environmentally harmful products alter the “terms of the tradeoff between the marginal cost of pollution control and its marginal

³ The issue is typically not discussed in any detail in most environmental economics textbooks and handbooks (Pearce and Turner 1990; Tientenberg 1996; Bromley 2000), in recent review essays on the state of the sub-discipline (Pearce 2002; Heal 2007) or in what is arguably the most influential essay on environmental policy and technological change published in recent years (Jaffe et al. 2002). Turner (2000) is one exception which will be further discussed in the main text.

social benefit.” When this is the case, a “specified level of environmental cleanup can be achieved at a lower total cost to society” while “a lower total level of pollution can be attained more efficiently.” While Turner (2000: 716) acknowledges the existence of opportunities for firms to develop innovations that are both profitable and environmentally beneficial, he argues: “Fundamental waste reduction measures will often prove to be financially unprofitable.” Indeed, this author stated in an earlier book that the “basic difference between natural and economic systems... is that natural systems tend to recycle their waste [while] economies have no such built-in tendency to recycle” (Pearce and Turner 1990: 36). This latter perspective is shared by Ayres (2004: 427) who postulates: “The industrial system is very wasteful of materials and recycles very little.”⁴ Wondering why industry fails “to incorporate recovery and recycling practices more routinely in its operations,” Kneese (1998: 10) suggested that “markets need to be fundamentally restructured so that prices reflect the full social costs of production” through the use of emissions and effluent fees. Summarizing the more radical perspective of ecological economists, Asafu-Adjaye (2000: 24) writes that the stocks of natural resources are “permanently reduced or degraded by economic activities, and the stocks of waste products released into the atmosphere are permanently increased.” In this framework, the absence of governmental intervention implies that such negative externalities will continue to increase as economic growth proceeds.

In short, many environmental economists currently view industrial waste and its resulting pollution as a market failure to be handled through government intervention, rather than a market opportunity for polluting businesses to develop profitable technologies that have both financial and environmental benefits. As Fullerton and Stavins (1998: 433) put it, many economists like themselves “make a living out of analysing market failures such as environmental pollution in which laissez-faire policy leads not to social efficiency, but to

⁴ Desrochers (2002) lists a large number of economists and other analysts who share a similar perspective. Interestingly, in an obituary of environmental economist Alan Kneese, an anonymous contributor to *The Economist* wrote that “‘Recycling’ is a big idea today. If it has an inventor, Mr Kneese would be a claimant” (Anonymous 2001). One can nonetheless find economists with a different outlook on the topic. For example, Considine et al. (2001: 1) observe in a detailed report on energy and material flows in the U.S. steel industry that its history provides “a classic example of an evolving industrial ecosystem” in which a considerable amount of waste products was collected, transformed and put back in circulation.

inefficiency.” Stavins (2004: 12) reiterated this point a few years later when he wrote: “If the market is left to itself, too many pollution-generating products get produced. There’s too much pollution, and not enough clean air, for example, to provide maximum general welfare. In this case, laissez-faire markets - because of the market failure, the externalities - are not efficient.” Turner (2000: 705) similarly concludes that “unfettered markets fail to allocate environmental resources efficiently.”⁵ In a more detailed conceptual analysis where they state that a typical firm “does not have an economic incentive to minimize the ‘external’ costs of pollution” (p. 165), Jaffe et al. (2005) write that “pollution creates a negative externality, and so the invisible hand allows too much of it” (p. 166) and go so far as to argue that technical change relative to the environment occurs at the nexus of two distinct and important market failures:

“[P]ollution represents a negative externality, and new technology generates positive externalities. Hence, in the absence of public policy, new technology for pollution reduction is, from an analytical perspective, doubly underprovided by markets. This suggests that the efficiency of environmental policy depends on its consequences for technological change, and also that there is a potential role for policy aimed directly at the stimulation of environmentally beneficial technological change” (Jaffe et al. 2005: 168).

The validity of this perspective is an essential prerequisite for the Porter hypothesis to be true. In Turner’s (2000: 722) words, “if ‘slack’ is present and properly designed environmental regulations are introduced, then the firms’ capacity for innovation and improvement in productivity terms can be harnessed. Many innovations can partially or more than fully offset the costs incurred.” However, as the following paragraphs will illustrate, this premise does not stand up to in-depth scrutiny. Not only is this line of reasoning inconsistent with large-scale trends observed in market-economies, these

⁵ Turner (2000: 705-706) further suggests, however, that all this “is not to argue... that freely functioning ‘unfettered’ markets cannot achieve improvements in environmental quality. If consumers change their tastes in favour of less polluting products (as indicated, at least in principle, through eco-labeling) market forces will lead to a change in the ‘pollution content’ of final products and services. Green consumerism may do little to alter production processes since the consumer is generally not well informed about the precise nature of such processes, and is in any case less able to affect the choice of processes in any direct way. But process changes will occur if industry also becomes environmentally conscious, and/or the cost signals to industry alter.”

opinions were not shared by past generations of analysts, including some of the most prominent and reputable economists in history.

Past Perspectives on By-Product Development and Environmental Mitigation

General Surveys

The positive impact of traditional market incentives on by-product development has been documented by a surprisingly large number of analysts in a diverse array of fields over the last two hundred years (Desrochers 2007). Applied scientists, engineers, and some of the most radical (but influential) economists the world has ever seen have all commented on how market incentives enticed industrialists to generate new profits from materials that were previously considered ‘waste.’ Perhaps the best concise statement on this once prevalent opinion was provided by the journalist Frederick Talbot (1920: 17-18): “To relate all the fortunes which have been amassed from the commercialization of what was once rejected and valueless would require a volume. Yet it is a story of fascinating romance and one difficult to parallel in the whole realm of human activity.” What follows is a brief overview of what are probably the most important early works of synthesis published on the topic in the English language.

The author of what is arguably the first extensive work of synthesis on by-product development, the business and technology journalist Peter Lund Simmonds⁶ (1862: 2), documented in his *Waste Products and Undeveloped Substances; or, Hints for Enterprise in Neglected Fields* how “in every manufacturing process there is more or less waste of the raw material, which it is the province of others following after the original manufacturer to collect and utilize.” Although this was done in various degrees in “almost every manufacture,” the process was particularly well-developed in the most important lines of work at the time, such as the cotton, wool, silk, leather, and iron industries. He observed that many ingenious persons were busily devising “means by which [the] rubbish may be worked up into a useful product,” that there were few important plants which did not have “one or more of these dependent industries attached to them” and that, as a result, “wherever we turn we find that the most trivial things may

⁶ Greysmith (2004) is a concise look at the life and work of this Danish-born British writer.

be converted into gold, the refuse and lumber of one manufacture or workshop, is the raw material of another” (Bethnal Green Branch of the South Kensington Museum 1875: 4).⁷ In his opinion, this was true not only in England and the European Continent, but also in resource-rich developing economies such as the United States, Argentina and Australia. Despite the fact that his book was more than four hundred pages in length, Simmonds (1862: v) warned that the subject was “too extensive in its scope to be discussed successfully in detail here, since any one branch would of itself form a useful and interesting volume,” a stance he maintained in the much revised and enlarged third (and last) edition of his book (Simmonds 1876).

This assessment is also found in similar books published - without any apparent knowledge of Simmonds’ pioneering contribution - in later decades. The German chemist Theodor Koller (1918: 1) argued in his *The Utilization of Waste Products: A Treatise on the Rational Utilization, Recovery, and Treatment of Waste Products of all Kinds* (338 pages) that while some waste products were occasionally “accumulating in such quantity as to injure and retard the continuous progress of a branch of industry,” it was also often the case that “the rational treatment and utilization of such waste products either increases very considerably the general profits of an industry or even forms a separate and not inconsiderable source of gain.” The British chemical engineer John B. C. Kershaw (1928: ix) observed in his *The Recovery and Use of Industrial and Other Waste* (212 pages) that even though not all industrial waste recovery processes that had survived the laboratory stage had proved permanently successful when tried on a larger scale, past experience showed a “larger number of recovery processes which have attained success.”

American journalist and publisher Charles Lipsett (1963: v) who wrote about the ‘reclamation industries’ for several decades, similarly noted in his *Industrial Waste and Salvage* (407 pages) that there was hardly a commodity “in which this process of producing and utilizing some form of scrap or waste materials does not occur, whether it be textile fibers, leather, glass, paper, chemicals, metals, etc.” Without the widespread

⁷ Although not formally identified as the author of this publication, Simmonds was the curator of this exhibit and reproduced *verbatim* countless passages of this document in his book on waste.

utilization of waste materials, he argued, there simply wouldn't be sufficient raw materials in the world to supply the needs of industries and that secondary raw materials were important to the economy of every nation. Lipsett (1963: 355) also identified a broad pattern in the development of by-products: "Yesterday's waste has become today's new product or chemical or food, with its own waste which through research and development will become tomorrow's new economic resource."

A brief survey of the history of economic thought on by-product development will now provide further support to the claims made by these authors.

History of Economic Thought on By-Product Development

General Statements

While it was probably never a major theoretical concern, several past economists did refer to by-products through the concept of joint production which occurs when commodities such as beef and hide, mutton and wool, or wheat and straw, are joined in common origins and cannot easily be produced separately (Clapp 1994; Kurz 1986, 2006; Baumgärtner et al. 2001). Among the best known analysts who devoted more than a few lines to the development of wealth from waste (as opposed to already established cases of joint production) are Karl Marx and Alfred Marshall. Marx's main passage on the issue can be found in the third volume of his *Capital*:⁸

With the advance of capitalist production the utilisation of the excrements of production and consumption is extended ... The general requirements for the re-employment of these excrements are: A great quantity of such excrements, such as is only the result of production on a large scale; improvements in machinery by which substances formerly useless in their prevailing form are given another useful in reproduction; progress of science, especially of chemistry, which discovers the useful qualities of such waste (Marx 1909/1894: Volume III, Part I, Chapter 5, non paginated).

⁸ Attributing any quote directly to Marx for this volume is nonetheless problematic. As is well-known, Friedrich Engels had underwritten Marx's labors on the first volume of *Capital* but, as Muravchik (2002: 89) points out, "was [later] shocked to discover the unfinished state of the notes that Marx had left for the remaining parts. Engels took these in hand, and from them produced volume two in 1885 and volume three in 1894."

After pointing out that the “so-called waste plays an important role in almost every industry,” Marx argued that rising prices of raw materials were a major impetus behind this process.

Alfred Marshall (1920: Book IV, Chapter XI, non paginated) made similar observations in his *Principles of Economics*. In it, he discussed a vast array of industries including textile materials, meat packing and petroleum refining to metallurgy, soda production and coal gas manufacturing and noted that: “Many of the most important advances of recent years have been due to the utilizing of what had been a waste product; but this has been generally due to a distinct invention, either chemical or mechanical, the use of which has been indeed promoted by minute subdivision of labour, but has not been directly dependent on it.” His most extensive treatment of the topic, however, can be found in his other classic book *Industry and Trade*, where a sub-section is devoted to explaining the “intimate connection between massive manufacture of homogeneous products and the utilization of by-products.” Marshall (1932: 238-9) claims that modern industry was successfully generating a demand for by-products while simultaneously improving their quality. Interestingly, one of his main intellectual opponents, John Atkinson Hobson (1917/1894: 75),⁹ concurred with him on this issue: “New industrial arts owing their origin to scientific inventions and their practice to machinery arise for utilising waste products... Conspicuous examples of this economy are found in many trades. During the interval between great new inventions in machinery or in the application of power many of the principal improvements are of this order.”

Marshall’s main illustration was the Chicago meat packing district, a topic much discussed by economists at the time in light of the large-scale development of tallow, glue, soap, felt, bone meal, glycerine, knife handles, buttons and countless other articles whose main inputs were previously wasted blood, feet, heads and other non-edible animal parts (Wells 1889; Commons 1904; Taussig 1920; Zimmermann 1933). Perhaps the best treatment of this case can be found in the work of the Canadian-born agricultural

⁹ Richmond (1978) is a more detailed treatment of Hobson’s economic writings.

economist Rudolf Alexander Clemen¹⁰ (1923; 1927) who observed that early work had been focused on food products such as oleomargarine and beef extract while later advances turned to more distant fields such as pharmaceuticals, explosives, lubrication oils, and cosmetics. Clemen (1927: vii) viewed these advances as part of a larger trend: “The development of by-products in [all] industry is one of the most outstanding phenomena in our economic life... From the viewpoint of individual business, this manufacture of by-products has turned waste into such a source of revenue that in many cases the by-products have proved more profitable per pound than the main product.”

In time, however, meatpacking operations became increasingly decentralized. An early discussion of the topic can be found in a 1904 essay published in the *Publications of the American Economic Association* (which later became the *American Economic Review*) by the business journalist Richard H. Edmonds. After observing that “the direct and indirect wastes of the past forty years have created the opportunity for the utilization of other wastes” (p. 163), Edmonds (1904: 165-166) documented his statement with the following examples: “The packer by making a chemical fertilizer of use in the cotton field, by using the cotton oil stearin in the manufacture of compound lard and cooking butters, and through his need of the cottonseed meal for feeding purposes, has begun to move to the South, nearer to the cattle-raising sections of the South-west.”

Another valuable contribution was a short entry on by-products in the 1930 edition of the *Encyclopedia of the Social Sciences* penned by John Maurice Clark.¹¹ While he briefly discussed the “varied constituents found together in products of nature,” using meatpacking and the chemical products of coal as “outstanding illustrations,” he also included related topics such as the utilization of spare capacity in plants and organizations. For

¹⁰ Born in Nova Scotia in 1893, Clemen completed his PhD work in economics and history at Harvard and taught, among other places, at Northwestern University, the University of Chicago and American University. He left academia for the ministry and eventually became part of the faculty at the Princeton Theological Seminary. He was also, among other things, President of Whitman College (1934-1936), Executive Vice-President of the Society of American historians and Associate Director of Armour’s Livestock Bureau (based on Edwards 2001 and various articles and book reviews written by Clemen available through www.jstor.org).

¹¹ John Maurice Clark was the son of famous economist John Bates Clark. For a more detailed treatment of his life and work, see Shute (1997). Interestingly, his article references Koller (1918) and Talbot (1920).

example, large packinghouses had diversified their activities into the distribution of general foodstuffs. Like all the writers surveyed thus far, Clark (1930: 129) observed that, by the time he wrote his entry, “every [residual] material [was] typically worked up into finished form.”

Perhaps the best concise general treatment on the issue ever written by an economist can be found in Erich Zimmermann’s¹² (1933) *World Resources and Industries*. Zimmermann observed that while nature used to be the only reservoir out of which humans drew the raw materials of production, a growing number of industries were relying on “secondary sources of supplies, salvaged from the waste heap and the junk pile, or artificial substitutes, especially synthetic products” whose raw materials often used to be wasted (p. 762). As can be expected, he distinguished between economic and technological waste by pointing out that “large amounts of energy and matter go unused even when their use is technically feasible” because “the cost of their recovery exceeds the proceeds from the sale of the recovered waste products” (p. 767). The determination of what constitutes of waste could therefore never “be determined by absolute standards but must be appraised in the light of general economic and social conditions” (p. 767). Whether or not waste elimination was economically feasible was also heavily dependent on “the size of the plant which in turn depends on the size of the market;” on the “interest rate which in turn depends on many other factors;” on the “labour effectiveness which in turn depends on training, climatic conditions, mental attitudes, and so forth” (p. 768).

Because he felt that “a comprehensive survey of waste elimination would fill volumes” (p. 769), Zimmermann limited the portion of his chapter on “resources from test tubes, waste heaps, and junk piles” to the description of a few outstanding examples, such as cottonseed, bagasse (a by-product of sugar extraction from sugar cane) and (mostly) packing house wastes. From these and other cases he inferred some general patterns, such as the fact that “the boundary lines between waste products and by-products are vague,”

¹² The German-born economist who, like Clark, belonged to the American Institutionalist School, taught at institutions including New York University and the University of North Carolina, but is perhaps best remembered for his stay at the University of Texas. For more detailed treatments of Zimmermann’s life and work, see Barnett (undated) and McDonald (1995). Interestingly, Zimmermann’s discussion of by-product development was omitted in later editions of his book.

that “the transfer from one category to the other is an almost daily occurrence” (p. 768), and that resource recovery would in time help equalize the distribution of economic activities on the globe “through synthetic chemistry, by-product utilization, waste elimination, and the recovery of secondary materials” (p. 763).

By-Product Development and Agglomeration Economies

Many economists further observed that by-product linkages often reinforced the geographical concentration of economic activities, in the process creating what would now be labelled “agglomeration economies” (i.e., external economies of scale).¹³ For example, after observing many such examples in farming, especially in the poultry and stock-raising industry that were often “merely incidental to farming,” Edward Ross¹⁴ (1896: 256) commented that one reason behind the growth of urban agglomerations was “the cluster of side industries that grow up about packing establishments, refineries, or gas-works, engaged in turning refuse into byproducts.” Charles Stanton Devas (1901: 98)¹⁵ similarly highlighted the role of the “greater growth of subsidiary industries, such namely as supply materials and utilize refuse, to do which for a single factory would not be worthwhile.” Talbot (1920: 303) further pointed out that, in order to be successful, “co-operative and individual methods [of resource recovery]... can only be conducted upon the requisite scale in the very largest cities where the volume of material to be handled is relatively heavy” because “waste must be forthcoming in a steady stream of uniform volume to justify its exploitation, and the fashioning and maintenance of these streams is the supreme difficulty.” In his classic study on the economic basis of urban agglomerations, Robert Murray Haig¹⁶ (1926: 191) explained: “Perishability during some intermediate process of fabrication tends to bin processes together at one place.” For example, New York City’s canneries were then, for the

¹³ Industrial ecologists now refer to such localized linkages as ‘industrial symbiosis’ (Chertow 2000).

¹⁴ A short biography of this American economist and sociologist, along with links to various texts about his life and work, can be found on the website of the American Sociological Association <<http://www.asanet.org/>>. Spellman (1979) is a more detailed look at his economic contribution.

¹⁵ Devas is described in his main book as a “sometime examiner in political economy at the Royal University of Ireland.” He was also a Catholic economist associated with the Christian Ethical School (Cannan 1901).

¹⁶ Although mostly remembered for his contribution to public finance theory (especially income taxation), R.M. Haig (1887-1953), who spent his whole career in various divisions of Columbia University, was also a pioneer in land economics (Anonymous 1953).

most part, “salvage plants designed to preserve the surplus supplies of temporary glutted markets, supplies which would otherwise decay and be wasted.”

Malcom Keir¹⁷ (1919: 39-40) pointed out that localization “attracts to itself plants whose business is the utilization of waste products” and that, for the factories, “the presence of the waste-using shops turns a loss into a profit, a charge into a credit or a liability into an asset.” He observed that each additional recovery plants added “an increment to the importance of a locality as the center of an industry,” for “by transforming liabilities into assets, and turning costs into profits,” they aided “in the defense of the community against the onslaughts of outside competition” and therefore augmented “the growth of the industry in the location where it is already rooted.” Keir illustrated these processes with various cases ranging from a great cement plant in Buffington, Indiana, that fed upon the slag of the largest steel mill in the United States located in the nearby town of Gary, to a glue and mucilage manufacturer in Gloucester, Massachusetts, whose main input was the heads and tails of fish from what was then one of the most important fishing ports in the world.

Most past explanations for developments of this type highlighted the importance of two types of pressures. The first, and most significant in the opinion of the vast majority, was the search for increased - or at least constant - profitability. The second was the necessity of removing nuisances to other parties that could result in legal actions and significant costs or even injunctions against polluters. I now turn to a discussion of both factors.

3. Competitive Pressures and By-Product Development

In a profit-driven economy, successful producers manufacture sellable goods and services using the least expensive input combinations, but perhaps more importantly create as much value as possible out of costly inputs. Entrepreneurs, managers and engineers have therefore always had some financial incentive to reduce emissions in their backyard, nearby running water or atmosphere. An early comment to this effect is by the polymath

¹⁷ Keir was a professor of economics at, among other places, the University of Pennsylvania and Dartmouth College (from various texts by or about Keir available on www.jstor.org).

Charles Babbage¹⁸ (1832, section II, chapter 22, non paginated) who observed that, among the factors behind the “cheap production of any article” is “the care which is taken to prevent the absolute waste of any part of the raw material.” The chemist and Scottish liberal politician Lyon Playfair (1852: 162-163) similarly observed two decades later that the “want of civilization and the effects of competition” require the ever more efficient use of labor and time and that “in the gratification of these wants, there is a constant aim to render objects apparently of little value useful and productive.”

Simmonds (1876: 205) also argued that, as competition became sharper, manufacturers had to look more closely to any item that might make the slightest difference between profit and loss, and had therefore to find ways to convert “useless products into those possessed of commercial value” because the discovery of “a heretofore unknown use for the waste product.... necessarily cheapens the cost of the principal article... and thus secures an advantage over competitors” (Simmonds 1883: 811). Clemen (1927: 2) later observed that by-products manufactured from “formerly partially or wholly wasted” residuals were widespread in all lines of work. As he put it, this development had been brought about “by the ever-increasing force of competition in American business, both between individual concerns within a single industry and among different ones.”

Zimmermann (1933: 767) highlighted the role of technological innovation in this respect by pointing out that one of “the major functions of modern science [is] to lower the cost of waste elimination; for reduction in such cost may render profitable, and therefore economically justified, practices of waste elimination which otherwise might be technically feasible but unwarranted for economic reasons.” This analysis was echoed by Fieldner (1925: 13) in his discussion of the purpose of fuel research whose object “is either to eliminate waste and increase efficiency in the mining, preparation and utilization of fuels,” or the conversion of the raw material “by treatment and processing into a more convenient or effective form for use with, in many cases, the recovery of valuable by-

¹⁸ Although mostly remembered as a computer pioneer, mathematician and/or polymath, Rosenberg (1994b: 24) argues that Babbage’s economic contribution is too often overlooked and that his pioneering book *On the Economy of Machinery and Manufactures* “first introduced the factory into the realm of economic analysis.” Interestingly, Marshall alluded to “Babbage’s instance of the manufacture of horn” in his discussion of by-product development (Book IV, footnote 129).

products for other purposes, as for example, the conversion of coal into coke and gas with the recovery of ammonia for fertilizers.”

Interestingly, this beneficial role of competitive pressures was acknowledged by Karl Marx (1894: non paginated) who observed that the reworked waste, “aside from the services which they perform as new elements of production, reduce the cost of raw material to the extent that they are saleable. For a normal loss is always calculated as a part of the cost of raw material, namely the quantity ordinarily wasted in its consumption.” Because this reduction in costs increased the rate of profit, Marx deemed industrial waste recovery the “second great branch of economies in the conditions of production” after economies of scale.

4. Legal Framework and Win-Win Innovations

Despite the credit now given to Porter (1991), the idea that legal/regulatory constraints or threats could trigger “win-win” innovations goes back at least to the middle of the nineteenth century. While some authors merely reported such cases, others went a step further and not only theorized the process, but also advocated the creation of specific regulations to encourage innovative behavior. Before dealing specifically with their writings, however, some background information on the historical evolution of the legal framework that dealt with polluting activities in advanced economies is required.

Environmental Protection: From Common Law to Statute Law¹⁹

It is now often believed that “laissez faire” policy is characterized by a lack of regulatory constraints on industrial polluters. What is forgotten, however, is that traditional institutions that served as vital pillars for any robust market economy did not only consist

¹⁹ Legal reality is, of course, more complex than the discussion presented in this section. For example, in the United States, the assignment of rights is the product of centuries of law-making of three sorts: legislative enactments (statutory law, including constitutions), court decisions (common law) and administrative decrees (administrative law). For the purpose of the present discussion, however, a simple dichotomy between common and statutory law was deemed sufficient. For more detailed recent discussions of past legal practices with regards to industrial waste in countries whose legal systems are based on English Common Law, see, among others, Brubaker (1995; 1998; 2007), Cross (1999), Meiners and Morris (2000), Meiners and Yandle (1999) and Rosen (2003). Private property rights played a similar role in this regard in countries with a civil law tradition (Brubaker 2007).

of the price system and the signals conveyed by profits and losses, but also included property rights and the rule of law. These latter factors served as a powerful means of protecting property owners from environmental degradation because damaging someone else's property through polluting emissions was no more acceptable than vandalizing it. For example, in countries operating under the British or legal tradition, common law precedents (i.e., legal rules and traditions developed over time through court decisions) included the theory of trespass (any entry on the property of another) and nuisance (indirect or intangible invasions - such as odors and noises - or unreasonable interferences with another's use or enjoyment of his property) under which property owners had the right to be free of pollution emitted by neighbors. Nuisance was originally limited to interference with the private use or enjoyment of rights in land, but was later extended to cover other invasions of the rights or interests of the general public. Its basic principle was typically summed up by the Latin maxim *sic utere tuo ut alienum non laedas*, or "use your own so as not to injure others."

Nuisance applications were quite comprehensive and covered, among other issues, public health (e.g. keeping of diseased animals), public safety (e.g. storage of explosives), public discomfort (e.g. dust, smoke, vibration) and public convenience (e.g. road obstruction). While this liability system mandated no specific conduct, remedies included compensation for past injuries, injunctions (an order by the court requiring the cessation of offensive activity or specifying corrective action), or compensation from expected future harm should the court allow the polluter to continue his actions. In some cases, remedies could also include abatement of the nuisance by self-help (Prosser 1966). Individuals could take legal actions against nuisances and seek either or both monetary damages or injunctions. According to most legal scholars, the threshold of proof was quite lenient as the plaintiff needed only to show that he or she had suffered physical or economic harms and such nuisance needed not be injurious to health.

From the early decades of the nineteenth century onwards, however, British and American judges increasingly sought to balance the benefits of economic growth against the health and comfort of the public, and litigation based on the violation of private

property rights slowly lost their effectiveness. For example, beginning in the 1850's, it was increasingly common "to hear a [British] judge say that life in factory towns required more forbearance than life elsewhere; or that an annoyance which was a nuisance on a quiet residential street might not be a nuisance elsewhere" (Brenner 1974: 414). In other words, a plaintiff would find it increasingly difficult to seek compensation for damages and/or environmental harms that were in some ways inherent to living in industrial areas. The reasoning used to deny the awarding of damages in these cases was based on the idea that plaintiffs residing in industrial areas enjoyed economic benefits (such as increased property value) that they would not enjoy in a less industrialized locale.

Eventually, specific regulations were added to this property rights-based approach in order to deal with industrial pollution such as air pollution – instance in which courts were faced with multiple polluters and conflicting claims. In practice, however, many policy makers used statutory law often quite intentionally to legalize pollution by nullifying the deterrent properties of private property rights (Brubaker 1995; Meiners and Morris 2000). According to one line of thought, because the common law proved too effective in rewarding a few victims at the expense of important industrial (which included not only owners and managers, but also workers) and governmental (such as municipal sewer operators) interests, lawmakers increasingly replaced it with more permissive government-made statutes and regulations in order to avoid costly constraints on important economic and public health operations. In other words, the hierarchy of laws meant that common law protection and liability was often overridden by political rules designed and implemented by elected officials and bureaucrats whose decisions, unlike those of neutral judges, were often driven by vested interests (Brubaker 2007).

These issues will now be further discussed in the context of past authors who anticipated the core PH argument.

Rights, Rules and Win-Win Innovations: PH Precursors²⁰

Charles de Freycinet (1828-1923)²¹

Perhaps the most sophisticated early proponent of Porter's core insight was the French engineer and prominent politician Charles de Freycinet. His writings on the issue can be traced back to a mandate he was given by French authorities in the 1860s to inquire into the ways by which legislators and rulers in other countries were handling matters of industrial hygiene, including the protection of workers and improvements of sanitation in large and densely populated cities. He eventually published various reports based on hundreds of interviews and site visits in England (1864), Rhineland Prussia and Belgium (1865) and France (1866), which were later summarized in his *Traité d'assainissement industriel* (1870) (Treatise on industrial cleansing). Freycinet (1870: 4, my translation) observed that, unlike mutual agreements between manufacturers and employees, "the situation between the manufacturer and its neighbours does not result from a mutual contract" and "most often the manufacturer established itself in the region despite opposition of its future neighbours." He pointed out that environmental degradation outside a factory was easily detected "without the necessity of violating the private home." While authorities in most European countries often did not hesitate to directly check abuses, they also sometimes let interested parties sort out problems through civil actions.

As Freycinet documented, manufacturers could be subjected to fines payable to the state as well as damages payable to private entities. They therefore had a direct interest in cleaning up their operations in order to escape onerous consequences. He further argued that a more powerful reason enticed industrialists to behave responsibly:

It results from this grand natural law, confirmed by everyday experience, that progress in sanitation is usually a source of benefit for those who accomplish it. When a manufacturer improves the state of his workshops or protect his neighbors from the effects of its operations, almost always he winds up improving his own situation. Besides the hygienic result he was going after, a financial one is found, which he was not expecting and that is like a reward for efforts undertaken to achieve the first result. To be convinced, it suffices to look at what has been

²⁰ To my knowledge, these authors provide the most interesting early discussions of this issue, but, of course, other analysts of significance might have been overlooked.

²¹ See Anonymous (1911) for a concise discussion of de Freycinet's life and work.

happening for twenty years in the principle factories of France and abroad (page 5, my translation).

Freycinet's research revealed that many polluting processes once responsible for the emission of harmful gases or the discharge of harmful solid or liquid waste had been superseded by cleaner ones that had also resulted in real gains for the manufacturers. A common scenario went as follows: As manufacturing operations expanded, so did the amount of residual matter produced while disposal space was becoming increasingly scarce. The manufacturer then had no choice but to find ways to neutralize wastes. "From that point on," Freycinet observed, it was only logical for industrialists to find ways to use them "and this step is continuously taken by the manufacturer in search of improved sanitation. As a result, we have seen a multitude of secondary manufacturing arise over several years, annexes of the principal industry for which they raised revenue" (page 6, my translation).

Freycinet (1870: 7, my translation) further added that the most flourishing factories were those that got the most out of their waste and best knew how to bring them back "into the circle of operations." In this way, not only was the neighborhood preserved, but the consumption of raw materials was considerably reduced, at least from the perspective of the innovative manufacturer. Interestingly, he added that industrialists "would have surely remained ignorant a long time still if the necessities of improving sanitation had not directed research in this direction." He therefore concluded that, no matter which side one looked at the issue, the natural law that governed sanitary improvements showed that the interests of the manufacturer were in perfect accord with the general interest and that "as long as science progresses and industrial procedures improve, harmony becomes more intimate and we can predict a day when, except for rare exceptions, industry will stop putting hygiene in serious danger" (pages 7-8, my translation).

The French engineer drew two main lessons from his work:

On the one hand, public authority would be wrong to abandon regulations for fear of harming production... when these have the goal of stopping serious causes of poor

health; on the other hand, manufacturers would be ill-advised to see harmful impediments to their industry in these regulations. They must, on the contrary, tell themselves that the law, while obliging them to improve sanitation, does them a real service most of the time and that for lack of philanthropic considerations, it is in their own interest to respect the security and the well-being of their fellow men (page 8, my translation).

While Freycinet's account seems plausible and is based on much empirical work, it is important to keep in mind, however, that his patrons might have somewhat 'inspired' the wording of his conclusions. As he would later write in his memoirs while reflecting on the context surrounding his mission and its original sponsor, the dictatorial regime of Napoleon III:

The imperial regime had always taken pains, as we know, to bring up questions that might occupy attention and in some way divert it from scrutinizing its origins. It was wise to lay down arms for a time and to supply another food for public thought. The questions of hygiene, the protection of workers, the improvement of sanitation in large cities opened up a field just as vast and fruitful. I was charged with the task of proceeding with the study and to make inquiries about the procedures put into practice in the United Kingdom to improve the sanitation of factories and densely populated areas (Freycinet 1907: 81-82, my translation).

By then freed from all external constraints, however, he restated his earlier conclusions in the following way:

After having long resisted legislative intervention, [British] manufacturers were finally convinced of their own excesses, and therein recognized the necessity [of doing something about them] and, from that point on, set to work. Rather than trying to outwit the law, they widely applied it and often even went further than its prescriptions. But, since the commercial spirit never wanes, they strove to transform material that they could no longer discard freely into useful by-products (Freycinet 1907: 85).

While Freycinet was perhaps the most sophisticated writer to introduce the core PH insight long before the late 20th century, two other analysts subsequently discussed the issue in quite a bit of detail. Interestingly enough, these individuals reached very similar conclusions without any apparent knowledge of other writers' contributions.

John Baker Cannington Kershaw (1862-1943)

The British engineer John B. C. Kershaw (1928: 2) observed in his by-product treatise that, whether through common or statutory law, the treatment of industrial wastes was often dictated “by the necessity of converting into an innocuous form some waste material, either solid, liquid, or gaseous, which, in its untreated state, is objectionable to the eyes or nose, or is detrimental to the health of the community.” He added that under such circumstances “the question of producing from it something which can be sold at a profit is entirely secondary in importance.” Kershaw (1928: 2-3) then commented that a growing number of waste products fell under the second category. As a result, at the time of his writing every “civilized” government was strengthening laws to prevent air and water pollution. It was nonetheless satisfactory to observe that “many processes which were imposed upon the manufacturer originally by legal pressure have become profit-earning at a later date.” He added that it was highly probable that efforts made then to reduce smoke emissions from domestic and factory chimneys would in time lead to similar results, and that “the laws which have been passed recently, in order to reduce the nuisance and damage caused by smoke, will lead ultimately to the use of coal with a much higher thermal efficiency in our homes and in our industries (*idem*).”

In Kershaw’s opinion, the “most notable example of a recovery process imposed upon the manufacturers by law, which afterwards became a source of large profits, is that of the recovery of hydrochloric acid from the waste gases of alkali works” that followed the adoption of the 1863 Alkali Act (p. 3). “The condensation of this gas, and its recovery in liquid form,” he argued, “led to the foundation of a new branch of industry.” In following years, a “very large share of the profits” made in this industry would be “derived from the chlorine products, for which the recovered hydrochloric acid served as the source of chlorine” (*idem*).

Erich Zimmermann (1888-1961)

Zimmerman anticipated Porter’s core argument when he identified “legal action” as the “third factor” promoting a fuller utilization of energies and substances after scientific advances and economies of scale triggered by increased competition. As he put it,

businesses were not always free to maximize profits “without social interference,” especially in densely populated and more advanced economies “where governments reflect a more mature appraisal of social values and echo a growing popular resentment against industrial practices harmful to health or otherwise” (Zimmermann 1933: 768). In such cases, waste elimination might have been enforced by law even when it proved economically costly. He suggested that such “compulsory waste elimination” should be viewed in the same light as taxation and that the incidence of the cost should be determined in a similar manner. Occasionally, however, “a corporation compelled by legal action to eliminate a waste at great expense, and unable to pass the cost on to the consuming public, may succeed, with the aid of scientific research, in converting the waste products into paying by-products – perhaps, even into a product of major importance” (idem). Zimmermann, however, did not provide an example to support his argument.

Again, however, while these and other authors spelled out the core insight and identified cases supporting the PH, they never denied the importance of the profit motive in triggering the widespread development of ‘win-win’ innovations and the resulting constant attempt to reduce ‘slack’ in all its forms in market economies. Besides, some of their supportive evidence might have been just as debatable as some of the examples later put forward by the Harvard Scholar. As will now be illustrated, the Alkali Act is a case in point.

*Case Study: The Alkali Act*²²

Freycinet’s original British inquiry was motivated in part by the debates surrounding what would become known as the 1863 Alkali Act,²³ which was later used by Kershaw (1928) to support the core principles of the PH. While the literature on what Playfair labelled the “monster nuisance of all” (quoted by Dingle 1982: 529) and what would later be referred to as the “archetypal command and control” environmental regulation (Pontin

²² For recent, more detailed and relatively jargon free technical discussions of the legislative and technical context surrounding the adoption and subsequent evolution of the Alkali Act and by-product development from Leblanc process residuals, see Dingle (1982), Donnelly (1994), Garwood (2004), Hardie and Pratt (1966), Pontin (1998), and Russell (2000).

²³ This Act was later amended in 1874, 1881, 1892 and 1906, most notably to include conduct-based standards (best practical means) to earlier emission limits.

1998: 663) is too large and complex to be analyzed in any detail, the basic facts of the case seem problematic for PH supporters.

In short, the Leblanc soda manufacturing process, which became dominant in the early nineteenth century, resulted, among other things,²⁴ in the emission of hydrogen chloride gas that had serious detrimental effects upon the surrounding populations, crops and buildings. The first version of the Alkali Act required the absorption of 95% of these emissions by whatever method was preferred by the manufacturer. The initial pollution-reducing steps were typically accomplished by having the waste gas sent up through a stone tower filled with coke and by having water dribbling down through the tower to absorb the hydrogen chloride, producing aqueous hydrochloric acid. These ‘Gossage towers,’ however, existed long before the adoption of the Act and were already used by most Alkali (and a few other) manufacturers, although with varying degrees of success. Indeed, as Dingle (1982) points out, only the existence of a preexisting practical technology made the legislative control of the alkali industry a possibility, for other damaging industrial processes without known practical pollution-control technologies, such as “wet” copper smelting, escaped the attention of legislators at the time.

More importantly, the solution created through the use of Gossage towers, while significantly reducing air pollution, was too dilute for the preparation of chlorine and was therefore release in brooks and streams where it created much environmental damage. Furthermore, the demand for hydrochloric acid only absorbed a small fraction of the supply produced in the years following the adoption of the Alkali Act. Indeed, it took several years before new developments in terms of chlorine products (most notably bleaching powder) and general economic expansion which significantly increased the demand for these products eventually decreased significantly the amount of pollution attributable to the Alkali trade. Kershaw’s (1928) use of this piece of legislation as a vindication of the core argument of the PH therefore seems debatable.

²⁴ Another significant problem was the production of vast quantities of residual mud containing 90 percent of the sulfur used in soda manufacture. This problem would also eventually be solved through by-product development.

5. Reflective Conclusion

Like most recent discussions of environmental policy, the Porter Hypothesis controversy takes place in a historical vacuum where participants assume that past generations of industrialists were unwilling or unable to develop ‘win-win’ innovations on a large scale and that no functional or credible legal threats or institutions existed to curb some of the most egregious examples of industrial pollution. While the former assumption of ‘widespread slack’ in market economies is contradicted by much historical evidence, a case could also probably be made that, in some instances, wasteful (and therefore polluting) production processes lasted longer than necessary as a result of numerous pro-development judicial decisions and legislative interventions that legalized nuisances, trespasses and violations of traditional property rights (Brubaker 1995, 1998; Meiners and Morris 2000). As Breger et al. (1991: 470) observed, “most people who are at least somewhat familiar with the issue see that regulation is a license to pollute, and a license to pollute for free.” Of course, below-market stumpage fees, royalties, or resource rents also often play(ed) a role in environmental degradation (Kjellingbro and Skotte 2005; OECD 2006).

While recent decades have seen the adoption of more stringent “command and control” regulations like the mandated destruction of hazardous waste, many commentators fail to realize that these developments often resulted in undesirable consequences. For example, in the American context, industrial residuals are often viewed as a nuisance to be destroyed rather than potentially valuable by-products. Indeed, once a residual has been labeled a “hazardous waste,” expensive, lengthy and complicated procedures makes its further use practically impossible, even though the “waste” might be chemically identical to or even less hazardous than a so-called “virgin” product. The failure of such a system to facilitate resource recovery can be explained by the tendency of legislators to assume a linear flow of materials to waste, rather than the internal cycling characteristic of a sustainable economy (Laudise and Graedel, 1998: 51). While it is beyond the scope of this paper to examine this issue in any detail, it seems reasonable to suggest that recent regulations have often shifted the traditional recovery focus of industry executives and workers toward regulatory compliance (Desrochers 2002). In this context, it would seem

plausible to argue that one of the best features of the Common Law system was that it didn't establish an arbitrary distinction between a useful material and a waste. As US Supreme Court Justice George Sutherland wrote in a famous 1926 case: "Nuisance may be merely a right thing in a wrong place like a pig in the parlor instead of the barnyard" (quoted by Meiners and Yandle 1999: 3).

In view of current problems and past successes, it can be suggested that environmental regulatory reforms should go beyond the replacement of process standards (under which government agencies go into elaborate detail specifying what devices companies may use under what circumstances) by performance standards (where governments only monitor compliance) and market-based instruments (such as tradeable permits, emission charges, subsidies and information programs). While the common law system was never flawless, unlike a regulatory system that sets out specific standards of conducts, it had, at least as far as solid waste is concerned, a proven track record of inducing polluters to resolve creatively their emission problems. It would therefore seem plausible to suggest that its "use your own so as not to injure others" maxim would prove much more sensible for all residuals that can be easily monitored than any "command-and-control" approach and should therefore be at the heart of "properly designed" criteria associated with PH discussions. In other words, the material discussed in this paper suggests that common law principles should be viewed as the presumptively optimal method of controlling environmental harms if only because they will always allow greater experimentation and innovation than rigid statutory rules or politically-determined fees and taxes.²⁵

Even though the evidence presented in this paper can only be considered preliminary, it nonetheless suggests that the rational interest of business has never been as far apart from the environmental interest of society as many academics, activists and regulators currently believe, and that a greater familiarity with the history of business and

²⁵ The Common law also had a few additional advantages over current regulatory alternatives. For instance, provided that their lawsuit was successful, those directly harmed by the pollution were able to receive direct compensation for the harm they suffered. In addition, since many pollution problems were localized, it allowed for the development of local remedies for local problems. The resulting decision was also a signal to other potential polluters that similar behavior would likely result in penalties.

technology, along with the work of past writers on relevant issues, might result in both better theoretical understanding and policy making. Given greater flexibility and freedom, the profit motive and competition will provide businesses with sufficient incentives to maximize the use of resources through recovery and by-product development over time. On occasion, however, private property rights and statutory laws will help the invisible hand develop a green thumb, but it would be unrealistic to expect a regulatory glove to work out miracles in this respect.

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