

The Porter Hypothesis, Property Rights, and Innovation Offsets: The Case of Southwest Michigan Pork Producers¹

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- Abstract -

The Porter Hypothesis, Property Rights, and Innovation Offsets:

The Case of Southwest Michigan Pork Producers

The Porter Hypothesis relates the effects of environmental regulation on (a) technological innovation and (b) economic performance. Specifically, it asserts that innovation offsets can occur. These are a type of technological change that will “partially or more than fully offset the costs of complying with environmental regulation” (Porter and van der Linde, 1995, p. 98). The hypothesis has been highly debated, in part, because nomenclature has been careless. Also, the role of property rights in defining innovation offsets has been neglected. If the Porter Hypothesis has validity in agriculture, its policy implications are important. Recent changes in agro-environmental legislation provides an opportunity to more thoroughly investigate the hypothesis and its implications.

Introduction

The “Porter Hypothesis” (Porter and van der Linde, 1995a) asserts that through technical change “policies mandating strict environmental compliance have [the] potential to make American firms and industries more competitive” (Thurow and Holt, 1997, p. 20). Porter and van der Linde (1995b) take issue with the usual economic textbook assumption that, because a firm is presumed to be maximizing profits, any profitable opportunities to improve environmental performance will be automatically undertaken. Any regulations requiring more environmental performance, therefore, can come only at a cost. Specifically, Porter and van der Linde take issue with the idea that pollution is only inefficient if it can be prevented for less expenditures than what it costs a firm to deal with it once it is created. They point to cases where innovation offsets—cost reductions due to technological change in response to environmental regulations—have resulted in “win-win” situations where both profits and environmental performance have improved.

The hypothesis has generated considerable debate. While Porter and van der Linde contend that these innovation offsets are likely to be common and large, others have disagreed (Gardiner and Portney, 1994; Palmer, Oates, and Portney, 1995; Thurow and Holt, 1997; Jaffe and Palmer, 1997). For example, Palmer et al. (1995) note their strong dispute with the Porter hypothesis; they argue that environmental regulation does indeed involve tradeoffs, that the cost of regulation will be neither negligible nor non-existent.

Studies of the Porter hypothesis to-date have focused on the process of innovation, the effects on R&D expenditures, and inventive output (Ferrante, 1998; Jaffe and Palmer, 1997). These studies have mainly been framed in the context of the manufacturing sector. There is some empirical evidence that innovation offsets are not common in the manufacturing industry (Palmer,

et al., 1995). Few studies, however, have investigated the existence of innovation offsets in agriculture.

This paper explores the Porter hypothesis as it relates to the existence of innovation offsets in agriculture—specifically for swine farmers in Michigan. It begins with an examination of the concept of innovation offsets. We argue that debating whether pollution is inefficient and therefore whether innovation offsets are “improvements in efficiency due to investments in reducing environmental damage” (Thurow and Holt, 1997, p. 20) is not appropriate when environmental regulations result in major changes in the property right structure. We further argue that the concept of “bounded rationality” can be used to explain how an institutional change such as a new agro-environmental regulation can change firm (producer) behavior toward adoption of profitable pollution prevention innovations. We conclude by using the concept of innovation offsets to frame a forthcoming empirical study addressing impacts of agro-environmental regulation.

Efficiency and Innovation Offsets

First, we explore the relationship between efficiency and innovation offsets. Is pollution an inefficiency, a waste, the correction of which yields innovation offsets? No, identifying inefficiency as the source of innovation offsets is not appropriate. Consider the concept of efficiency. Assume a firm is using the most efficient production function given a property right structure. If a new property right structure is implemented, and, in response, the firm adopts some new technology, this adoption expands a firm’s production possibility set. It is not correct to call this adoption an improvement in efficiency, rather, this is an expansion in the firm’s production opportunities.

This conclusion is reinforced by a careful examination of property rights. Property rights are rules that define what has to be taken into account in economic decisions and activity³. They specify a firm's opportunity set; thereby influencing the firm's behavior. Property rights both constrain and liberate behavior by influencing benefits and costs, and their distribution. As Schmid (1987) notes, property rights describe the relationship of one agent to another with respect to a resource. If one owns the property right to a natural resource, the owner is able to create costs for others. Thus, "one person's right is another's cost" (p. 9).

Consider an example. Let A own the property right to a natural resource and let B be affected - incur costs - from A's ownership. As Schmid notes, in order to "reduce the external effects on B of A's acts is to increase the external effects on A of B's acts" (p. 10). Thus, the allocation of property rights directs the distribution of benefits and costs. Therefore, a change in property rights can expand one's opportunity set by providing the owner with new benefits and the ability to shift costs to others. This expanded opportunity set will affect the choices and actions, or behavior, of the owner and those affected. This change in economic behavior in turn affects economic performance.

Specifically, assume that Firm A holds the property right to use a body of surface water for disposal of waste residues. The service provided by the surface water as a sink for Firm A's discharges is a free input into A's production process although this use clearly results in costs to society in terms of sustained environmental damages. Firm A is able to create costs for society due to its ownership of the property right.

³This section draws from Schmid, 1987.

Now, let the institutional structure change for some reason, perhaps due to changing societal preferences. Society now holds the property right to a certain level of clean water. Firm A is no longer able to freely discharge into the surface water, rather, society now dictates that A is limited in how much pollution it can discharge. If it discharges more than it is allowed, it must pay a fine that increases as the limit is exceeded.

Clearly, the levels and distribution of benefits and costs to both Firm A and society have changed. Society now benefits from cleaner water, but firm A incurs direct costs in using water that it did not earlier. Society's opportunity set has expanded while A's has diminished.

Efficiency, the maximization of the net social benefits, then is a function of the prevailing property rights structure. Under the initial pre-environmental regulation property rights structure, a firm's discharges are not an inefficiency. For Firm A, water was a free input and there was no incentive for it to economize on its use of the resource. After the change in property rights, water use does entail a direct cost for Firm A. Under this new post-regulation property rights structure and prices, the profit-maximizing firm will want to reduce its use of water for pollution disposal. Thus, environmental regulations provide incentives for the firm to reduce pollution because the change in property rights makes pollution a direct cost for the firm, not just for society.

Thus, innovation offsets are due to an induced innovation; they result in both an increase in profits and an improvement in environmental quality. They do not result from improvements in efficiency. Rather, once benefits and costs change, profits for A are modified since it now bears a cost for improving environmental quality. Depending upon the technology adopted by Firm A in response to the environmental regulation, innovation offsets may or may not occur. Theoretically

it is only known that a change in benefits and costs changes economic performance. Whether profits improve is an empirical question.

Behavior Implications

How does Firm A react to the new property right structure? Can Firm A offset its increased production costs which stem from compliance with the new water quality requirements?

Hicks' induced innovation hypothesis provides insight:

A change in relative prices of the factors of production is itself a sign to invention, and to invention of a particular kind -- directed to economizing the use of a factor which has become relatively expensive (Hicks, 1932).

The change in property rights has caused the relative cost of water to increase for Firm A. It follows from Hicks' induced innovation hypothesis that Firm A will reduce the amount of water that it uses for pollution disposal. Firm A will choose from a vector of existing technologies that change its production process in such a fashion as to reduce its water use for pollution disposal. It will invest in ways to meet its new constraints at lower costs.

A Simple Model of Innovation Offsets

With the implementation of the environmental regulation, and the change in property rights, pollution is now a cost for Firm A. How innovation offsets occur can now be seen with the following simple model⁴. Economic theory predicts that Firm A will reduce its use of water in order to minimize costs, and perhaps improve profits given that it must meet a new environmental standard. Figure 1 illustrates the effect of this induced technical change. The production possibility frontier (PPF) depicts the feasible set of water quality and profits that are produced by

⁴Adapted from Batie, 1997.

Firm A. Water quality is measured on the X-axis; it increases as one moves from left to right.

Profit is on the Y-axis.

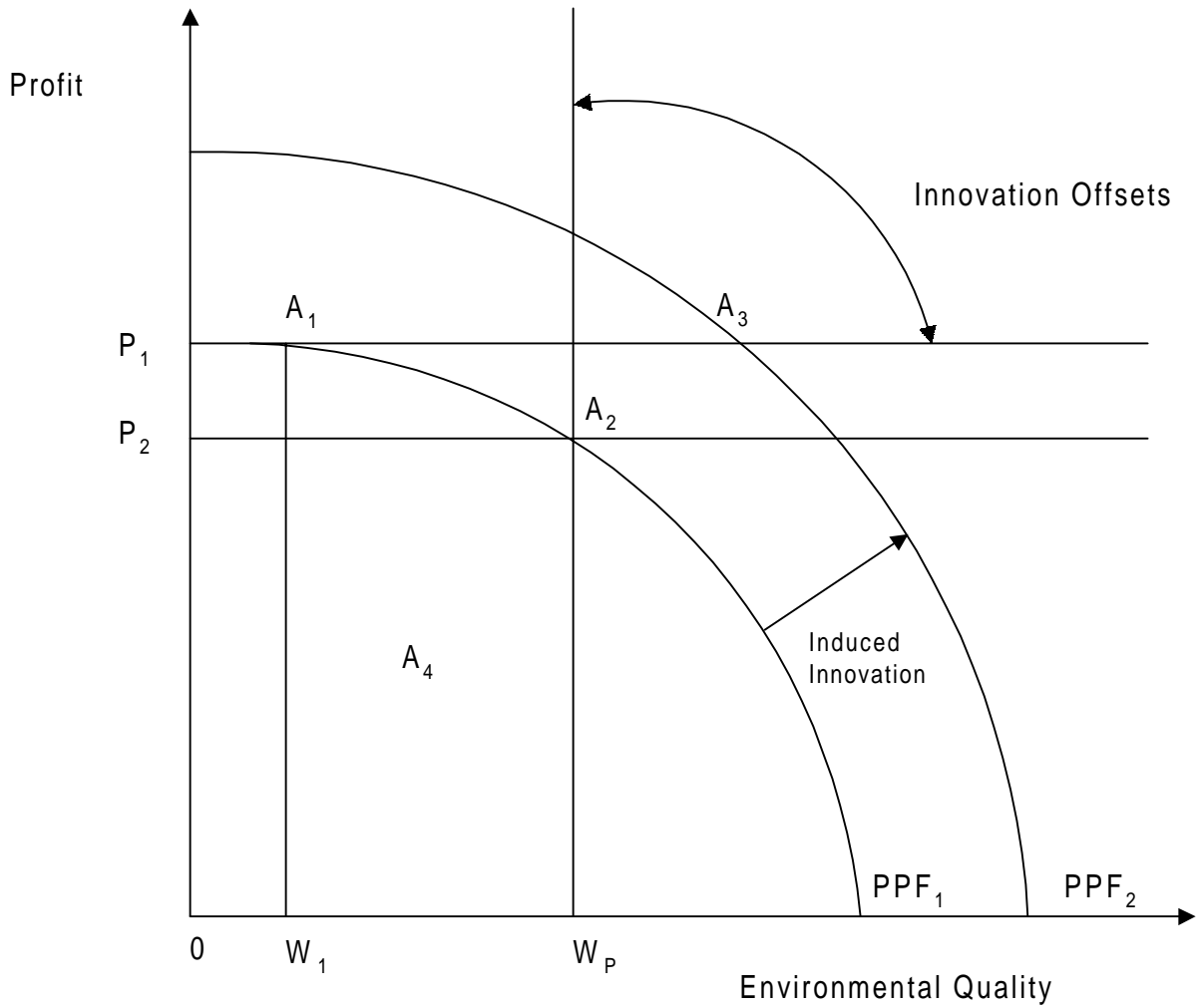


Figure 1: Innovation Offsets

Before the environmental regulation, Firm A is at point A_1 on the production possibility frontier (PPF), labeled PPF_1 . At this point it earns P_1 profits and generates a water quality level

equal to W_1 . Since water is a free input for A, it will likely be close to the Y-axis since it does not bear any direct costs from water degradation.

Now let an environmental performance standard be implemented, one which specifies the maximum amount of ambient pollution that can be allowed from Firm A. Let the minimum level of ambient water quality that A must meet be W_p . At point A_1 it is clear that Firm A is producing too much pollution and must move to at least A_2 along the frontier PPF_1 . Here Firm A earns profits P_2 which are less than P_1 , but produces less pollution. Thus the costs that Firm A must now bear due to the change in property rights has reduced its profits, and forced it to produce a different set of output levels than when it was owner of the property right. These are compliance costs that A must incur to be in compliance with the new environmental regulation. It is clear that there is a trade-off between profits and improved environmental quality for Firm A.

But A is a profit-maximizing company, and Hicks' induced innovation hypothesis says the firm will seek out technologies that lower compliance costs (and improve water quality). Thus, after some time, A shifts out to a new frontier, labeled PPF_2 ⁵. This shift in the production possibility frontier is an induced innovation. But where will Firm A be on the new PPF? Given the performance standard, it must be to the right of W_p . If it is on any part of PPF_2 below the horizontal line (P_1), Firm A earns less profits than it did without the environmental regulation. Environmental quality, though, improves. Points along this lower portion of PPF_2 are not innovation offsets. If Firm A repositions itself on this part of the frontier, economic performance, as measured by innovation offsets, does not improve.

⁵The technology that is adopted by Firm A could be biased towards profits or environmental quality, in which case the outer boundary would be closer to the respective axis. For illustrative purposes though, the PPF is assumed to take the shape shown.

The only section that results in an innovation offsets is that part of PPF_2 that lies to the right of vertical line, W_p , and above the horizontal line, P_1 .⁶ All points on this section of PPF_2 , such as point A_3 , result in higher profits *and* improved water quality. Firm A's profits increase due to technical innovation as does environmental quality.⁷

Does this mean that Porter and van der Linde were correct and their critics wrong? Not so. Critics (Gardiner and Portney, 1994; Palmer et al., 1995) are correct in stating that we cannot have it all. This conclusion is seen from Figure 1. There is an opportunity cost to any position along both frontiers, including PPF_2 ; there is a tradeoff between profits and environmental quality due to scarcity of resources. In fact, this tradeoff will always exist regardless of the technology that is adopted. If the regulatory performance standard did not have to be met, the firm could improve profits at the cost of lower water quality. Regardless of this tradeoff, the change in property rights can make a firm more profitable, if such previously unexploited technologies can be found that result in innovation offsets.

Bounded Rationality and Innovation Offsets

The potential existence of induced innovation and innovation offsets raises the question as to why, under normal operating circumstances, firms do not pursue all profitable opportunities for new products and processes (Gardiner and Portney, 1994; Palmer et al., 1995; Jaffe and Palmer,

⁶Innovation offsets have been defined somewhat differently elsewhere in the literature; while improving environmental quality, they reduce compliance costs, but do not necessarily increase profits. An example of this would be any point along PPF_2 where Firm A reduces its compliance costs by earning a profit level greater than P_2 , but less than P_1 . A's profits relative to its initial point A_1 do not increase. This definition of innovation offset is not used in this study.

⁷This is in contrast with the model of innovation in abatement technology used by Palmer, et al. (1995). They conclude that stricter environmental regulation makes a firm unambiguously worse off. This result is based upon the assumption of perfect information (p. 123). But this assumption may not hold for various reasons, explored later.

1997). Critics of the Porter Hypothesis tend to assume perfect information, which does not hold in the real world. Moreover, bounded rationality prohibits managers from considering all possible profitable opportunities⁸. The set of information considered by managers is influenced by such things as prices, institutional factors such as business custom, firm culture, social culture, and property rights.

But changes in any of the above institutions, perhaps due to citizen movements, political response, or changes in property rights, can cause managers to change their agenda and widen the set of information they use. Managers may respond by searching for innovations that reduce pollution⁹. Once bounded rationality is acknowledged, it can be seen that institutional changes can change behavior, and do affect which, among the large number of profitable possibilities, come to the attention of managers.

In addition, there may be profitable paths that firms can pursue, but explicitly do not follow because returns to investments must exceed a specified “hurdle rate” or certainty payback threshold. Simple measures like payback thresholds are used due to bounded rationality; they help managers focus their attention by allowing them to deal with a subset of their entire knowledge.

Furthermore, it may be that managers only pay attention to some profitable processes because they become more valuable with the environmental regulation than without it. For instance, without the environmental regulation some process or product may have returned 10 percent on the investment, but with the change in property rights, and its ensuing changes in

⁸The authors wish to thank A.A. Schmid for this intellectual contribution.

⁹It should be added that if the changes in institutions are strong enough, direct sanctions may not be needed to change the behavior of managers.

benefits and costs, the return could be 30 percent. This process may only be pursued now that it surpasses the minimum certainty payback threshold.

The simple model that was presented earlier, however, assumes technical efficiency, which can result from perfect information. Are innovation offsets still possible if this perfect information assumption is relaxed? Consider point A_4 in Figure 1. Assume that initially Firm A is at point A_4 , inside the PPF_1 . This position may be due to the reasons mentioned above, such as “bounded rationality.” Next a performance standard of W_p is implemented. The change in property rights may force the firm to the frontier PPF_1 . The firm experiences innovation offsets only if the new location on PPF_1 is to the northeast of A_4 . Here profits increase and environmental quality improves.

Of course there can be a situation where the performance level is set so high that no innovation offsets are possible. Thus the possibility of innovation offsets, when information is imperfect and bounded rationality exists, is dependent upon where the performance standard is set. An improvement in economic performance is ambiguous.

The Case of Southwest Michigan Pork Producers

Jaffe and Palmer (1997) suggest that one interpretation of the Porter hypothesis is that certain types of environmental regulations—such as those that focus on outcomes and not processes—stimulate innovation. Few studies have investigated innovation offsets in agriculture, perhaps because there are so few agro-environmental performance standards. Since 1998, however, the Environmental Protection Agency has specified that states must implement Water Quality Standards (WQS) for phosphorous loadings into surface waters in the state that do not meet the set water quality standard. This regulation does not specify any technology that must be

used, rather, in the agricultural non-point pollution context, the choice is left to farmer. This new requirement for environmental regulations that specify agro-environmental performance standards provides an opportunity for study of the Porter hypothesis and the existence of innovation offsets.

What type of innovation, or technical change, will occur in response to these performance standards? The process of technical change and the adoption of technology is not well understood, whether in response to environmental legislation, or without it. Technical change is often described as a dynamic two-stage process (Chavas, Aliber, and Cox, 1997): 1) the creation of new knowledge and technology, and 2) the adoption of new technology by firms. Expenditures on R&D generate new knowledge, but since acquiring knowledge and adapting it is costly, the adoption process can be slow. Note that both stages of technical change can be induced by regulatory stipulations.

A forthcoming case study of southwestern Michigan swine producers will focus on the effect of this new property right structure and the performance standard (WQS) on technology adoption behavior of pork producers. Southwestern Michigan Pork Producers were selected for the case study since they are located in an area where maximum daily load performance standards for phosphorus from livestock production will require changes in farming practices or systems. The situation is complicated by the fact that some producers are contractees, some are independent, and all are experiencing a rapidly consolidating industrial structure. Some have large recent investments in fixed assets, others are more flexible. The producers are in different stages of their careers.

While the research is just starting, we anticipate that we will identify suites of technologies—from changed farm practices to whole farm redesign to changed hog diets—and then

we will estimate the impact of these technologies on phosphorus loadings for specific farm locations. We will also estimate the impact on profits. Probit models of adoption will be developed that include the unique characteristics of the enterprise and the decision-maker. These unique characteristics will be identified—via a detailed personal interview—based on the information set viewed as important by the producer. That is, out of all possible profitable opportunities for the farm firm, which are considered most important and why. Similarly, the decision-makers response to the foreseeable performance standard will be explored, in part by viewing the performance standard as a shift in the relative price of waste disposal to other activities. In addition, we plan—through survey questions—to obtain some insight into the dynamics of land grant expenditures on research and development that would minimize the costs of compliance for phosphorous performance standards. Through this investigation we will be able to investigate the applicability of the simple model presented earlier and the role played by changing property rights structure in orienting producers to seek out innovation offsets.

Summary

If the Porter hypothesis has validity in agriculture, the policy implications are important. They are that, if agro-environmental regulations are designed as performance standards: these regulations may be more cost-effective than other non-point pollution strategies, they may focus producer and contractor attention to search for innovation offsets, and they may induce innovation by redirecting R&D expenditures to cost minimizing pollution prevention technologies. Because of recent changes in agro-environmental policy, research can be directed at the validity of the hypothesis in an agricultural context.

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