

Pigou, Coase, and Efficiency Applied to Pennsylvania Coal Mining Law

Please do not quote without my permission.
Humberto Barreto
hbarreto@depauw.edu

by
Humberto Barreto
Department of Economics
Wabash College
Crawfordsville, IN 47933

presented at
1995 History of Economics Society meetings
South Bend, IN
June 2 - 5

Comments Welcome
barretoh@wabash.edu
(765) 361-6315
Please do not quote without the author's permission

TABLE OF CONTENTS

1.0 Introduction	1
2.0 Pennsylvania Coal Mining: Information and Issues	2
2.1 How to Mine Coal	2
2.2 The Conflict Over Resource Use	3
2.3 A Brief History of Pennsylvania Coal Mining Law	5
2.3.1 Introduction	5
2.3.2 <i>Pennsylvania Coal v. Mahon</i> (1922)	5
2.3.3 <i>Keystone Coal v. DeBenedictis</i> (1987)	12
2.4 The Change in Coal and Property Values in the 20th Century	16
2.5 Conclusion	20
3.0 Pigou and Coase on Pennsylvania Coal Mining Law	21
3.1 The Question Posed	21
3.2 A Pigovian Analysis of Pennsylvania Coal Mining Law	22
3.2.1 Framing the Problem	22
3.2.2 The Case for the Market	25
3.2.3 The Case for Improving Upon the Market System	26
3.2.4 Pigou's Analysis Applied to Pennsylvania Coal Mining Law	30
3.2.5 Conclusion	32
3.3 A Coasian Analysis of Pennsylvania Coal Mining Law	33
3.3.1 Framing the Problem	33
3.3.2 The Case for the Market	34
3.3.3 The Case for Improving Upon the Market System	35
3.3.4 Coase's Analysis Applied to Pennsylvania Coal Mining Law	38
3.3.5 Conclusion	41
3.4 Comparing Pigou and Coase	41
4.0 Pennsylvania Coal and the Efficiency of the Common Law	44
5.0 Conclusion	46
6.0 Bibliography	48

1.0 Introduction

When conflict over a resource use arises, three basic alternatives exist:

- (1) impose a solution from above;
- (2) create the means so that a resolution can emerge from within—of the many variants here, special attention will be focused on the Pigovian and the Coasian Solutions; or,
- (3) combine the opposing resource owners under one roof—i.e., vertical integration.

Instead of an intellectual history of these options or a theoretical description of Coase versus Pigou, this paper will compare the Coasian and Pigovian solutions by applying them to the interesting history of Pennsylvania coal mining law. The analysis will be informed by reference to the original works of Pigou and Coase, not by the myriad interpretations since offered, nor the textbook presentations of their ideas. The goal here is to comprehend better the Pigovian and Coasian alternatives in the ubiquitous conflicting resource class of problems while improving our understanding of the positions held by Ronald H. Coase and Arthur C. Pigou. This paper will argue that they are not as far apart as commonly thought—in fact, they share a belief in the efficacy and desirability of decentralized solutions. In addition, the examination of how the law has reacted to the conflicts involving coal and surface land owners will offer another observation in the continuing study of the economic motivation inherent in the common law.

The next section provides necessary information about coal mining, the unavoidable friction between miners and surface owners, a brief legal history of Pennsylvania's regulatory efforts, and a review of changes in coal prices and property values. After explaining the conflicting uses and other background information, section three turns to the Pigovian and Coasian solutions to the problem. Section four discusses the U.S. Supreme Court decisions on coal mining law as a case study for those who see economic efficiency in the common law.

2.0 Pennsylvania Coal Mining: Information and Issues

2.1 How to Mine Coal

The basic “room-and-pillar” underground coal mining technique has been used in the United States since the mid-19th century. The authors of “Safety and Management Problems in Mine Operations in Pennsylvania” provide a clear description of this method.

Let us visualize a coal seam six or eight feet thick. In the general development of a mine, one or more main parallel passageways, or “headings,” are first driven through the coal seam at predetermined intervals and along predetermined lines. These main passageways are used to transport the coal, the men, and the supplies. They are also used as a means to circulate air in the mine. These headings are located to provide maximum service and convenience to the underground development and with due regard to outside facilities for handling coal. The next step of the development of a mine is to strike off, generally at right angles to the main headings, a series of secondary passageways or headings. These are termed “flats.” These flats are merely extensions of the main headings to serve smaller areas or panels. At right angles to the flats are excavated another group of passageways known as “rooms.” These rooms are cross-connected by other passageways called “breakthroughs.” When the advance into any particular tract of coal is complete, the blocks of coal outlined by this network of passageways are called “pillars.” Extraction of the coal in these pillars is never complete in a deep mine, but it is the last step in the development and exploitation of any particular body of coal.

In an underground coal mine, any particular location from which coal is being removed is called a “working place” or “face.” The extraction of coal in driving the passageways is termed “development work.” Coal extraction from the pillars is “rib work.” Just as development is along predetermined lines, so is the rib line. Pillars are moved diagonally and in a flanking line. As the retreat is made, the stratum previously overlying the coal seam caves in on the void, and this is called the “gob.” (Bane, et al., pp. xix-xx)

Although many improvements have been made in extraction techniques and transportation in the coal industry, seemingly unavoidable by-products of maximum

exploitation of underground coal reserves include danger to mine workers and harmful effects to the surface. As the underlying coal is removed and the gob is created, mine workers must face the possibility of explosions of various sorts (including coal dust or natural gas), asphyxiation, premature collapse, and a variety of other hazards. In addition, room-and-pillar coal mining may lead to cave-ins, collapse, or subsidence of surface lands. It is the latter of these negative effects that forms the crux of the question explored in this paper.

2.2 The Conflict Over Resource Use

The classic harmful-effect problem is now easy to see. Owners of coal deposits, in using their resources efficiently, are in direct opposition with those who own the rights to the surface. Coal companies have a strong monetary incentive to get as much coal as feasible out of any given mine for coal left in the ground implies foregone revenue. In their pursuit of maximum profits, however, they clash with the desires of surface owners because of the lowering of strata overlying a coal mine. Justice John Paul Stevens described the “devastating effects” of subsidence:

It often causes substantial damage to foundations, walls other structural members, and the integrity of houses and buildings. Subsidence frequently causes sinkholes or troughs in land which make the land difficult or impossible to develop. Its effect on farming has been well documented—many subsided areas cannot be plowed or properly prepared. Subsidence can also cause the loss of groundwater and surface ponds. In short, it presents the type of environmental concern that has been the focus of so much federal, state, and local regulation in recent decades. (*Keystone Coal*, pp. 481-482)

To be clear, no easy, economically feasible solution to this conflict exists. The coal must be extracted in order for the firm to make money; but upon removal of the coal, settling of the surface, with its consequent “devastating effects” is unavoidable (since “the stratum previously overlying the coal seam caves in on the void.”) It is, of course, possible to remove only part of the coal, leaving enough to prevent the lowering of the surface strata, but coal companies are understandably reluctant to leave valuable assets unharvested.

It is important to realize that the dilemma posed here refers to the effects of subsidence to a surface owner who owns *only the surface rights to the land*. The courts of Pennsylvania have recognized three distinct estates (or separate titles) in mining property: (1) the surface land rights, (2) the ownership of the subjacent minerals, and (3) the right to have the surface supported. The last right is often called the Support (or Third) Estate and “has been recognized as so distinct from the ownership of the surface or the minerals that it may be transferred to and held or conveyed by one who was neither the owner of the surface nor of the coal. *Penman v. Jones*, 256 Pa. St. 416; *Charnetski v. Coal Co.*, 270 Pa. St. 459; *Young v. Thompson*, 272 Pa. St. 360.” (Davis, et al., p. 396) Thus, conflict over use of property rights occurs only in those cases where ownership of the surface right has been divorced from the other two estates. In other words, when an owner of the coal and Support Estate damages the surface “directly overhead” belonging to another person, we have the problem of how to deal with the harmful effects.

If a coal mine causes subsidence or otherwise infringes upon the rights of a non-contiguous owner of all three estates, then the law has always held that the coal company is liable. In fact, in *Plymouth Coal Co. v. Pennsylvania*, 34 S Ct 359, the Supreme Court held that the state of Pennsylvania could require mine operators to leave a barrier pillar along the line of an adjoining mine in order to protect the safety and welfare of adjoining property owners. In addition, if all three estates are held by the same owner, the problem of reconciling competing interests is solved internally (i.e., through vertical integration).

Thus, the conflicting resource use involved in this paper is not simply that of a coal mine operator affecting surface lands alongside the mine or the optimization problem faced by a single owner of two competing resources, but the much more difficult situation in which the surface and subjacent rights have been separated and are now in opposition. The state of Pennsylvania has tried for many years to resolve this problem.

2.3 A Brief History of Pennsylvania Coal Mining Law

2.3.1 Introduction

The dangers associated with coal mining have led to a series of attempts by the Pennsylvania State Legislature and, more recently, the Pennsylvania Department of Environmental Resources to regulate the coal mining production process. After 108 men and boys were killed in an anthracite coal mine on September 6, 1869, the Pennsylvania Mine Safety Law of 1870 (Act of 1870, March 3, P. L. 3) was passed. This “first comprehensive mine safety legislation in the United States” required ventilation systems, inspections, and detailed maps, and prohibited the employment of boys under age twelve. (Bane, et al., pp. xvi-xvii)

It took fifty years for the state to turn its attention to the second danger of room-and-pillar coal mining, subsidence. It would be over another half-century before Pennsylvania’s efforts to control the harmful effects to surface lands would survive the scrutiny of the United States Supreme Court. Before Pigou and Coase’s views on the solution to the conflicting resource use problem can be presented, a thorough understanding of the facts at hand and the persuasive arguments of two of the country’s most brilliant jurists must be considered.

2.3.2 *Pennsylvania Coal v. Mahon (1922)*

On May 27, 1921, the Pennsylvania State Legislature passed P.L. 1198, commonly known as the Kohler Act. In the preamble, the expressed intent of the law was to protect the life, health, and safety of the public from the dangers of subsidence. In Section 1, the Kohler Act made it unlawful to mine coal so “as to cause the caving-in, collapse, or subsidence of —

(a) Any public building or any structure customarily used by the public as a place of resort, assemblage, or amusement, including, but not being limited to, churches, schools, hospitals, theatres, hotels, and railroad stations.

(b) Any street, road, bridge, or other public passage-way, dedicated to public use or habitually used by the public.

(c) Any track, roadbed, right-of-way, pipe, conduit, wire, or other facility, used in the service of the public by any municipal corporation or public service company . .

(d) Any dwelling or other structure used as a human habitation, or any factory, store, or other industrial or mercantile establishment in which human labor is employed.

(e) Any cemetery or public burial ground.” (May 27, 1921 P. L. 1198)

Sections 2 through 5 assign administrative tasks for public officials and describe procedures. Section 6 states that the Act shall not apply to a series of cases, including mines in townships of the second class (population less than 300 people per square mile), wild or unseated land, nor where such surface is owned by the owner or operator of the underlying coal and is distant more than one hundred and fifty feet from any improved property belonging to any other person. (May 27, 1921 P. L. 1198) Penalties are established in Section 7 and the Act concludes with a Section 8 that states, “The Courts of Common Pleas shall have power to award injunctions to restrain violations of this act.” (May 27, 1921 P. L. 1198)

The coal companies’ response was swift and sure. On August 27, 1921, the very same day the Kohler Act actually took effect, the Pennsylvania Coal Company notified surface owners H. J. Mahon and M. C. Mahon of impending mining under their property. When those same owners called upon the protection of the Kohler Act and refused to vacate their homes, the parties went to court. The Mahons held title only to the surface; although the coal company had sold the surface rights in 1878, the mineral rights and Support Estate remained with Pennsylvania Coal:

The deed conveys the surface, but in express terms reserves the right to remove all the coal under the same, and the grantee [the surface owner] takes the premises with the risk, and waives all claim for damages that may arise from mining out the coal. (*Penn Coal*, p. 412).

The surface owners argued that, whatever rights the coal company may have had, they had been superseded by the Kohler Act. The Mahons asked the court to grant an injunction against Pennsylvania Coal.

The Court of Common Pleas refused to grant the injunction, finding that the Kohler Act was unconstitutional; but the Supreme Court of the State ruled in favor of the surface owners. Finally, the case, *Pennsylvania Coal Co. v. Mahon, et al.*, 260 U.S. 393, 67 L Ed 322, 43 S Ct 158, 28 ALR 1321, came before the United States Supreme Court. It was argued on November 14, 1922, and decided December 11, 1922. *Penn Coal* remains a landmark case because of the complexities involved, the rule developed to establish the limits of the state regulation, and the compelling debate between Justices Oliver Wendell Holmes and Louis Brandeis.

Although a number of subsidiary issues were discussed (including impairment of contracts and due process extending to the states), the crux of the case centered on how far the state can regulate a property right before it becomes a “taking” requiring, per the Fifth Amendment, just compensation:

No person shall . . . be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation. (U.S. Constitution, Amendment V)

In *Mugler v. Kansas*, 123 U.S. 623 (1887), the Supreme Court upheld a state statute prohibiting the manufacture and sale of intoxicating beverages. Mugler’s claim that the state had unconstitutionally taken his property (since his brewery had been made virtually worthless) was rebuffed by Justice Harlan’s argument that the state holds certain police powers:

It belongs to that department [the legislative branch of government] to exert what are known as the police powers of the State, and to determine, primarily, what measures are appropriate or needful for the protection of the public morals, the public health, or the public safety. (*Mugler*, p. 623).

In *Penn Coal*, however, Justice Holmes made clear that the Constitution places limits on the state’s police powers:

As applied to this case the statute is admitted to destroy previously existing rights of property and contract. The question is whether the police power can be stretched so far.

Government hardly could go on if to some extent values incident to property could not be diminished without paying for each and every such change in the general law. As long recognized, some values are enjoyed under an implied limitation and must yield to the police power. But obviously the implied limitation must have its limits, or the contract and due process clauses are gone. One fact under consideration in determining such limits is the extent of the diminution. When it reaches a certain magnitude, in most if not in all cases there must be an exercise of eminent domain and compensation to sustain the act. . . .

The general rule at least is, that while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking. (*Penn Coal*, pp. 413 and 415)

Holmes' Majority Opinion:

For Holmes and the majority, all that remained was to determine whether the Kohler Act had reached that “certain magnitude,” had gone “too far.” In applying the rule, Holmes offered the following pieces of evidence to be placed on each side of the scale:

- The extent of the public interest is rather limited because (1) the Kohler Act protects a single or a few private houses and (2) it does not apply to land where the three estates are held by one owner (see Section 6 of the Kohler Act, described above). For Holmes, simply put, “The damage is not common or public.” (*Penn Coal*, pp. 413) In addition, the government’s laudable desire to protect the health and safety of the public could be provided for by notice. “Indeed,” wrote Holmes, “the very foundation of this bill [in equity—by which the Mahons first sued] is that the defendant gave timely notice of his intent to mine under the house.” (*Penn Coal*, p. 414)

- Balanced against these seemingly weak arguments in favor of the Act, Holmes saw large sacrifice, “On the other hand the extent of the taking is great.” (*Penn Coal*, p. 414). The Kohler Act destroys a valuable estate in land and previously existing contracts. Holmes is not swayed by claims that the coal has not actually been taken,

What makes the right to mine coal valuable is that it can be exercised with profit. To make it commercially impracticable by requiring the surface land to remain undisturbed to mine certain coal has very nearly the same effect for constitutional purposes as appropriating or destroying it.” (*Penn Coal*, p. 414)

Given the values imputed to the countervailing weights, it is easy to see how the majority arrived at their decision to rule the Kohler Act an unconstitutional taking. The Court did not deny the Pennsylvania legislature’s conviction that an exigency existed, but suggested that the appropriate way to correct the problem would be through the exercise of eminent domain:

We are in danger of forgetting that a strong public desire to improve the public condition is not enough to warrant achieving the desire by a shorter cut than the constitutional way of paying for the change. (*Penn Coal*, p. 416)

Brandeis’Dissent:

Justice Brandeis wrote a dissent that focused on what he believed were the reasonable restrictions enacted by the state in its efforts to protect the public health and safety. He performs the same kind of weighing of alternatives as the majority, except he gives far different values to the particular items.

- Although it is true that the restrictions inherent in the Kohler Act impair previously existing property rights, the extent of the state’s interference is not that great:

The restriction here in question is merely the prohibition of a noxious use. The property so restricted remains in the possession of its owner. The State does not appropriate it or make any use of it. The State merely prevents the owner from making a use which interferes with the paramount rights of the public. Whenever the prohibited use ceases to be noxious—as it may because of further change in local or social conditions—the restriction will have to be removed and the owner will again be free to enjoy his property as heretofore. (*Penn Coal*, p. 417)

In a further effort to convince his brethren that the resulting diminution in value is rather small, Brandeis argues that we should consider the loss from the perspective of the entire parcel of land: “But I suppose no one would contend that by selling his interest above one hundred feet from the surface he could prevent the State from limiting, by the police power, the height of structures in a city.” (*Penn Coal*, p. 419). Thus, for Brandeis, the Kohler Act is a relatively minor inconvenience for the coal companies, especially when viewed relative to the entire parcel of land.

- Balanced against the small cost imposed by the Act, Brandeis sees huge gains in terms of the state’s interest in protecting public safety and health. He sees the Kohler Act as an obvious attempt by the state to control a noxious use:

If by mining anthracite coal the owner would necessarily unloose poisonous gasses, I suppose no one would doubt the power of the State to prevent the mining, without buying the coal fields. And why may not the State, likewise, without paying compensation, prohibit one from digging so deep or excavating so near the surface, as to expose the community to like dangers? (*Penn Coal*, p. 418)

Unlike the majority, Brandeis saw the Kohler Act as a perfectly reasonable response to the harm inflicted on surface lands by the underground mining of coal. As such, the Kohler Act was an appropriate application of the state’s police powers.

Postscript:

With the Kohler Act ruled unconstitutional, the situation reverted to the *status quo ante*. This meant that coal companies could continue mining coal wherever they had property rights to the coal and the Support Estate (or barrier pillar). Owners of only the surface rights were seemingly out of luck. In an interesting twist to the story, however, the New York *Times* of December 11, 1922 reported that:

Notwithstanding the decision of the Supreme Court in the Kohler act [*sic*], the Lehigh Valley Coal Company will continue its policy of repairing and restoring all property damaged by mining operations conducted by it, President J. M. Humphrey announced tonight . . . ‘The company has always repaired the property so damaged or recompensed the owner, and despite today’s decision that policy will be continued.’

Thus, for public relations or other reasons, coal companies saw it worthwhile to compensate surface owners even though they had no legal obligation to do so. Apparently, the true purpose of the litigation was to establish clearly the coal company's property rights in the state of Pennsylvania. They would maintain these rights until the U.S. Supreme Court revisited the issue in 1987.

2.3.3 *Keystone Coal v. DeBenedictis* (1987)

Of course, the Court's 1922 *Penn Coal* decision did not make the conflicting resource use problem go away. The state of Pennsylvania continued its efforts to mitigate the dangers inherent in the mining of coal. With respect to the persistent problems of cave-in and collapse of surface lands, the legislature passed P.L. 31, commonly known as the Bituminous Mine Subsidence and Land Conservation Act (or Subsidence Act), on April 27, 1966, and amended it on October 10, 1980 (under P.L. 874).

In substance, the Subsidence Act is remarkably similar to the Kohler Act. The law prohibits the mining of coal "so as to cause damage as a result of caving-in, collapse, or subsidence" to a series of different kinds of structures or dwellings. Legal coal mining would require that the company leave sufficient barrier pillars to prevent subsidence—regardless of whether or not the surface owner holds the Support Estate—and, should subsidence occur, the company would repair the damage or compensate the surface owner.

Unlike the Kohler Act, however, the Subsidence Act expressly states in the Title and Purpose of the Act "the existence of a public interest in the support of surface structures." The Subsidence Act posits that previous laws have "failed to protect the public interest," "damage from mine subsidence has seriously impeded land development . . . and has caused a very clear and present danger to the health, safety and welfare of the people." The Act also notes that, "In the past, owners of surface structures have not in many instances received adequate notice or knowledge regarding subsurface support." Finally, the Subsidence Act makes no exception for situations in which the three estates are held by the same person. Companies are everywhere, strictly prohibited from mining coal such as to cause subsidence.

Individual coal companies and an industry association argued that the state law violated the Fifth Amendment and the Contract Clause and, thus, sued Nicholas DeBenedictis (Secretary of the Pennsylvania Department of Natural Resources). They lost in the U.S. District Court for the Western District of Pennsylvania and the

U.S. Court of Appeals for the Third Circuit. The U.S. Supreme Court then agreed to hear *Keystone Bituminous Coal Association, et al. v. Nicholas DeBenedictis*.

On March 9, 1987, in a 5-4 decision, the U.S. Supreme Court held that Pennsylvania's Subsidence Act neither constituted a "taking" of property under the Fifth Amendment nor a violation of the contracts clause. Joining in Justice Stevens' opinion were Justices Brennan, White, Marshall, and Blackmun. Chief Justice Rehnquist (joined by Justices Powell, O'Connor, and Scalia) wrote the dissenting opinion.

Stevens' Majority Opinion:

Of primary importance in reaching a decision in *Keystone Coal* was the *Penn Coal* precedent. The majority argued that the 1922 *Penn Coal* decision was not controlling because of the different facts surrounding the current case: "The Subsidence Act differs from the Kohler Act in critical and dispositive respects." (*Keystone Coal*, pp. 487) According to this view, *Keystone Coal* was distinguished from *Penn Coal* by virtue of two crucial differences: (1) the State showed a substantial public interest in enacting the law and (2) the extent of the alleged taking was not that great. Thus, for the majority, no precedent was overturned and no new rule was elaborated—the decision was simply a matter of using the same tools on a new set of circumstances. For the majority, the "particular facts" at hand showed that:

- With respect to the nature of the public interest, the Subsidence Act "served valid public purposes that the Court had found lacking in the earlier case." (*Keystone Coal*, p. 479) Stevens emphasized that the state of Pennsylvania was acting to arrest various perceived threats to the common welfare and offered as evidence the declarations to this effect in the Subsidence Act itself (see above). He also pointed out that the offending exception in the Kohler Act (by which the statute did not apply to land where the three estates were owned by the same person) had been removed. Finally, Stevens was impressed by Pennsylvania's claim that timely notice was not enough to protect the wide variety of public and environmental interests targeted by the Subsidence Act.

• As for the “extent of the taking” involved, the majority felt this was relatively small because the surface support was “one strand” in the total bundle of rights and Keystone Coal failed to show substantial financial loss. At trial court, the parties stipulated that the Subsidence Act’s “sufficient barrier pillar” requirement would force the coal company to leave approximately 27 million tons of coal in place. The majority ruled that this coal should not be viewed in isolation: “The 27 million tons of coal do not constitute a separate segment of property for takings law purposes.” (*Keystone Coal*, p. 498) Properly interpreted, said the Court, this coal is but a mere two percent of the total coal holdings and, thus, a restriction on the use of a portion of a parcel (as in a zoning law setback) is not an unconstitutional taking. The Court recognized the apparently unique nature of Pennsylvania’s Support Estate, but held that this was irrelevant for the purposes of determining whether an unconstitutional taking occurred: “our takings jurisprudence forecloses reliance on such legalistic distinctions within a bundle of property rights.” (*Keystone Coal*, p. 500)

In addition, the majority heard no anguished cries of devastating financial loss. Stevens pointed to the Pennsylvania Coal Company’s alarming statements in their attorney’s brief in which they asserted

that the impact of the statute was so severe that ‘a serious shortage of domestic fuel is threatened.’ . . . The company explained that until the Court ruled, ‘no anthracite coal which is likely to cause surface subsidence can be mined,’ and that strikes were threatened throughout the anthracite coal fields . . . The coal company claimed that one company was ‘unable to operate six large collieries in the city of Scranton, employing more than five thousand men.’” (*Keystone Coal*, p. 482-83 and 498)

In contrast, noted Stevens, the 1987 version of the coal companies’ suit contained no such language. The majority believed that coal mining would continue at reasonable profit levels under the Subsidence Act: “There is no showing that petitioners’ reasonable ‘investment-backed expectations’ have been materially affected by the additional duty to retain the small percentage that must be used to support the structures protected by §4 [of the Subsidence Act].” (*Keystone Coal*, p. 499)

Thus, reaching the same judgment as Brandeis, a majority of the Court saw a substantial public interest clearly dominating a minor restriction on the use of property and found the Subsidence Act a constitutionally valid exercise of the State's police powers.

Rehnquist's Dissent:

Unlike the majority, the minority saw no essential difference between *Penn Coal* and *Keystone Coal* or between the Kohler and Subsidence Acts. Rehnquist emphasized the "strikingly similar" effects of the two acts and expressed a firm belief that any differences between the two cases "verge on the trivial." Accordingly, the factors cited by the majority as tilting the balance in favor of the state of Pennsylvania and allowing them to distinguish *Keystone* from *Penn Coal* are dismissed by Rehnquist, who maintains that Holmes' judgment remains correct and that the Court is overturning an important precedent:

- Pennsylvania's public interest is as clear in the Subsidence Act as it was in the Kohler Act. For Rehnquist, this merely meets a prerequisite for the exercise of the police powers. He, unlike the majority, is not particularly impressed by the wording of the Subsidence Act itself. Rehnquist argues that the Kohler Act contained similar language (e.g., "remedial legislation, designed to cure existing evils and abuses") that made it obvious that it was meant to serve a public purpose. He concludes that "The public purposes in this case are not sufficient to distinguish it from Pennsylvania Coal." (*Keystone Coal*, p. 511)

- The minority also disagreed with the majority's estimate of the "extent of the taking." Rehnquist rejects the majority's claim that the "mere" 27 million tons of coal do not constitute a separate segment of property: "There is no question that this coal is an identifiable and separable property interest." (*Keystone Coal*, p. 517) For Rehnquist, the "one strand in the bundle" argument does not apply because, as Holmes pointed out, "the right to coal consists in the right to mine it." In addition, since the surface support right has been actively traded and recognized as a separate property right, the Subsidence Act, in the minority's opinion, is unconstitutional:

[The Subsidence Act] extinguishes the petitioners' interest in their support estates, making worthless what they purchased as a separate right under Pennsylvania law . . . this complete interference with a property right extinguishes its value, and must be accompanied by just compensation. (*Keystone Coal*, p. 517)

Thus, the 1987 *Keystone Coal* case was notable for shifting balances: Brandeis' minority position in 1922 became the view of a majority of the Court; the public interest loomed larger, while the extent of the taking seemingly diminished; and, finally, the value of underground coal vis-à-vis the surface rights dwindled. This last shifting balance plays a major role in the application of Pigovian and Coasian logic to coal mining law and, thus, merits closer inspection.

2.4 The Change in Coal and Property Values in the 20th Century

As indicated by Stevens' majority opinion, the Court felt there had been a substantial increase in the public interest and a similar decrease in the harm imposed by the state's regulation of subsidence. The tremendous structural shocks that buffeted Pennsylvania's coal industry from 1922 to 1987 played a prominent role in forming the majority's perception and are a crucial factor in the Pigovian and Coasian analyses of Pennsylvania coal mining law.

Perhaps the most obvious change in the U.S. coal industry during this century is the discovery and utilization of vast coal deposits in the Western states. Table 1 shows that, as of January 1, 1991, Western states held over one-half of the demonstrated coal reserves. Pennsylvania still holds substantial coal deposits (including almost all of the anthracite coal in the United States), but as Table 1 clearly indicates, the vast majority of Pennsylvania coal is underground.

TABLE 1: Coal Demonstrated Reserve Base, January 1, 1991
(Billion Short Tons)

Region and States	Total		
	Underground	Surface	Total
Appalachian			
Alabama	1.5	3.3	4.8
Eastern Kentucky	7.4	1.6	9.0
Ohio	12.8	5.7	18.5
<i>Pennsylvania</i>	<i>27.8</i>	<i>1.3</i>	<i>29.1</i>
Virginia	1.9	0.7	2.6
West Virginia	32.3	4.8	37.1
Other	1.2	0.4	1.6
Total	84.9	17.8	102.7
Interior			
Illinois	62.8	15.4	78.2
Indiana	8.9	1.3	10.2
Western Kentucky	16.5	3.8	20.3
Other	4.8	20.3	25.1
Total	93.1	40.7	133.8
Western			
Alaska	5.4	0.7	6.1
Colorado	12.1	4.8	16.9
Montana	71.0	49.0	120
Wyoming	42.5	25.5	68
Other	9.5	12.9	22.4
Total	140.5	92.9	233.4
U.S. Total	314.4	108.9	469.9

Source: *Annual Energy Review 1991*, Table 49, p. 109

Notes: Sum of components may not equal to total due to independent rounding.

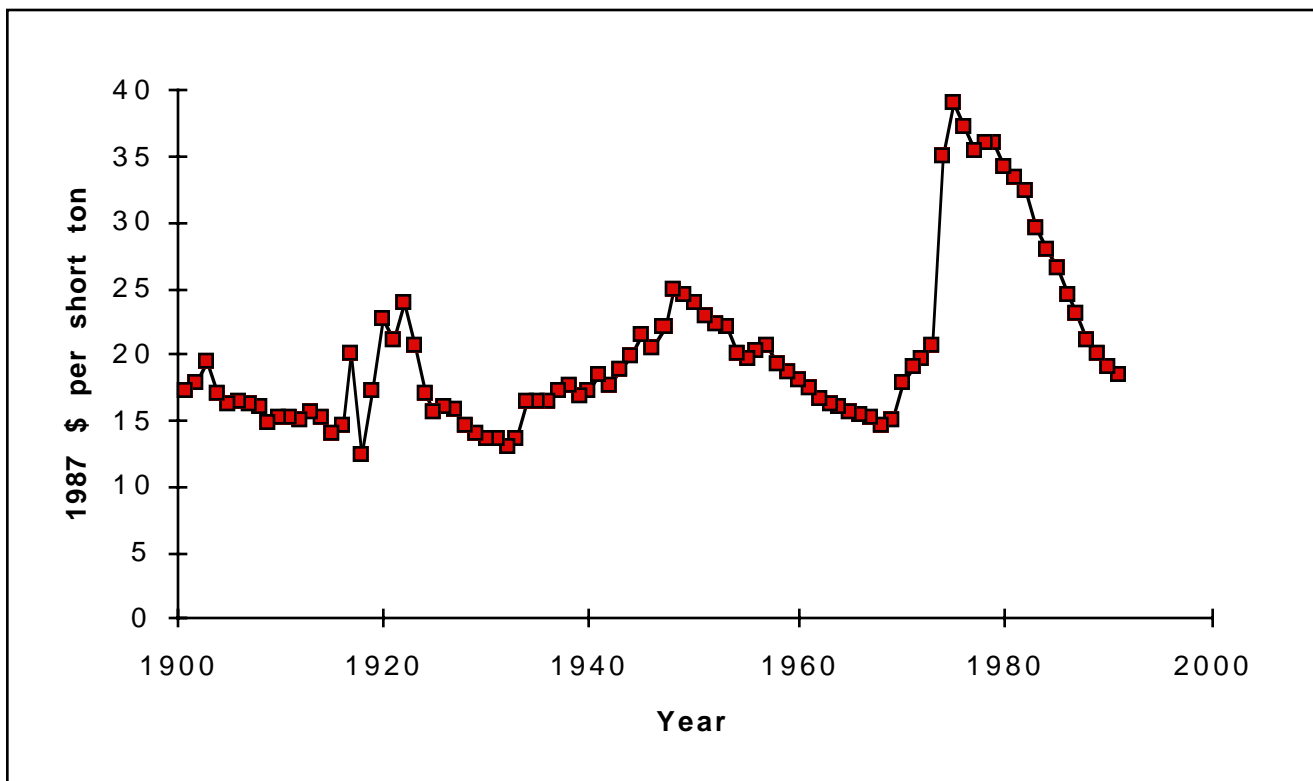
Not only does the West hold much coal, “most of the coal has a low sulfur content and a good deal of it [92.9 billion short tons or 40 percent of Western, demonstrated reserves] is close enough to the surface for strip mining.” (Atwood, p. 55). These two factors give strip mined, Western coal a decided edge over the Pennsylvania, underground competition because the relatively recent realization of acid rain pollution makes low sulfur, Western coal more environmentally attractive. Furthermore, not only is Western coal less damaging to the environment, technological advances in strip mining have boosted productivity well above that of underground mining:

In 1991, average productivity in all mines (excluding anthracite) reached an all-time high [at that time] of 4.1 short tons per miner hour. That year, productivity of underground mines (excluding anthracite) was 2.7 short tons per miner hour and productivity of surface mines (excluding anthracite) was 6.5 short tons per miner hour. (Annual Energy Review 1991, p. 191)

Not surprisingly, higher coal mining productivity, especially from strip mined coal, has led to falling coal prices:

FIGURE 1: Real Bituminous Coal and Lignite Prices, 1901-1987

(1987 \$ per short ton, f.o.b. mine)



Sources: *Annual Energy Review 1991*, Table 90, p. 203;

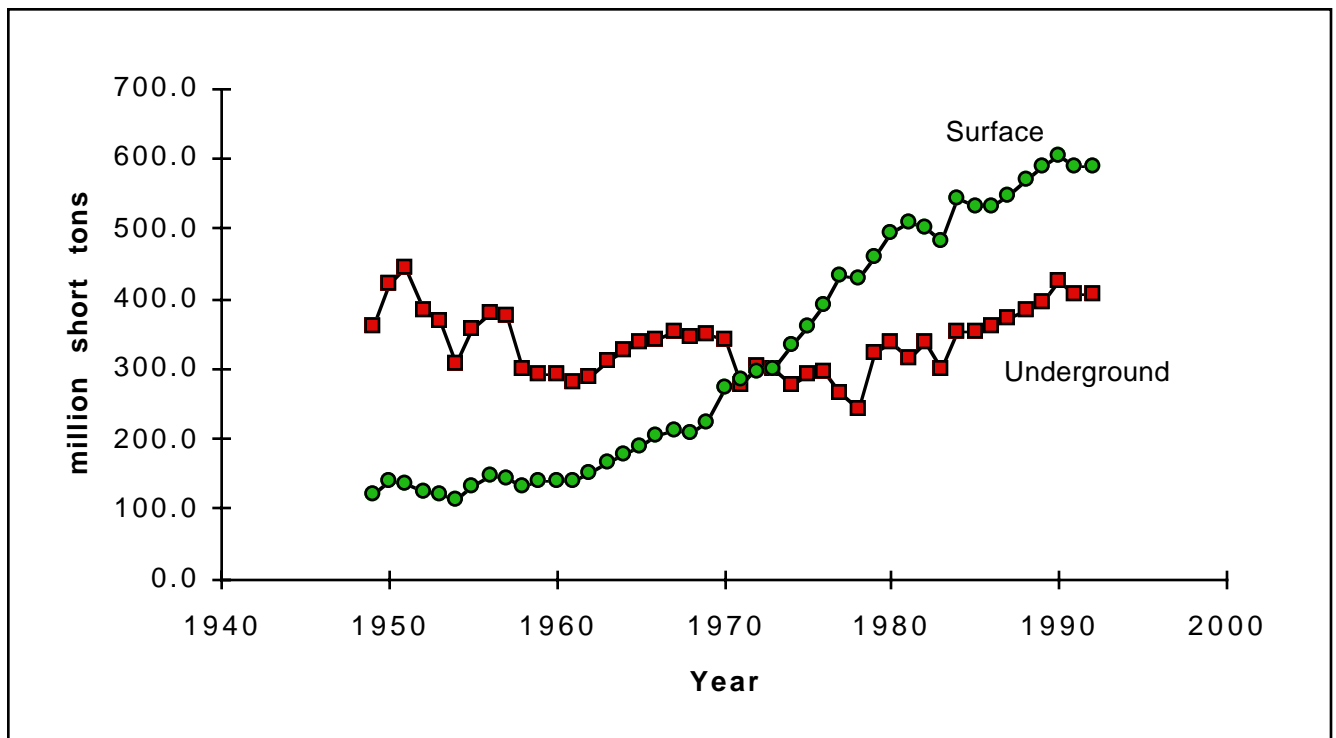
Historical Statistics of the United States: Colonial Times to 1970, Series E-1 and M-96; and
Economic Report of the President 1995 Table B-3, p. 278.

Notes: Real price calculated using Implicit Price Deflator for GDP

As Figure 1 shows, after a discontinuous jump in real coal prices due to the 1973 Arab oil embargo, the real price of bituminous coal and lignite (in 1987 dollars) fell every year from 1978 through 1991 to \$18.49 per short ton. This compares with a real price of \$23.95 per short ton in 1922.

The combination of technological advances in the reclamation of strip mined land, the lower pollution caused by Western coal, and the recent decline in coal prices (due in part to the higher productivity of strip mined, Western coal) has caused major readjustments in Pennsylvania's (and the rest of Appalachia's) underground coal mining industry. In terms of production by mining method, surface mining passed underground mining in the early 1970s and continues to extend its lead.

FIGURE 2: Coal Production by Mining Method, 1949-1992
(million short tons)



Source: *Annual Energy Review 1991*, Table 84, p. 191

But perhaps nowhere is the pressure exerted by strip mined, Western coal more evident than in the absolutely stunning employment statistics. From 1950 to 1992,

Pennsylvania saw coal mining employment drop 86 percent as 93,200 jobs dwindled to 12,659. In fact, Appalachia's coal mining disaster has come, not from mining accidents and disease, but from economics—substitution, technological change, and competition.

Against this backdrop of a greatly decreased need and importance of underground, Pennsylvania coal, the increases in population and surface structures must be added. It is rather obvious that subsidence of surface land in Pennsylvania would create far greater harm today than in 1922. Not only does higher population density increase the value of surface land, but the environmental impact of underground coal mining is much better understood and measured.

Thus, there is little doubt that, in comparison to 1922, there has been an enormous change in the value of underground Pennsylvania coal vis-à-vis the surface and its structures. Strip mined, Western coal is environmentally safer to use, cheaper to produce, and in abundant supply; while the proliferation of surface structures and heightened environmental awareness contribute to the increased damage caused by subsidence.

2.5 Conclusion

During most of this century, Pennsylvania has struggled with the conflicting resource use problem posed by the underground mining of coal. It is a problem with no easy technological solution—remove the coal and the surface sinks. The 1921 Kohler Act was ruled an unconstitutional taking of property in *Penn Coal v. Mahon* (1922). More recently, however, the U.S. Supreme Court held, in *Keystone Coal v. DeBenedictis* (1987), that the Subsidence Act was a valid exercise of the state's police powers. By examining the majority and dissenting opinions in these landmark cases, the complexity of the issues involved and the various arguments presented are better understood. Finally, a cursory glance at the U.S. coal industry during this century showed a marked decline in the importance of underground, Pennsylvania coal and a

corresponding increase in the harm resulting from subsidence. These lessons will be useful as we turn to the Pigovian and Coasian solutions to the problem.

3.0 Pigou and Coase on Pennsylvania Coal Mining Law

3.1 The Question Posed

Given the conflicting resource use problem presented in the case of Pennsylvania coal mining law, the question is:

How would Pigou and Coase analyze this particular problem?

The answer is that they would, first, set up an environment in which individual, optimizing behavior would lead to the right answer. Were this to fail to optimally allocate resources, they would then explore other ways to reach the right answer, choosing the best available alternative.

Thus, unlike the orthodox interpretation of Coase and Pigou (which Coase himself helped create), this paper stresses the similarities inherent in the Pigovian and Coasian solutions. As such, it is in agreement with DeSerpa's finding of "astounding parallels between the roads over which they travelled" and his conclusion that:

Despite radical differences in emphasis and method, [Pigou and Coase] cover the same territory and draw virtually identical conclusions. They are complementary and without mutual contradiction. (DeSerpa], p. 28)

Unlike DeSerpa and other treatments of Pigou versus Coase, however, here the comparison is applied to a particular situation, i.e., conflicting resource use in Pennsylvania coal mining. By focusing on a concrete case, it will enable a better understanding of the Pigovian and Coasian analyses of conflicting use problems.

3.2 A Pigovian Analysis of Pennsylvania Coal Mining Law

3.2.1 Framing the Problem

The starting point of the Pigovian analysis of any conflicting use problem is the notion that there is a resource allocation problem that can be optimally solved. In *Wealth and Welfare* (1912), *The Economics of Welfare* (originally published in 1920, last reprint of 4th revised edition in 1962), *A Study in Public Finance* (originally published in 1928, last reprint of 3rd revised edition in 1960), and various other sources, Pigou made clear that society was faced with the choice of how to allocate scarce productive resources to competing ends. The ultimate goal, for Pigou, was to maximize total social welfare. In practical terms, this reduced to maximizing economic welfare, “that part of total welfare which can be brought directly or indirectly into relation with a money measure” and whose “objective counterpart economists call the national dividend or national income.” (Pigou (1962), p. 31)

Pigou was concerned about the channeling of “real” factors of production to their best uses. He saw particular configurations of factors of production as yielding a measurable worth of total output and sought that arrangement that generated a maximum value. Pigou’s emphasis on the “real economy” formed the basis of John Maynard Keynes’ disagreement with what Keynes called the “classical school:”

The conviction, which runs, for example, through almost all of Pigou’s work, that money makes no real difference except frictionally and that the theory of production and employment can be worked out (like Mill’s) as being based on ‘real’ exchanges with money being introduced perfunctorily in a later chapter, is the modern version of the classical tradition. (Keynes, pp. 19-20)

Once Pigou framed the problem as the allocation of real factors of production to maximize the total value of output, he was able to describe characteristics indicative of an optimal configuration and to define deviations from this optimal solution as inefficient. A crucial part of the analysis was the concept of changes in output resulting from a movement of resources from one use to another and, therefore, Pigou took great pains to define carefully marginal net product as

the difference between the aggregate flow of product for which that flow of resources, *when appropriately organised*, is responsible and the aggregate flow of product for which a flow of resources differing from that flow by a small (marginal) increment, *when appropriately organised*, would be responsible. (Pigou (1962), p. 132)

Pigou then drew a distinction between social and private marginal net product.

The marginal social net product is the total net product of physical things or objective services due to the marginal increment of resources in any given use or place, no matter to whom any part of this product may accrue. It might happen, for example, as will be explained more fully in a later chapter, that costs are thrown upon people not directly concerned, through, say, uncompensated damage done to surrounding woods by sparks from railway engines. All such effects must be included—some of them positive, others negative elements—in reckoning up the social net product of the marginal increment of any volume of resources turned into any use or place. . . . The marginal private net product is that part of the total net product of physical things or objective services due to the marginal increment of resources in any given use or place which accrues in the first instance—*i.e.* prior to sale—to the person responsible for investing resources there. In some conditions this is equal to, in some it is greater than, in others it is less than the marginal social net product (Pigou (1962), pp. 134-35)

In a first pass through the problem, assuming no costs of resource movement, Pigou noted that a necessary condition for a maximum is that the marginal social net product (MSNP) of each resource employed in any use or place be exactly equal. Were resources to be distributed so that the MSNP of each factor of production was unequal, the total value of output could be increased by moving resources from uses with lower MSNP to those with higher MSNP. This straightforward application of the equimarginal principle is the key to Pigou's analysis.

The natural extension to the notion of an ideal, global optimum is consideration of impediments that block the realization of the best possible result. Starting from a decentralized system in which self-interested resource owners make decisions concerning the employment of their labor and capital, Pigou presented a framework that paired “obstacles to free movement” and divergence of private from social

marginal net product as two fundamental elements that prevent resources from flowing to their best uses.

Obstacles to free movement are composed of costs of movement and imperfect knowledge. For Pigou, costs of movement include not only the payments to the agents who transport factors of production from one place to another (“promoters, financing syndicates, investment trusts, solicitors, bankers, and others” (Pigou (1962), p. 158)), but also the imperfect divisibility of productive resources. DeSerpa points out that Pigou’s costs of movement can be broadly interpreted to include transactions costs of every type (principal-agent, holdout, and similar problems): “What Alchian and Demsetz (1972) called transactions costs are directly related to Pigou’s costs of movement!” (DeSerpa (1993), p. 36)¹

When the assumption of no costs of movement is relaxed, Pigou modifies the optimal solution to be one in which the MSNP of each resource diverges by less than the cost of movement. Obviously, if the gain from driving two MSNPs to equality is outweighed by the cost of the movement, then such a move is inefficient. Thus, in the presence of costs of movement, a given configuration might show some inequalities in MSNP yet may be

the best arrangement, not indeed absolutely, since if there were no costs, a better arrangement would be possible, but *relatively to the fact of the initial distribution and the existing costs of movement*. (Pigou (1962), p. 138, footnote omitted)²

¹It would seem more correct, however, to consider Pigou’s overarching category, “obstacles to free movement,” which encompasses both costs of movement and imperfect knowledge, as the appropriate counterpart to today’s “transactions costs.”

²Pigou also discusses second order conditions and considers the implications of several local maxima. He offers the possibility that State action might be “justified” if it could “jerk the industrial system out of its present poise at a position of relative maximum, and induce it to settle down again at the position of absolute maximum—the highest hill-top of all.” (Pigou (1962), p. 141) Later, however, he adds that worries about relative versus global maxima are a “secondary matter.” (Pigou (1962), p. 143)

After discussing how imperfect knowledge can, like costs of movement, prevent the attainment of an optimal resource allocation, Pigou turns to the issue of divergence between private and social marginal net products. This point will be analyzed carefully below, but it is important to note here that Pigou sees obstacles to movement and divergence of private and social net product as separate, but possibly concurrently operating factors, either of which may be manipulated by the State in order to effect an improved allocation of resources.

For Pigou, the problem facing society is one of allocating resources so that the total value of output is maximized. He makes extensive use of the “flowing resources” metaphor:

A flowing stream of resources is continually coming into being and struggling, so far as unavoidable costs of movement allow of this, to distribute itself away from points of relatively low returns towards points of relatively high returns. (Pigou (1962), p. 149)

A clear signal of the performance of any observed configuration of resources is the marginal social net product of each resource. There is an answer to society’s resource allocation problem and, thus, deviation from optimality cannot only be judged inadequate, it can be improved.

3.2.2 The Case for the Market

Armed with the objective of maximizing total value of output, the focus on observing real factors of production, the logical tool of marginal product, and the awareness of obstacles to movement and divergences of private and social product, Pigou set about judging how well a market system performs. Pigou considered the market allocation mechanism as the default scheme and was interested in comparing the optimal resource configuration to that yielded by the market system.

Pigou thought it a settled matter that the market system often generated an optimal solution and, thus, did not spend much time or effort explaining this result. Self-

interested resource owners, unhampered by ignorance, seeking to maximize their private returns, will allocate resources so that marginal private net products will everywhere deviate by less than the costs of movement and, thus, the sum total of returns will attain a maximum. If private and social product are equivalent, the free play of self-interest yields a socially optimal allocation.

3.2.3 The Case for Improving Upon the Market System

Unlike the “optimistic followers” of the “classical school” who believed that markets would “naturally” or “automatically” produce a socially optimal result “if only Government refrains from interference,” Pigou pointed out that “even Adam Smith himself” recognized the need for “an organised system of civilized government and contract law.” (Pigou (1962), p. 127-28) So the invisible hand, the spontaneous order, and the self-organized, emergent pattern that are touted as congruent with a socially optimal configuration is *not* a routine outcome of every decentralized system. On the contrary, human institutions and rules have evolved “to the end of directing self-interest into beneficial channels.” (Pigou (1962), p. 129) There is no reason to reject out of hand “Government interference” because Government is already intimately involved in the system. Once this point is understood, the Pigovian’s question becomes, “Have we used Government in an optimal fashion?”

For Pigou, Government sets the rules to which the agents respond. Pigou advocated State action in selective and studied ways. He did not propose direct government control of individual agents; instead, he saw government providing the necessary incentives, carrots or sticks, that would improve upon the current allocation of resources. It is of utmost importance that the reader be made aware of Pigou’s continued reliance on individual ownership and control of resources by self-interested agents.

Returning to his framework of deviations from an ideal, global optimum being caused by obstacles to movement and divergences of private from social product, he argued

that decreases in either of these factors would improve economic welfare. In successive chapters in *The Economics of Welfare*, he patiently described how decreases in obstacles to movement due to improved information or lower costs of movement could be effected by manipulating the rules of the market game. For example, Pigou sees the development of stock exchanges as an ingenious way to make capital more finely divisible. This lowers the costs of movement of capital because it can flow more perfectly, to continue Pigou's metaphor, into ever smaller streams and tributaries. But with regard to inefficiency caused by imperfect knowledge, Pigou cites securities regulations as an appropriate means of combating fraud and the associated misallocation of resources because they

check the fraudulent exploitation of incompetent investors by dishonest professionals [and, thus,] tend *pro tanto* to diminish the range of error to which the general mass of operative forecasts made in the community is liable. (Pigou (1962), p. 154)

His view of a stock exchange and the government regulatory apparatus surrounding it shows how Pigou saw the market system—a decentralized group of self-interested resource owners making decisions about the use of their factors of production under a set of rules designed to channel those resources to their highest valued uses.

When Pigou turns his attention to the second main category which leaves a socially inefficient allocation, the divergence of private and social returns, he simply applies the same set of ideas.

Subject to costs of movement, self-interest will tend to bring about equality in the values of marginal private net products of resources invested in different ways. But it will not tend to bring about equality in the values of the marginal social net products except when marginal private net product and marginal social net product are identical. When there is a divergence between these two sorts of marginal net products, self-interest will not, therefore, tend to make the national dividend a maximum; and, consequently, certain specific acts of interference with normal economic processes may be expected, not to diminish, but to increase the dividend. (Pigou (1962), p. 154)

Uncompensated services or disservices cause divergences between private and social product that are “bound to lead to maladjustments.” In such cases,

it is always possible, on the assumption that no administrative costs are involved, to correct them by imposing appropriate rates of tax on resources employed in uses that tend to be pushed too far and employing the proceeds to provide bounties, at appropriate rates, on uses of the opposite class. (Pigou (1960), p 99)

There is no need to go into further detail because the immense externality literature explores the conditions under which “appropriate” tax/subsidy schemes will correct the “maladjustment.” The point here, however, continues to be that Pigou saw tax/subsidy manipulations as one way to improve the incentive structure of the system. Agents maintain control of their resources and follow their self-interest in generating a configuration of resource uses. For this reason, taxes and subsidies are merely one of a myriad of incentive-altering options available. Pigou cites penalties in contracts or threat of lawsuit, for situations in which the parties are in direct contact, as other ways of closing the gap between private and social product. When it is difficult to exact payment for services or damages to other parties, Pigou sees the Government as the means by which the rules can be rewritten to better align private and social marginal net products. In the case of patents, “By offering the prospect of reward for certain types of invention they do not, indeed, appreciably stimulate inventive activity, which is, for the most part, spontaneous, but they do direct it into channels of general usefulness.” (Pigou (1962), p. 185, footnote omitted)

In some cases, the divergence of private and social product may be so pathological, e.g., fraudulent advertising or adulterated products, because from the first dose the MSNP is negative, that absolute prohibition is required. And, finally, when other remedies have been exhausted, there may be certain cases in which direct government intervention, “either by the exercise of control over concerns left in private hands or by direct public management” (Pigou (1962), p. 329) may be necessary in order to maximize the national dividend. In these extreme cases, Pigou warns that we should not proceed,

until we have considered the qualifications which governmental agencies may be expected to possess for intervening advantageously. It is not sufficient to contrast the imperfect adjustments of unfettered private enterprise with the best adjustment that economists in their studies can imagine. For we cannot expect that any public authority will attain, or will even whole-heartedly seek, that ideal. Such authorities are liable alike to ignorance, to sectional pressure and to personal corruption by private interest. (Pigou (1962), p. 332)³

Consistent with his focus on maximizing the national dividend, Pigou warned against blind application of every conceivable rule that could lower the obstacles to movement or close the gap between private and social marginal net product. The gains from the proposed incentive must be weighed against the costs of implementation:

Of course, in real life considerable administrative costs would be incurred in operating [tax/subsidy] schemes of this kind. These might prove so large as to outweigh the benefit even of the *optimum* scheme, and, *a fortiori*, of the others. (Pigou (1960), p. 100)

3.2.4 Pigou's Analysis Applied to Pennsylvania Coal Mining Law

Applying Pigou's analysis to the conflicting resource use problem seen in Pennsylvania coal mining is not difficult; whether or not this is what Pigou himself would have said is, of course, impossible to determine. The conclusion here is that Pigou would have sided with Holmes in the 1922 *Penn Coal* case, then reversed himself and sided with Stevens in *Keystone Coal* (1987). The foundation of this inference lies in Pigou's unwavering advocacy of policies designed to maximize the total value of output and his view that current system-wide rules can and should be changed if the gains outweigh the costs.

³Although it is true that he held out hope for "enlightened" Government staffed by "experts," those who are sure Pigou represents Leviathan and leads the forces of Utopian Government Control would do well to note the tone and content of the above quotation.

When reminding the reader that “even Adam Smith himself” recognized the need for rules and institutions under which the market game was to be played, Pigou mentions that the State enacts prohibitions against theft and prevents enforcement of many contracts, including, for example, gambling debts and contracts in restraint of trade.

These kind of coercive legal devices for directing self-interest into social channels is well illustrated by the limitations which some civilised States impose upon the absolute powers of owners of property— such limitations as the Bavarian rule forbidding owners of forests to exclude pedestrians from their land, the French and American rules restraining a man from setting fire to his own house, and *the practice prevalent in all countries of expropriating private owners where their expropriation is urgently required in the general interest.* (Pigou (1962), p. 129, emphasis added)

Obviously, Pigou sees nothing sacrosanct about the rules of property in any particular place or time. They are subsets of the various regulations and laws that society uses to channel resources optimally. As such, they become part of the menu from which society can choose to create the best climate for the market system.

When arguing that Government has available to it a variety of incentive measures and schemes to improve upon an observed configuration of resources, Pigou points out that society might change the rules of real estate ownership in order to provide a better environment for the free play of self-interest:

It is as idle to expect a well-planned town to result from the independent activities of isolated speculators as it would be to expect a satisfactory picture to result if each separate square inch were painted by an independent artist. No ‘invisible hand’ can be relied on to produce a good arrangement of the whole from a combination of separate treatments of the parts. . . . In this [zoning] Act, for the first time, control over individual buildings, from the standpoint, not of individual structure, but of the structure of the town as a whole, was definitely conferred upon town councils. (Pigou (1962), p. 195)

It seems fairly clear then, that Pigou would not be distressed by limiting the sphere of legally-sanctioned actions by a property owner nor by changing the rules if circumstances warranted it. Thus, in 1922, faced with evidence concerning the loss of valuable coal deposits in favor of the Mahon’s home, Pigou would agree with the

side that enabled the coal to be mined. On the other hand, the changed landscape of 1987 would dictate that owners of coal deposits and the Support Estate lose the right to mine coal so as to cause subsidence.⁴

Perhaps Pigou would use his divergence of private from social marginal net product to illustrate the effect of the discovery of low sulfur, strip mined, Western coal. In 1922, Pennsylvania Coal might not incorporate, according to Pigou, the full marginal cost of its mining activities. However, the divergence of private from social marginal net product is relatively small—too small to justify government intervention. By 1987, the private marginal net product of resources devoted to mining underground Pennsylvania coal is much, much higher than its marginal social net product (which, when environmental factors are counted, may actually be negative). Although a range of rules would accomplish the desired result, i.e., the prevention of mining so as to cause subsidence and loss of valuable resources, expropriating the Support Estate is a reasonable solution.

Maintaining the decision-making power in the hands of coal producers, under varying institutional arrangements, would strike Pigou as an ideal solution. Like taxes and subsidies that induce socially optimal decisions, court-established demarcations of rights of action are an appropriate way to create an environment that leads self-interested individuals to maximize the total value of output.

From Pigou's perspective, the history of Pennsylvania coal mining law would be an excellent example of how the rules must be changed in order to accommodate changes in production processes and discoveries of new resources. He would also point to the fact that, left alone, the free play of self-interest is sometimes unable to adjust optimally to exogenous shocks and this provides the opportunity for the Government to play an important role in maximizing the value of output.

⁴Of course, the crucial legal issue in the coal cases is not whether the State can change existing property rights, but whether it should pay for the change. This introduces distributional complications and makes guessing what Pigou would have said much more difficult.

3.2.5 Conclusion

Pigou's view of the economic world has self-interested individuals operating within a given system of institutions and rules of which the Government is a major part. The system works fairly well, according to Pigou, "in the main body of industries," but can improved upon by decreasing obstacles to movement and divergences between private and social cost. Government is responsible, not for the direct control of resources, but for providing an environment which ensures that the free play of self-interest will yield the maximum total value of output. Seen in this context, Pigovian tax/subsidy proposals are merely one of many devices that Government might use, in addition to many already in effect, in order to maximize economic welfare by improving the incentive mechanisms operating in a completely unfettered market. Thus, Pigou's analysis of Pennsylvania coal mining law would support whatever rules led to maximizing the total value of output. As such, he would find the 1921 Kohler Act unconstitutional, then reverse himself and side with the State in 1987.

3.3 A Coasian Analysis of Pennsylvania Coal Mining Law

3.3.1 Framing the Problem

For Coase, the problem under consideration is quickly and easily captured in the often cited and repeated phrase, "The real question that has to be decided is: Should A be allowed to harm B or B be allowed to harm A? The problem is to avoid the more serious harm." (Coase (1960), p. 2) Coase, like Pigou, frames the problem in terms of maximizing the total value of output,

What has to be decided is whether the gain from preventing the harm is greater than the loss which would be suffered elsewhere as a result of stopping the action which produces the harm. (Coase (1960), p. 27)

In a series of examples, Coase starkly contrasts one resource use in conflict with another which forces the decision maker to choose. Cattle stray and crops are damaged—for society, “The nature of the choice is clear: meat or crops.” Firms produce and pollution kills fish—“the question to be decided is, Is the value of the fish lost greater or less than the value of the product which the contamination of the stream makes possible?” (Coase (1960), p. 2) As Coase has said on various occasions, conflicting use problems are no different from other resource allocation problems, no different from a consumer deciding whether to buy this or that, “no different from deciding whether a field should be used for growing wheat or barley.” (Coase (1970), p. 9)

As did Pigou, Coase begins by presenting a description of a resource allocation problem that has an answer. The focus is on real resource uses, optimal configurations of these uses, i.e., those that maximize the total value of output, and judging market generated allocations.

Unlike Pigou, however, Coase emphasized the total, instead of marginal, productivity of an entire system, instead of a single movement of a resource, as the appropriate guide in judging a particular allocation mechanism. In a first pass through the problem, assuming zero transactions costs (which includes clearly delineated property rights), Coase concludes that self-interested individuals will trade resources until all mutually advantageous exchanges are exhausted and, thus, an efficient resource allocation is reached. Instead of Pigou’s “equality of MSNP” litmus test for analyzing an observed pattern of resources, Coase uses what one might call a “comparison of total value of output under different regimes” approach. In essence, Coase accuses Pigou of too narrowly framing the problem:

The question at issue is not whether it is desirable to run an additional train or a faster train or to install smoke-preventing devices; the question at issue is whether it is desirable to have a *system* in which the railway has to compensate those who suffer damage from the fires which it causes or one in which the railway does not have to compensate them. When an economist is comparing alternative social arrangements, the proper procedure is to compare the *total* social product yielded by these different arrangements. The

comparison of private and social products is neither here nor there. . . . The Pigovian analysis shows us that it is possible to conceive of better worlds than the one in which we live. But the problem is to devise practical arrangements which will correct defects in one part of the *system* without causing more serious harm in other parts. (Coase (1960), p. 34, emphasis added)

Thus, Coase is in search of a system-wide framework that maximizes the total value of output. He is not interested in finding specific, particular instances where a carrot or stick or, more likely, direct order or prohibition would slightly improve the overall situation. Coase sees such a government micro-managed, idiosyncratic maze of rules as inefficient.

3.3.2 The Case for the Market

Equipped with a clear problem statement that focuses on the distribution of factors of production so as to maximize total value of output, and a desire to analyze alternative institutional arrangements and rules from a global, system-wide perspective, Coase is ready to tackle the issue of conflicting resource use in a market system.

Coase divides the world into two possible states, then reaches the following conclusion: If transactions costs are zero, conflicting resource use problems will be ideally, perfectly handled by the market system;⁵ on the other hand, conflicting resource use problems, in the presence of positive transactions costs, may benefit from alternative arrangements, but the market system usually will still prove optimal.

Absent transactions costs, it is clear that self-interested resource owners would ensure that every factor of production would be stationed at its highest valued use for any contrary arrangement would imply foregone, mutually advantageous trades (that are costless). Coase used the assumption of zero transactions costs to show that, in such a world, the State needed merely to assign property rights and allow the

⁵As Medema (1994) and others have pointed out, this is merely one of many versions of the Coase Theorem.

invisible hand to generate an emergent, spontaneous order that exactly matched the optimal configuration.

Coase emphasized that the State's proper role in such a world was to make clear who owned exactly what rights. Judges need not initially assign a property right to its highest valued use, since costless transacting would ensure it would arrive there anyway.

3.3.3 The Case for Improving Upon the Market System

Of course, the assumption of zero transactions costs was merely a benchmark, a Boettkean foil, in order to better understand the positive transactions costs, real world. After stating that zero transactions costs "is, of course, a very unrealistic assumption," Coase argues that a practical, real world analysis creates a weakness in the market system:

Once the costs of carrying out market transactions are taken into account, it is clear that a rearrangement of rights will only be undertaken when the increase in the value of production consequent upon the rearrangement is greater than the costs which would be involved in bringing it about. (Coase (1960), pp. 15-16).

This opens the door for alternative institutional arrangements and raises the possibility of output-increasing Government action.

One substitute for market transactions is the firm. Individual trades to guide resources to their highest valued uses are eliminated in favor of administrative fiat. Where A and B clash over a resource use, a merger or buyout occurs, and the resource is directly assigned to its optimal position. In a world of positive transactions costs, vertical integration may be the least cost solution for a conflicting resource use problem.

This solution would be adopted whenever the administrative costs of the firm were less than the costs of the market transactions that it supersedes and the gains which would result from the rearrangement of activities greater than the firm's costs of organizing them. (Coase (1960), p. 17)

Another possible solution to the conflicting use problem in the presence of costly exchanges is direct government regulation. When high transactions costs make neither market trading nor vertical integration economically feasible, the government can act as a "super-firm" to directly control the allocation of resources: "Just as the government can conscript or seize property, so it can decree that factors of production should only be used in such-and-such a way." (Coase (1960), p. 17)

Coase, however, is quick to point out that "the governmental administrative machine is not itself costless. It can, in fact, on occasion be extremely costly." (Coase (1960), p. 18) He cites fallible administrators, political pressures, lack of competitive checks, and the inflexibility of regulations that apply to all cases as sources of government costs. For this reason, Coase mentions one last alternative to the conflicting use problem, "which is to do nothing about the problem at all." (Coase (1960), p. 18)

When transactions costs are so high that neither market trading nor vertical integration yield the highest possible value of output, but a governmental solution is more costly than the increased value of output, then the optimal solution is to do nothing—i.e., accept the market allocation as the best attainable result. This is no rare situation, according to Coase, for "it will no doubt commonly be the case that the gain which would come from regulating the actions which give rise to the harmful effects will be less than the costs involved in Government regulation." (Coase (1960), p. 18) Coase is drawing a distinction between an ideal, perfect solution and an optimal, efficient one. In a world of high transactions costs, the market system may not yield the highest possible global maximum, but it will generate the best resource allocation under the transactions costs constraint. Where Pigou felt obliged to remind his readers of the necessary functions of Government, Coase feels compelled to remind them that we do not live in a costless, frictionless world and, thus, some deviations from perfection are too expensive to fix. This is one of Coase's most

important contributions for he felt that modern-day economists have forgotten that market, firm, and governmental solutions to the resource allocation problem all have costs. Thus, instead of an ideal solution, the best we can hope for is a least-cost, closest-to-perfect, optimal solution.

Not only do positive transactions costs create a *possible* opportunity for improvement in the market solution to a conflicting use problem, they also provide the court system with resource allocating powers. No longer is the judge's decision irrelevant. Since transactions costs may prevent the resource from moving after it has been initially assigned, Coase argues that judges should be and are aware of the economic ramifications of their decisions. If, as Medema describes, a "legal flypaper effect" is going to make the property right "stick" where it is initially assigned, then judges should award the property right to whoever values it most from the very beginning.

A different strategy, more in keeping with the desire to let trading determine the final resource allocation, would be to use the State to establish rules that make exchanges more likely. Since the publication of "The Problem of Social Cost," others have pointed out that alternative legal rulings and arrangements (such as liability rules, arbitration, and the like) can be interpreted as attempts by the legal system to lower transactions costs so that, once again, self-interested traders can chaperon resource to their highest valued uses.

3.3.4 Coase's Analysis Applied to Pennsylvania Coal Mining Law

As before, it is unclear exactly what Coase would have said about the coal cases described above, but it is possible to apply the Coasian analytical framework in order to reach a measured conclusion. When the Coasian tools are utilized to judge the Pennsylvania coal cases, the result is that Coase would have sided with Holmes in 1922, while struggling in the more recent case. Eventually, however, he would agree with Stevens and the majority. Not only are their decisions similar, as we saw with

Pigou, the heart of this inference lies with the focus on maximizing the total value of production.

Coase might begin his analysis by pointing triumphantly to the Support Estate as a beautiful example of the advantages of an ever-finer delineation of property rights. By selling only the surface rights, the coal company and original buyer managed to maximize society's scarce resources. After all, the record in the *Penn Coal* case shows that the deed was first executed in 1878 and the coal company did not show up until some fifty years later. That is fifty years of use of the surface rights that might not have been possible for there is no doubt that the Mahons, and other buyers like them, paid substantially lower prices by only buying the surface rights.

Next, Coase might lead the reader through the surreal world of zero transactions costs. Here, the conflicting resource use problem magically disappears as the Mahons and the Pennsylvania Coal Company costlessly, effortlessly reach a mutually satisfactory bargain—in which, of course, in 1922, the Mahons move and the coal is mined. Rule for Pennsylvania Coal and declare the Kohler Act unconstitutional and the Mahons must move while the coal is mined. Were Brandeis to somehow have managed a majority and the Court upheld the validity of the Kohler Act per the state's police powers, then the result would be no different in terms of resource allocation—the coal company would immediately buy the surface rights, Mahon would move and the coal would be mined. In 1987, the exact opposite solution holds. Now the surface is worth much more than the underlying coal so the modern-day Mahons keep the right if it is initially assigned to them or buy it if not. In either case, 1987 sees the Mahons enjoying the Pennsylvania surface, while Western coal is strip mined to fire electric generators. But this zero transactions costs exercise would be only a prelude to the real analysis in the real world of positive transactions costs.

As is by now rather obvious, the conflicting resource use problem in the case of Pennsylvania coal is that some, mainly owners of surface rights alone, are unhappy with the prospect of subsidence, cave-in, and collapse when underground coal is

mined. Knowing the relative valuations of the competing resource uses in 1922, it is not difficult to imagine Coase suggesting, as did Holmes,

So far as private persons or communities have seen fit to take the risk of acquiring only surface rights, we cannot see that the fact that their risk has become a danger warrants the giving to them greater rights than they bought. (*Penn Coal*, p. 416)

Coase would take the opportunity to remind his audience that punishing the injurer, emitter, or otherwise “guilty” party is a mistake brought into economics by Pigou’s private and social cost calculus. In *Penn Coal v. Mahon*, as in *Sturges v. Bridgman* and other cases cited by Coase, it is extremely difficult to find Pennsylvania Coal culpable. Yes, mining will cause subsidence, but there are no charges of fraud here. It was “expressly stated” in the deed that only the surface rights were being exchanged. The Mahons knew, or should have known, that their sweetheart, low price deal carried risks. And, of course, stop Pennsylvania Coal from mining in order to prevent the harmful effects of subsidence and you have succeeded, not only in protecting the Mahons and their home, but also in raising the price of coal so that some will have less or no heat, throwing thousands out of work, and a hundred other disagreeable—but, at first blush, invisible—effects.

The positive transactions costs, real world, Coase would argue, forces the Court to be wary. No longer can they rely upon the trades of self-interested resource owners to ensure that the property right comes to reside in its highest value use. Give the property right to the Mahons in 1922 and they might try to strategically extract the highest price the coal company is willing to pay. Informational asymmetries and other real world frictions might prevent a mutually advantageous bargain from ever

being struck.⁶ In 1922, the safest route would be to simply declare the Kohler Act unconstitutional and assign the property right to the coal company.⁷

By 1987, however, the changing relative valuations would put an entirely different spin on the matter. The many Mahons scattered across the Pennsylvania surface would make it prohibitively costly to bargain with various coal companies over the Support Estate. Faced with the prospect of being locked into an inefficient allocation of resources, Coase would concede that an alternative arrangement was needed. With vertical integration of surface and coal owners out of the question, the only solution remaining is the governmental one. After all, Coase never said that government regulation was always inferior to its market and firm alternatives, just that it was over-used:

It is my belief that economists, and policy-makers generally, have tended to over-estimate the advantages which come from governmental regulation. But this belief, even if justified, does not do more than suggest that governmental regulation should be curtailed. It does not tell us where the boundary line should be drawn. (Coase (1960), p. 18)

From Coase's perspective, the history of Pennsylvania coal mining law offers an excellent example of how property rights can be more finely divided and then traded in order to maximize the value of total production. Couched in a positive transactions costs world, the predicament in which the state of Pennsylvania found itself might provide a situation in which Coase would countenance Governmental regulation of the market system. If so, it would be the unwavering attention focused on the goal of maximizing the value of production that would convince Coase to accept Government regulation.

⁶Coase's response to Samuelson's concern over bilateral monopoly shows that faith in the self-interested nature of individuals leads to the conclusion that, "However, there is good reason to suppose that the proportion of cases in which no agreement is reached will be small." (Coase (1988), p. 161)

⁷Another possibility, first suggested by Calabresi and Melamed, would be to use a liability rule, in which one party must sell the property right upon payment of court determined damages. This has the virtue of greatly lowering transactions costs (since strategic bargaining over price is precluded), but the court must set the price correctly or an inefficient allocation would result.

3.3.5 Conclusion

This section has considered, in turn, the Pigovian and Coasian analyses of Pennsylvania coal mining law. By first presenting the overall views of Pigou and Coase, highlighting the areas they believed important, then applying their ideas to the *Penn* and *Keystone Coal* cases, a better understanding of the Pigovian and Coasian approaches can be gained. In the next section, a comparison of these two perspectives is undertaken.

3.4 Comparing Pigou and Coase

It is the express purpose of this paper to argue that Arthur C. Pigou and Ronald H. Coase, long seen as mortal enemies in a great intellectual battle, actually have more in common than in disagreement. This remarkable claim can be defended, first, by noting that the Pigovian and Coasian analyses of Pennsylvania coal mining law yielded the same results and, more importantly, for the same fundamental reason—they both frame conflicting resource use problems as optimization problems. Both see maximizing the total value of output as a goal that is reached by distributing scarce factors of production to their best uses. Both see markets as working flawlessly in an idealized world with no obstacles to movement/zero transactions costs. Both recognize the virtues of market incentives in generating an optimal solution. Both are willing to accept market alternatives in the face of clearly inefficient market solutions. Both insist on weighing benefits and costs of alternative solutions to the market system.

Coase is willing to concede as “essentially correct” that part of Pigou’s argument which points out that “even Adam Smith himself” recognized the need for an appropriate environment in which to couch the free play of self-interest. Pigou understands well that Government does not provide a panacea for conflicting use

problems. It is, as DeSerpa says, a case of two different roads leading to the same destination.

If this is true, then the natural question is, Why are they perceived as so different? Part of DeSerpa's answer lies in the different paths they were taking: "Whereas *Welfare* was developed as a criticism of doctrinaire *laissez-faire*, Coase (1959, 1960) was a criticism of doctrinaire government regulation." (DeSerpa (1993), p. 34) Another part of the explanation lies in the twisted transformation from original source to textbook, from the master's words to the disciples' translations, and from Coase's own exceedingly uncharitable presentation of Pigou's ideas. No attempt to trace the first two parts will be undertaken here, but a brief presentation of the role Coase has played will support the thesis that Pigovian and Coasian solutions to conflicting resource use problems are similar.

Coase has often complained of being misunderstood, but it was really Pigou who was grossly caricatured when rendered by Coase in "The Problem of Social Cost."⁸ By painting Pigou as a wild-eyed socialist, eager to step in and regulate at the drop of a hat with absurdly incalculable tax/subsidy/regulatory schemes, Coase effectively destroyed the true Pigovian view of the conflicting resource use problem, in particular, and of markets, in general. In doing so, Coase seemed to take the middle ground, but even a cursory reading of *The Economics of Welfare* immediately reveals Pigou's respect for market forces. After all, how can the same person who was vilified by Keynes for being too *laissez-faire* also be too Government interventionist?

In comparing Pigou and Coase, a case can be made that it is actually Coase, not Pigou, who is unduly limited in the range of available solutions to conflicting use problems. Where Pigou actively considers a wide range of governmental incentives and options, it is Coase who sees the legal system as separate from Government. For Coase, Governments prohibit, force, decree, and coerce as they establish an authoritarian solution. Pigou's Government might eventually have to do these things

⁸Not only was Pigou mistranslated, it happened to him twice—once by Coase and once by John Maynard Keynes.

(in the service of maximizing economic welfare), however, it first entices, induces, and helps channel resources, under the direct control of self-interested individuals, to their optimal uses. If Coase would stop to consider Pigou's argument and the context in which it was first presented, perhaps he would agree that there is much more overlap than discord in the Coasian and Pigovian views of the world.

In any comparison, the question of perspective is absolutely crucial. Viewed narrowly, the Industrial Revolution was a slow, gradual evolution of new forms and relationships. But, in the history of the world from 8000 BCE to the present, the Industrial Revolution is best described as a discontinuous, sudden upheaval. Close up, Pigou and Coase seem to have many differences; but these meld together as a broader perspective is taken. They were approaching the same result via different routes and, by the end, there were important areas of complete agreement.

4.0 Pennsylvania Coal and the Efficiency of the Common Law

In "The Problem of Social Cost," Coase mentioned that judges were, sometimes only subconsciously, aware of the economic impact of their decisions. In doing so, he anticipated the "economic analysis of the law" and the claim by Richard Posner that the common law "bears the stamp of economic reasoning." (Posner (1972), p. 6) Since we have the material at our disposal, it seems worthwhile to check the validity of this claim against the experience of Pennsylvania coal law.

The splitting of property rights in Pennsylvania into three components would seem to offer support to the claims of Alchian and Demsetz that property rights emerge when it is optimal for them to do so. The economic explanation for this phenomenon would ride on the efficiency properties of such a splitting of a previously unified bundle of rights of action. As mentioned above, the separation of coal lands into coal deposits, surface rights, and the Support Estate enabled Pennsylvanians to increase the value of production. It would seem logical, in this case, that the benefits of a finer division of

property rights outweighed the corresponding costs and that this simple calculation spurred the creation of the Support Estate as a separate, identifiable property right.

In the opinions themselves, further evidence can be found to support the claim that judges are aware, in this case explicitly, of the economic ramifications of their decisions. The takings test enunciated by Holmes is based on a weighing of benefits and costs. In fact, Brandeis did not so much disagree with the test itself as with the weights imputed to the sides of the scale. And, as we have explored at length, the differing decisions seem to be completely determined by the changing values of the benefits and costs. Stevens went so far as to write that the *Penn Coal* precedent was not overturned since the same test was applied; the only difference was that conditions had changed so that a different result was obtained.

Finally, the *Penn Coal* and *Keystone Coal* decisions would seem to support the economic analysis of the law. As discussed above, a zero transactions costs world would have seen maximum coal extraction in 1922, while part of the coal would be used as a “barrier support” in 1987. This is, of course, the exact conclusion reached by the Court. All in all, the history of Pennsylvania coal law seems to be supportive of the Posnerian claim that the common law “mimics the market.”

On the other hand, the fact that the strands in the bundle may have been “over-split” is cause for concern. Economists describe an inexorable movement from no property rights, to communal property rights, to private property rights, to more finely delineated private property rights. Here, however, we seem to have run across an anomalous case in which property rights have been inefficiently, over fragmented. Perhaps, like too many cereals and too many phone calling plans from which to choose, the correct economic argument is not one of inexorable movement toward more finer divisions, but gravitation toward an optimal division. And if it was optimal for Pennsylvania to create a property right in the Support Estate, what of the other coal mining states? Why don't we see such finely divided property rights across the coal mining countryside?

Similarly, although the decisions do seem to “mimic the market,” they also point to a disconcerting interference with settled law. After all, once the property right had been granted to Pennsylvania Coal, further adjustments or interference would seem to only raise transactions costs by confusing the identity of the property rights owner. Bouncing around from one settled property rights assignment to another could hardly be optimal.

The economist’s rebuttal would be that this movement could be interpreted as a response to an exogenous shock (in this case, the discovery of low sulfur, strip mined, Western coal). What we have witnessed over the past half-century in Pennsylvania coal mining law, according to the economic explanation of the law, is then nothing but a simple comparative statics exercise.

One that suffers, say the critics, from such a tautological construction, that it has no real explanatory power. After all, there is little doubt that the economic analysis of the law could easily rationalize *any* judgment. Were the cases to have turned out differently, we would simply be offering alternative interpretations of benefits and costs such that, once again, the law would “mimic the market.”

5.0 Conclusion

Most economists believe that a wide chasm separates Arthur C. Pigou and Ronald H. Coase. This paper has analyzed a particular conflicting use problem and found that there are many more similarities than differences in the Pigovian and Coasian approaches. Of course, at the most detailed level, the two might disagree concerning the appropriate kinds of incentives or institutional structure; but, seen from a more distant perspective, Pigou and Coase merge into one. Both focus on allocating real factors of production so as to maximize the value of output. Both are searching for the environment that enables self-interested individuals to channel resources efficiently. And, both insist on comparing the performance of real-world alternatives

in order to reach the best attainable result. These broad areas of agreement translate into similar judgments in *Penn Coal* and *Keystone Coal*, two landmark cases in the area of takings jurisprudence.

The Pigovian approach allows the market system a first stab at solving the resource allocation problem. If the results are not optimal, the search begins for ways to improve upon the free play of self-interest. Pigou expresses a clear preference for modifications to the market system that enable resources to stay under the direct control of resource owners. In theory, alterations to the rules must first meet a cost-benefit test and then the best is chosen. When applied to Pennsylvania coal mining law, Pigou would advocate that which is likely to lead to an optimal resource allocation—he would rule with Holmes in 1922 and with Stevens in 1987.

The Coasian approach is, likewise, market oriented. Truly inefficient market system allocations, however, are not tolerated. If the prospect of improved performance by firm or government schemes can be shown to outweigh the costs of implementation, these alternatives are supported. Importantly, a final option, to do nothing, is always available. When applied to Pennsylvania coal mining law, Coase would advocate that which is likely to lead to an optimal resource allocation—he would rule with Holmes in 1922 and with Stevens in 1987.

The three alternatives to conflicting resource use problems include:

- (1) impose a solution from above;
- (2) create the means so that a resolution can emerge from within; and
- (3) combine the opposing resource owners under one roof.

This paper has argued that today's orthodox interpretation of a Pigovian solution (due in no small measure to Coase himself) as a Type (1) Authoritarian solution is simply false. Pigou, like Coase, is firmly ensconced in the Type (2) Decentralized solutions category. Unlike Coase, Pigou saw Government (including the legal system) as providing supplementary incentives to those used by a "pure" free market. It

remains a Type (2) Decentralized solution so long as self-interested individuals maintain control of resources and trading yields a spontaneous order. Of course, both Pigou and Coase were willing to admit that the other two solutions might, eventually, be necessary. Further comparison of the Pigovian and Coasian approaches might indicate in exactly which details the two differ, but the conclusion of this work is that such a study must be aware of the fundamental generalities that they share in common.

6.0 Bibliography

Annual Energy Review 1992. Energy Information Administration, 1993.

“High Court Voids Act Curbing Mining.” *The New York Times*, December 12, 1922

Historical Statistics of the United States: Colonial Times to 1970. U.S. Department of Commerce, 1975.

Keystone Bituminous Coal Association, et al., Petitioners v Nicholas DeBenedictis. (1987) 480 US 470, 94 L Ed 2d 472, 107 S Ct 1232

Mugler v. Kansas. (1887) 123 US 623.

Pennsylvania Coal Company v Mahon, et al. (1922) 260 US 393, 67 L Ed 322, 43 S Ct 158, 28 ALR 1321

“Pennsylvania Mining Laws.” 52 P.S. §1406.1-§1551.1.

Atwood, Genevieve. “The Strip-Mining of Western Coal” in *Energy: Readings from Scientific American*. San Francisco: W.H. Freeman and Company, 1979.

Bane, John, Jr., Gilbert J. Helwig, James H. McConomy, and Robert F. Banks. “Safety and Management Problems in Mine Operation in Pennsylvania.” XV-XXIX.

Buchanan, James M. “Politics, Property, and the Law: An Alternative Interpretation of Miller, et al. v. Schoene.” *The Journal of Law and Economics* 15 (1972): 439-452.

Coase, R. H. “The Nature of the Firm.” *Economica*, n.s. 4 (1937): 386-405.

Coase, R. H. “The Problem of Social Cost.” *The Journal of Law and Economics* 3 (1960): 1-44.

Coase, R. H. “Discussion.” in *Legal and Economic Aspects of Pollution*, Chicago: The University of Chicago Center for Policy Study, 1970.

Coase, R. H. “Social Cost and Public Policy.” in *Exploring the Frontiers of Administration: Six Essays for Managers*, ed. G.A. Edwards. Toronto: York University Faculty of Administration Studies, Bureau of Research, 1970.

Coase, R. H. “Adam Smith's View of Man.” *The Journal of Law and Economics* 19 (1976): 529-46.

Coase, R. H. “The Wealth of Nations.” *Economic Inquiry* 15 (1977): 309-25.

Coase, R. H. “The Coase Theorem and the Empty Core: A Comment.” *The Journal of Law and Economics* 24 (1981): 183-7.

Davis, John W., Frank W. Wheaton, Henry S. Drinker, and Resse H. Harris. Argument for Plaintiff in Error in *Pennsylvania Coal Company v Mahon, et al.* (1922) 260 US 393.

DeSerpa, Allan C. "Pigou and Coase in Retrospect." *Cambridge Journal of Economics* 17 (1993): 27-50.

Eaton, J. D. "A Decade of U.S. Supreme Court Decisions—An Appraiser's View:Part 4: Court Shifts on Compensable Taking." *Appraisal Journal* 58 (1990): 230-238.

Goldberg, Victor P. "Pigou on Complex Contracts and Welfare Economics." *Research in Law and Economics* 3 (1981): 39-51.

Keynes, John Maynard. *The General Theory of Employment, Interest, and Money*. First Harbinger Edition, 1964 ed., London: Harcourt Brace Jovanovich, 1936.

Knight, F. H. "Some Fallacies in the Interpretation of Social Cost." *Quarterly Journal of Economics* (1924): 582-606.

Kramer, Daniel C. "When Does a Regulation Become a Taking? The United States Supreme Court's Most Recent Pronouncements." *American Business Law Journal* 26 (1988): 729-782.

Lin, Steven A. Y., ed. *Theory and Measurement of Economic Externalities*. New York: Academic Press, Inc., 1976.

McMichael, Susan Manges. "Mahon Revisited: *Keystone Bituminous Coal Ass'N v. DeBenedictis*, 480 U.S. 470 (1987)." *Natural Resources Journal* 29 (4 1989): 1067-1077.

Medema, Steven G. "Reflections in the Glass: Ronald Coase as an Historian of Economic Thought." in History of Economics Society Conference held at Babson College, 1994 1-38.

Medema, Steven G. *Ronald H. Coase*. New York: St. Martin's Press, 1994.

Medema, Steven G. and Richard O. Zerby Jr. "Ronald Coase, the British Tradition, and the Future of Economic Method." in American Economics Association Conference held in Washington, D.C., 1994, 1-29.

Pigou, Arthur C. *Wealth and Welfare*. London: Macmillan, 1912.

Pigou, Arthur C. *The Economics of Welfare*. 4th ed., London: Macmillan, 1962, (originally published in 1920).

Pigou, Arthur C. *A Study in Public Finance*. 3rd (rev) ed., London: Macmillan, 1960, (originally published in 1928).

- Posner, Richard A. *Economic Analysis of Law*, Boston: Little, Brown, 1972.
- Randall, Alan. "Coasian Externality Theory in a Policy Context." *Natural Resources Journal* 14 (1974): 35-54.
- Samuels, Warren J. "Interrelations Between Legal and Economics Processes." *The Journal of Law and Economics* 14 (1971): 435-449.
- Samuels, Warren J. "In Defense of a Positive Approach to Government as an Economic Variable." *The Journal of Law and Economics* 15 (1972): 453-459.
- Samuels, Warren J. "The Coase Theorem and the Study of Law and Economics." *Natural Resources Journal* 14 (1974): 1-33.
- Samuelson, Paul A. *The Collected Scientific Papers of Paul A. Samuelson*. Vol. II. ed. Joseph E. Stiglitz. Cambridge, MA: The M.I.T Press, 1966.
- Stigler, George J. *The Theory of Price*. 3rd ed., New York: The Macmillan Company, 1966 (originally published in 1942).
- Young, Allyn A. "Pigou's Wealth and Welfare." *The Economic Journal* 23 (1913): 672-686.