

**COMPETITION, CONSUMER WELFARE, AND  
THE SOCIAL COST OF MONOPOLY**

**By**

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# Competition, Consumer Welfare, and the Social Cost of Monopoly

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Conventional deadweight loss measures of the social cost of monopoly ignore, among other things, the social cost of inducing competition and thus cannot accurately capture the loss in social welfare. In this Article, we suggest an alternative method of measuring the social cost of monopoly. Using elements of general equilibrium theory, we propose a social cost metric where the benchmark is the Pareto optimal state of the economy that uses the least amount of resources, consistent with consumers' utility levels in the monopolized state. If the primary goal of antitrust policy is the enhancement of consumer welfare, then the proper benchmark is Pareto optimality, not simply competitive markets. We discuss the implications of our approach for antitrust law as well as how our methodology can be used in practice for allegations of monopoly power given a history of price-demand observations.

## I. INTRODUCTION

Monopoly and market power constitute the backbone of federal antitrust law. The Sherman Act<sup>1</sup>—largely regarded as the origin of the federal antitrust law and passed in 1890—was the government's response to cartelization and monopolization. Section 2 of the Sherman Act specifically prohibits monopolization as well as attempts to monopolize. In modern antitrust law, the existence of monopoly power is one of the two essential elements of the *Grinnell* test,<sup>2</sup> a test that is applied in all Section 2 cases of the Sherman Act.<sup>3</sup> Proof of market power is also required for antitrust violation under Section 7 of the Clayton Act.<sup>4</sup> Judge Richard A. Posner argues that “the economic theory of monopoly provides the only sound basis for antitrust policy.”<sup>5</sup> That antitrust scholars are mindful of the social cost of monopoly and market power is also illustrated, for instance, by Professor William M. Landes and Judge Posner's remark that the *size of the market* should be a determinant factor in judging whether a certain degree of market power should be actionable under antitrust law.<sup>6</sup> They note that “the actual economic injury caused to society is a function of [the size of the market]” and “[i]f the amount of economic activity is small, the total social loss is small, and an antitrust proceeding is unlikely to be socially

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<sup>1</sup> 15 U.S.C. §2 (1976).

<sup>2</sup> See *United States v. Grinnell Corp.*, 384 U.S. 563 (1966).

<sup>3</sup> For a brief description of the development of Section 2 of the Sherman Act, see KEITH N. HYLTON, *ANTITRUST LAW* (2003).

<sup>4</sup> 15 U.S.C. §18 (1976).

<sup>5</sup> RICHARD A. POSNER, *ANTITRUST LAW* 9 (2001).

<sup>6</sup> See William M. Landes & Richard A. Posner, *Market Power in Antitrust Cases*, 94 HARV. L. REV. 937, 953 (1981).

cost justified[.]”<sup>7</sup> Accordingly, a clear understanding and a workable definition of the social cost of monopoly are essential in shaping and implementing antitrust law.

A familiar measure of the social cost of monopoly is the deadweight loss triangle—the social surplus unrealized due to monopoly pricing. Judge Posner has suggested another metric that is a refinement of the conventional deadweight loss analysis. In this Article, we review the current deadweight loss analysis of the social cost of monopoly. Most prominently we suggest three reasons to reconsider this analysis. First, the deadweight loss analysis uses the sum of consumer and producer surplus to give an approximate measure of gains and losses without giving any consideration to the consumers’ relative utility levels. Second, the analysis relies on the questionable assumption of profit-maximizing firms, not taking into consideration that where the shares of firms are widely-held—as is the case with most firms that have monopoly—managers may be motivated by goals other than profit maximization. Third, the analysis is problematic to the extent that it ignores the social cost of inducing perfect competition in a given industry, and thus assumes a counterfactual that is not attainable even by a benevolent social planner.

As an alternative approach to analyzing the social cost of monopoly, we propose an applied general equilibrium model. The index of social cost we use is the coefficient of resource utilization introduced by Gerard Debreu.<sup>8</sup> This measure provides an exact, ordinal measure of the economic cost of monopolization in terms of wasted real resources. We take as benchmark a Pareto optimal state of economy that provides the same level of consumer satisfaction as achieved in the monopolized state.<sup>9</sup> The primary objective of antitrust policy is to promote consumer welfare and efficiency, and Pareto optimality embodies both of these objectives. To this extent, we suggest that *marginal cost pricing should be viewed not only as a consequence of perfect competition but also as a necessary condition for achieving Pareto optimality.*<sup>10</sup>

The rest of this Article is divided into several Parts. Part II is a review of the current analysis of the social cost of monopoly based on the deadweight loss triangle. In Part III, we discuss how the notion of Pareto optimality as the benchmark state of the economy can lead to a more appropriate measure of the cost. In Part IV, we formalize the social cost analysis using a two-sector model and illustrate how to compute the coefficient of resource utilization. In Part V, we derive a family of linear inequalities, where the unknown variables are utility levels and marginal utilities of income of households and the marginal costs of firms. These inequalities suffice for an empirical determination of monopoly power in a series of historical observations of market data, and this methodology can be used by courts in applying the *Grinnell* test.

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<sup>7</sup> *Id.*

<sup>8</sup> See Gerard Debru, *The Coefficient of Resource Utilization*, 19 *ECONOMETRICA* 273 (1951).

<sup>9</sup> See *infra* Section III.A. Ultimately, our methodology can be used to calculate the snap-shot social cost in terms of the dollar values in relation to an attainable counterfactual.

<sup>10</sup> See *infra* Part III. Whenever this condition is violated in a sequence of observed equilibria we can calculate the social cost in each observation via Debreu’s coefficient of resource allocation. See *infra* Section III.B.

## II. RECONSIDERING THE DEADWEIGHT LOSS AS THE SOCIAL COST OF MONOPOLY

By now, most economists agree as to the *nature* of the problem posed by monopoly and market power. A monopolist who cannot price-discriminate has an incentive to reduce output and charge a price higher than marginal cost, and in turn, prevent transactions that would have been mutually beneficial. Faced with monopoly pricing, consumers either pay higher than necessary prices to obtain their goods or must choose false alternatives—alternatives that appear to be cheaper even though they might require more resources to produce.<sup>11</sup> Put differently, monopoly is inefficient because in preventing such transactions, society uses up more resources than necessary to achieve given levels of utility among consumers.<sup>12</sup> Although destruction of mutually beneficial transactions is patently inefficient from society’s perspective, it remains unclear what is the proper metric to measure the social cost of monopoly. Intuition tells us that, whatever the metric is, it should indicate the extent to which the current state of monopolized economy deviates from an efficient state of economy that could have been achieved if resources were better allocated. In traditional textbook microeconomics, the social cost of monopoly is measured by the deadweight loss triangle.

<<INSERT FIGURE 1 HERE>>

Triangle A in Figure 1 depicts this loss since this area represents the amount of additional social surplus that could have been realized had the pricing been at marginal cost. Alternatively, taking potential rent-seeking behavior among firms into consideration, Judge Posner argues that in certain markets where firms compete to become a monopoly, the social cost should include producer surplus in addition to the deadweight loss.<sup>13</sup> In Figure 1, this quantity is represented as the sum of A and B. Despite capturing the essence of the inefficiency of monopoly, the social cost metrics such as these, which are based on the conventional deadweight loss triangle, are inappropriate because they require some

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<sup>11</sup> This point has long been recognized. A.P. Lerner in a landmark article writes that “[I]ncreasing the price of the monopolized commodity [causes] buyers to divert their expenditure to other, less satisfactory, purchases. This constitutes a loss to the consumer which is not balanced by any gain reaped by the monopolist, so that there is a net social loss.” A.P. Lerner, *The Concept of Monopoly and the Measurement of Monopoly Power*, REV. OF ECON. STUD. 157 (1937).

<sup>12</sup> The foregoing analysis is the “resource allocation” aspect of monopoly. See Arnold C. Harberger, *Monopoly and Resource Allocation*, 44 AMER. ECON. REV. PAPERS & PROC. 77 (1954). Clearly, there is also a distribution effect: monopoly pricing tends to redistribute income in favor of the monopolist. But insofar as these are mere transfers, antitrust economists do not regard them as socially inefficient. See, e.g., Lerner, *supra* note 11, at 157 (“A levy which involves a mere transference to buyer to monopolist cannot be said to be harmful from a social point of view unless it can be shown that the monopolist is less deserving of the levy than the people who have to pay it . . . .”); POSNER, *supra* note 5, at 13 & 24.

<sup>13</sup> See generally Richard A. Posner, *The Social Costs of Monopoly and Regulation*, 83 J. POL. ECON. 807 (1975). To formalize this idea, Posner sets forth three conditions that need to be satisfied for this assertion to hold: (1) firms compete to obtain a monopoly; (2) firms face a perfectly elastic long-run supply of all input; and (3) the costs the firms spend in attempting to obtain the monopoly serve no socially useful purposes. *Id.* at 809. See also POSNER, *supra* note 5, at 13-17.

implausible assumptions.

First, these measures of social cost and surplus use the money metric: all benefits and inefficiencies are quantified in terms of dollars. How should we understand the relationship between the money metric and social surplus? Suppose Abigail is willing to pay as much as \$5 for a widget, and Brian, \$4, but a widget only costs \$2. Then after purchasing a widget, Abigail is left with \$3 to spare, and Brian, \$2. They can devote their remaining dollars towards consumption of other goods. But to add these values together and say \$5 is the measure of social welfare does not really tell us what benefit each of them could have derived from additional consumption; little information is revealed about consumer welfare. In order for this surplus measure to truly represent the social loss, we would need “the heroic assumption that a dollar is worth the same to everybody.”<sup>14</sup> This notion of maximizing social surplus is related to the notion of Kaldor-Hicks efficiency but only loosely so since we are using dollar values as a proxy to measure social welfare. There may be instances where the only feasible and testable solution is to quantify all benefits and costs in terms of dollars. The cost-benefit analysis commonly used in health and safety regulation is one example. But the cost-benefit analysis paradigm, too, has been criticized on many grounds, not the least of which is the validity of this “heroic assumption.”

A second failing of the deadweight loss analysis is that it relies on the concept of a profit-maximizing monopolist who produces goods until marginal cost equals marginal revenue. Let us forget for the moment that this directive may be extremely hard to carry out in reality due to imperfect information. What is somewhat striking is that even with perfect information, the profit-maximizing condition often fails to describe accurately actual behaviors of monopolists. The literature provides several reasons why a monopolist might not consciously seek to maximize profit. First of all, rarely do we see any prominent monopolist firm that has a sole owner or a sole shareholder. Instead, most monopolist firms have multiple shareholders; and in many cases, these firms’ shares are widely held. Investment and cost decisions of a firm are ultimately made by the managers of the firm who receive salaries and bonuses but are not necessarily owners. These managers may neglect to maximize profits if that is not in their own best interest to do so. This could be the case, for instance, if managers were allowed to reap personal profits at the expense of corporate well-being; insider-trading is one example. The literature of industrial organization and microeconomic theory is replete with sources of inefficiency in principal-agent models. Fortunately, corporate law provides several institutional safeguards to minimize this type of opportunities for managers. Insider trading and false financial reporting are illegal under the Rules 16, 10(b), and 10(b)-5 of the Securities and Exchange Act of 1934.<sup>15</sup> Managers and directors owe a duty of loyalty to their shareholders and cannot benefit themselves at expense of corporation. The corporate opportunity doctrine precludes directors from taking a business opportunity for their own when the opportunity is within the firm’s line of business and the firm can afford to exploit the opportunity.

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<sup>14</sup> POSNER, *supra* note 5, at 23. In the jargon of economic theory consumer surplus only measures changes in consumers’ welfare if the marginal utility of income is the same for every household, rich and poor alike.

<sup>15</sup> The Securities and Exchange Act of 1934.

And importantly, a majority of shareholders can vote out the incumbent management in case they are dissatisfied with the firm's performance.

But more importantly, even if shareholders and corporate law can create incentive schemes for managers to induce them to do what is best for the shareholders, managers would maximize profits only if that is in the best interest of shareholders. Shareholders come in various types, and for many, the firm's profit-maximization can run afoul of their best interest.<sup>16</sup> Specifically, if a shareholder happens also to be a consumer of the firm's output, then she will suffer by paying high prices for the firm's output. Second, a shareholder who sells factor inputs to the firm would stand to lose if the firm uses its market power to drive down the price for the factor she sells. Third, a shareholder who owns a diversified portfolio may be hurt if the firm uses its market power to hurt its competitors. Finally, even if the shareholder has no interaction with any of the firm's output, she may be hurt if she consumes a good that is complementary to the firm's output, since the firm's pricing policy will necessarily impact the demand curves for complementary goods.

Non-economic arguments may also play a role, as “[w]hen the monopolist is not working on purely business principles, but for social, philanthropic or conventional reasons” or more likely “when the monopolist is working on purely business principles, but keeps the price and his profits lower than they might be so as to avoid political opposition.”<sup>17</sup> Although the notion that a monopolist maximizes profit has some intuitive appeal, it may nevertheless run counter to the shareholder's best interests, and thus will not always be pursued. In actuality, a monopolist's behavior is more likely to resemble that of cost-minimization, rather than of profit-maximization. If monopolists do not obey the profit-maximizing conditions in practice, then the social cost of monopoly certainly should not be measured on the assumption that they do.

Our third and most important point is that the social cost of monopoly as measured by deadweight loss is problematic to the extent that it implicitly assumes that the relevant benchmark of efficiency—the counterfactual against which we measure the social loss—is the state of perfect competition. The rationale is that under perfect competition price will equal marginal cost, and a willing buyer and a willing seller will engage in transactions without wasting any resources. Nevertheless, the assumption of perfect competition as the ultimate benchmark is less innocuous than it appears. Perfect competition requires atomism of firms and buyers. But the literature is often silent as to exactly where these “other” firms suddenly come from. It is unlikely that there are these firms idly sitting around and not producing any socially useful goods but waiting to enter this market. A more likely scenario is that firms or individuals somewhere have to cease their existing, socially useful activities in order to enter a particular industry. For this reason, the perfect competition benchmark unrealistically assumes a sudden costless creation of countless new firms while everything else in society remains unchanged. More generally, as A.P. Lerner

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<sup>16</sup> This argument is only cursorily included in this section. For a more detailed treatment, see DAVID M. KREPS, *A COURSE IN MICROECONOMIC THEORY* 726-29 (1990). As a result, Kreps concludes that the notion of profit-maximizing firm is more applicable to price-taking firms without market power. *Id.* at 729.

<sup>17</sup> Lerner, *supra* note 11, at 170.

articulates, “[t]he direct comparison of monopolistic with competitive equilibrium . . . assumes that cost conditions are the same and that demand conditions are the same. Neither of these is likely, and the combination of both is much less likely.”<sup>18</sup>

We can illustrate the last point with a stylized example. Suppose we have a competitive market for widgets. But one day one of the widget-manufacturing firms, Firm A, patents a new formula to make “twidgets”—a new beneficial invention otherwise unrelated to widgets but a more profitable venture—out of the resources and technologies originally used to produce widgets. Twidget becomes an instant hit in the market, but for the first twenty years, Firm A enjoys monopoly due to the patent right. We have a government-sanctioned inefficiency in this case. As the patent expires, other widget companies will rush into the twidget market, consumers can then buy twidgets at marginal cost and the deadweight cost from the widget monopoly is extinguished. Notice, however, that the widget market will likely suffer now because widget firms are expending their resources to producing twidgets. In other words, in order to induce perfect competition in one industry that was originally monopolistic, one would have to pull out resources from other industries. The supply curve will, then, shift inward in one or more of other industries, and the new resource allocation reduces the social surplus generated from those industries.

Figures 2a and 2b demonstrate this example. Figure 2a represents the twidget market, and Triangle ABC measures the gain in social surplus due to competition in the twidget market. Meanwhile, Figure 2b refers to the competitive widget market and the counterfactual when the twidget patent expires. Area represented by EFGH measures the reduction in social surplus due to the inward shift of the supply curve in the widget market. A more accurate measure of the social cost, therefore, would have to consider the totality of circumstances; the gain ABC would have to be measured against the loss EFGH. All of sudden, it is not at all obvious that eliminating deadweight loss by inducing perfect competition in the twidget industry is particularly desirable; the result may be overall reduction in social surplus.

<<INSERT FIGURES 2a AND 2b HERE>>

An economic analysis which focuses on the social surplus of one sector without considering possible implications for other sectors is called partial equilibrium analysis. Partial equilibrium analysis remains a powerful methodology for analyzing the behavior of firms in an isolated market where the impact on prices in other markets is negligible. And yet this is hardly the case with interesting instances of monopoly power, e.g., AT&T, IBM, and Microsoft. In all of these cases, prices were affected well beyond the immediate markets, and the static one-sector model cannot correctly estimate the social cost of monopoly. At a minimum, we must consider the effect of inducing perfect competition in one industry on a different industry from which resources are drawn; a proper model thus

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<sup>18</sup> Lerner, *supra* note 11, at 161. Lerner is making one additional observation that the long-run cost curve faced by a single firm in general may not be the same long-run cost curve if many firms are competing in the market.

would have to consider at least two separate sectors with common factors (which can be, broadly speaking, capital and labor). What is more, since inducing perfect competition in and of itself may not be desirable on the whole, we must also consider other states of the economy that are potentially superior.

### III. CONSUMER WELFARE, PARETO OPTIMALITY AND GENERAL EQUILIBRIUM THEORY

In general equilibrium theory, consumers simultaneously provide labor and capital to firms, own shares of the firms, and maximize their utility based on consumption subject to their income constraints; meanwhile, firms from different sectors produce different goods but use common factor inputs, labor and capital. Notwithstanding the seemingly all-encompassing features of general equilibrium theory, its application to antitrust policy and the social cost of monopoly has been remarkably limited to date.<sup>19</sup> In this Part, we briefly discuss the elements of general equilibrium theory and propose an alternative method of measuring the social cost of monopoly power—one not subject to the concerns raised above but nonetheless consistent with the aims of antitrust law.

We stress that a reasonable measure of the social cost of monopoly should be based on a proper counterfactual. If perfect competition is inappropriate as a counterfactual, then what should be the ideal state of the economy against which to measure the social cost of monopoly? We propose that the benchmark of comparison for the purpose of measuring the social cost of monopoly should be a counterfactual *state that achieves the same or greater level of utility for everyone but with the least amount of resources*. If such a state can be constructed, then the economic cost of monopoly is simply the dollar amount of wasted resources; the given monopolized state performs no better than the counterfactual for any individual but simply uses up more resources.

The proposal merits some explanation. The notion of efficiency and welfare in general equilibrium theory is Pareto optimality, also known as *allocative efficiency*.<sup>20</sup> A state of the economy is said to be Pareto optimal if no consumer can be made better off by reallocating productive resources and engaging in mutually beneficial trades without making another consumer worse off; Pareto optimality thus represents a state of maximal consumer welfare. The crown jewels of general equilibrium theory are the two welfare theorems. The first welfare theorem states that every competitive equilibrium—i.e., equilibrium achieved under perfect competition—is Pareto optimal.<sup>21</sup> In short, we tend to “value competition because it promotes efficiency, that is, as a means rather than as an

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<sup>19</sup> The conspicuous absence of application of general equilibrium theory to antitrust law is due in part to the indeterminacy of the price level in the Arrow-Debreu general equilibrium model. As such, the model does not admit price-setting, profit-maximizing firms.

<sup>20</sup> The literature appears to use these terms interchangeably. *See, e.g.*, THOMAS D. MORGAN, CASES AND MATERIALS ON MODERN ANTITRUST LAW AND ITS ORIGIN 8-9 (2000) (describing allocative efficiency as the state in which “there [is] no combination of production or exchange that could make anyone better off without making someone else worse off.”).

<sup>21</sup> For an excellent treatment of general equilibrium theory, see ANDREU MAS-COLELL ET AL., MICROECONOMIC THEORY 511-786 (1995). For the First Welfare Theorem in particular, see *id.* at 549.

end.”<sup>22</sup>

The primary goals of antitrust policy are efficiency and the enhancement of consumer welfare.<sup>23</sup> Both of these concepts appeal to Pareto optimality. Robert Bork “[insisted] that the achievement of Pareto optimality was the sole objective of Congress (as long as 1890) when it enacted the nation’s antitrust statutes.”<sup>24</sup> Similarly, President Reagan’s first Council of Economic Advisers specifically defined efficiency in an economy in terms of Pareto optimality, not Kaldor-Hicks efficiency.<sup>25</sup> Curiously, this nexus between Pareto optimality and antitrust law has been all but overlooked in the economics literature due to the singular focus on the deadweight loss analysis.<sup>26</sup> Our analysis restores this nexus and suggests that the proper benchmark for measuring the cost of monopoly should be a Pareto optimal state of the economy, not simply competitive markets. A correct social cost metric should therefore reflect both the degree of deviation from a Pareto optimal state of the economy and the dollar amounts wasted.

But an economy can have possibly infinitely many Pareto optimal allocations, and we have not yet specified which of the many possible Pareto optimal states we should take as the relevant benchmark. We propose the unique Pareto optimal state characterized by Debreu’s *coefficient of resource utilization*,  $\rho$ . This coefficient is the smallest fraction of total resources capable of providing consumers with utility levels at least as great as those attained in the monopolized economic state.<sup>27</sup> Hence the efficiency loss in real terms is  $(1 - \rho) \times$  total resources; the economy can throw away  $(1 - \rho) \times$  total resources and not make anyone worse off.<sup>28</sup> For example, suppose Abigail has ten apples, Brian has ten

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<sup>22</sup> POSNER, *supra* note 5, at 28. In addition, Lerner notes that the “importance of the competitive position lies in its implications of being . . . the position in which the ‘Invisible Hand’ has exerted its beneficial influences to the utmost.” Lerner, *supra* note 11, at 162.

<sup>23</sup> William F. Baxter, the first antitrust chief during the Reagan Administration, says “the antitrust laws are a ‘consumer welfare prescription’—that is, they are intended to promote economic efficiency, broadly defined.” Likewise, Bork insists that the “only legitimate goal of American antitrust law is the maximization of consumer welfare . . . .” See Walter Adams et al., *Pareto Optimality and Antitrust Policy: The Old Chicago and the New Learning*, 58 SOUTHERN ECON. J. 1, 6 (1991). Modern courts also appear to understand the aim of antitrust law as enhancement of consumer welfare. Case law suggests that courts by way of antitrust law have shifted their focus from promoting competition to maximizing consumer welfare. See HYLTON, *supra* note 3, at 40.

<sup>24</sup> *Id.* at 5.

<sup>25</sup> According to the Council, an economy “is said to be ‘efficient’ if it is impossible to make anyone better off without making someone else worse off. That is, there is no possible rearrangement of resources, in either production or consumption, which could improve anyone’s position without simultaneously harming some other person.” See *id.*

<sup>26</sup> However, one of the few analyses that link monopoly and Pareto optimality was given by A.P. Lerner as early as 1937. See Lerner, *supra* note 11, at 162.

<sup>27</sup> Debreu analyzes economic loss associated with nonoptimal economic states and identifies three kinds of inefficiencies in economic systems. Only one need concern us here: “imperfection of economic organization such as monopolies or indirect taxation or a system of tariffs.” Debru, *supra* note 8, at 289. To measure the economic loss, he posits a cost-minimization problem dual to Pareto’s maximization of social welfare.

<sup>28</sup> An attentive reader might reason that this measure actually offers a lower bound of the social cost since applying the same  $\rho$  across all resources is constraining. Indeed, if we can determine the minimum level of resources necessary to achieve the same utility level without imposing the same proportion of reduction

pears, and although each would prefer a mixed bundle of pears and apples, they are prohibited from trading for some reason. If Abigail is indifferent between having ten apples and having a bundle of two apples and four pears, and Brian between ten pears and a bundle with five apples and three pears, then the current state of economy is no better off than one that could be achieved with only seven apples and seven pears. Thus society is squandering three apples and three pears, as they add nothing to consumer welfare. If no smaller bundle can achieve the same level of consumer welfare as the current state of economy, then the coefficient of resource utilization in this case is 0.7.

Importantly, the fact that we choose  $\rho$  to be the minimal coefficient renders the new state of the economy—in which nobody is worse off than in the monopolized state Pareto optimal relative to the reduced resource endowment.<sup>29</sup> Recall our discussion earlier that the inefficiency of monopoly could be viewed as using up more than necessary amounts of resources to achieve a particular utility level. Then the natural benchmark for a monopolized economy is the Pareto optimal economic state that uses the least amount of resources but produces the same or higher level of consumer satisfaction; specifically, society’s endowment in the new state will be exactly  $\rho \times$  total resources. The associated economic cost indicates the inefficiency due to monopolization and can be converted into a dollar amount.

<<INSERT FIGURE 3 HERE>>

This cost is indicated in Figure 3.<sup>30</sup> The original production possibility frontier (“PPF”) can be thought of as a social budget constraint.  $\alpha_1$  is the given state of economy, and  $\alpha_2$  is an alternative state that lies on the community indifference curve and is tangent to the counterfactual PPF. The counterfactual PPF represents the PPF produced with “minimal” social resources and yet is tangent to the community indifference curve, meaning every individual in the community is indifferent between the current state and the counterfactual state.

Of course, this notion of economic cost would have meaning only insofar as the relevant benchmark is actually achievable. After all, one of the reasons for which we are not satisfied with the deadweight loss triangle as the measure of the cost of monopoly was that the counterfactual was not an achievable state of economy. This is where the second

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across all resources, the measure of social cost might be greater. Nevertheless, there is no guarantee that such minimum bundle of resources is uniquely determined. The coefficient of resource utilization provides the benefit that such a level necessarily exists and is uniquely determined.

<sup>29</sup> The proof is by contradiction, and we include only a sketch here. Assume every consumer’s utility strictly increases, however small amount, with a positive change in any one of their goods. If the new economy were not Pareto optimal with respect to the reduced endowment, then the reduced endowment can be reallocated so as to increase at least one consumer’s utility by a positive measure. Then we can take some of this consumer’s endowments away from him and distribute them across everybody so as to increase everyone’s utility by a positive measure. By continuity we can find a way to distribute so that everyone’s utility returns to the normal level or remains slightly higher when everyone’s endowment is systematically reduced by a fraction close to but less than 1, say  $\beta$ . This violates the minimality of  $\rho$ , since  $\beta\rho < \rho$ .

<sup>30</sup> We thank T.N. Srinivasan for suggesting this diagram.

welfare theorem of general equilibrium theory comes in, which tells us that *every* Pareto optimal economic state can be realized as a competitive equilibrium with lump sum transfers of income between households.<sup>31</sup> As a result, using only  $\rho \times$  total resources and with lump sum transfers, society can achieve the desired Pareto optimal state. Hence a benevolent social planner with perfect information could achieve our counterfactual while he cannot achieve the perfect competition benchmark. In addition, the resulting measure of social cost provides the added benefit of assuming only ordinal measures of utility. We need no longer assume either that a dollar is worth the same to everyone or that utility functions can be aggregated across consumers. Adding up the cost of resources too makes sense with this framework since we are not equating these economic costs with gains or losses in individual utility levels. Our task thus reduces to estimating  $\rho$  and the amount of resources wasted in a given monopoly state.

Before we go on, we want to make an important observation. Our exclusive focus on Pareto optimality seems to ignore the welfare of the producers, and this may appear to be inconsistent with the original concern for social surplus, which includes both consumer surplus and producer surplus. Not so. If one were to make an analogy at all, general equilibrium theory's notion of Pareto optimality should be compared with partial equilibrium theory's notion of social surplus, not consumer surplus. This is because in general equilibrium theory, consumers own the firms, and thus the firm's profits are distributed back to the consumers according to their shares of ownership. Firm decisions are made so as to maximize the welfare of consumer-shareholders, and there are no personas associated with the producers.

#### IV. A TWO-SECTOR MODEL AND COST-MINIMIZING EQUILIBRIA

We now formalize our idea and illustrate the computation of  $\rho$  with a two-sector general equilibrium model.<sup>32</sup> By now, we hope the motivation for having a two-sector model is clear to the readers: if the cost of monopoly in an industry can only be analyzed in relation to another industry that shares same factor inputs, a proper analysis of the social cost must include at least two sectors. While our model can be generalized to accommodate multiple sectors, we only really need two sectors in order to convey the main ideas effectively. There are two consumers, two commodities, two firms, and two factors of production.<sup>33</sup> We make the standard assumptions from microeconomic theory.

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<sup>31</sup> See MAS-COLELL ET AL., *supra* note 21, at 551-58.

<sup>32</sup> We formulate our model following John B. Shoven and John Whalley's work. See generally JOHN B. SHOVEN & JOHN WHALLEY, *APPLYING GENERAL EQUILIBRIUM* (1992). The relevant parts are Sections 3.2 and 3.3, and also Chapter 6, where the authors include Arnold Harberger's two-sector general equilibrium analysis of capital taxation. This model can easily extend to three or more sectors.

<sup>33</sup> This model is widely used in the applied fields of international trade and taxation where the focus is on general equilibrium comparative statics for policy evaluation. Also the data available such as national accounts and input-output data are easily accommodated in a two-sector model. For readers unfamiliar with the properties of the two-sector model, we recommend SHOVEN & WHALLEY, *supra* note 32. Here we follow the notation in Donald J. Brown & Geoffrey M. Heal, *Marginal vs.. Average Cost Pricing in the Presence of a Public Monopoly*, AMER. ECON. REV. 189 (1983).

Consumers have smooth, concave monotone utility functions and endowments of capital and labor and shareholdings in firms; they maximize utility subject to their budget constraints and are price-takers in the product and factor markets. Each firm produces a single output with a smooth monotone and strictly quasi-concave production function. In equilibrium all markets clear.

Competitive firms maximize profits and are price-takers in both the product and competitive factor markets; they produce at minimum cost and price output at marginal cost. Most of general equilibrium theory conventionally assumes competitive markets in all sectors.<sup>34</sup> In order to extend the paradigm to encompass the existence of monopoly power, we introduce a new notion of market equilibrium: firms with monopoly power have unspecified price-setting rules for output—where the price of output is a function of the level of the output<sup>35</sup>—but are assumed to be cost-minimizing price-takers in competitive factor markets.<sup>36</sup> This means, for instance, that Microsoft may have monopoly power in the software market but it still needs to pay competitive wages for its employees. Meanwhile, in equilibrium they make supra-competitive profits since the monopoly price exceeds the marginal cost of production. Our analysis derives from a subtle but important distinction between price-setting profit-maximization—which we rejected—and monopoly power, i.e. the power to raise price above the competitive level and make supra-competitive profits.<sup>37</sup> Both OPEC and Microsoft have monopoly power under this definition and it seems reasonable to assume that both attempt to produce output at minimum cost. But neither OPEC nor Microsoft appears to be setting prices to maximize monopoly profits.

We denote the two consumers as  $x$  and  $y$ . The inputs or factors are capital ( $K$ ) and labor ( $L$ ). The outputs or goods are natural gas ( $G$ ) and electricity ( $E$ ). Each consumer has a utility function denoted  $U_x$  and  $U_y$ . Consumers are endowed with capital and labor, which they provide to firms in exchange for wages and rental rates; they also have shares in the ownership of the firm. Endowments and shareholdings in firms for  $x$  and  $y$  are given by  $(K_x, L_x)$ ,  $(K_y, L_y)$ ;  $(\theta_{xG}, \theta_{xE})$ ,  $(\theta_{yG}, \theta_{yE})$ . Each firm has a production function,  $F_G$  and  $F_E$ . Let  $K = K_x + K_y$ , and  $L = L_x + L_y$ . Let  $P_G$  and  $P_E$  denote the prices of natural gas and electricity, and  $w$  and  $r$  denote the prices of labor and capital. Consumers can freely trade goods with each other, but not their labor or capital endowment; firms can freely trade factor inputs. We suppose that the gas market is competitive but the electricity market is monopolized. Therefore  $P_G = MC_G$ , the marginal cost of producing gas, and gas is produced with constant returns to scale.

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<sup>34</sup> In fact, the Arrow-Debreu general equilibrium model, with its indeterminate absolute price level, cannot accommodate price-setting, profit-maximizing firms. See Richard R. Cornwall, *The Concept of General Equilibrium in a Market Economy with Imperfectly Competitive Producers*, 29 METROECONOMETRICA 55 (1977); Volker Bohm, *The Foundation of the Theory of Monopolistic Competitive Revisited*, 63 J. ECON. THEORY 208 (1994).

<sup>35</sup> See KREPS, *supra* note 16, at 726-29.

<sup>36</sup> “By pure monopoly is meant a case where one is confronted with a falling demand curve for the commodity one sells, but with a horizontal supply curve for the factors one has to buy for the production of the commodity; so that one sells as a monopolist but buys in a perfect market.” Lerner, *supra* note 11, at n.2.

<sup>37</sup> This latter definition is consistent with Lerner’s index. “If  $P$  = price and  $C$  = marginal cost, then the index of the degree of monopoly power is  $(P-C)/P$ .” Lerner, *supra* note 11, at 169.

Let us consider how the economy operates. Consumers consume electricity and gas to maximize their utility subject to their budget constraints. They have several sources of income: wages from providing labor, interest rates on their capital investment, and dividends from the firms' shares, which are determined by the firms' profits. Therefore, we write the consumer's problem as follows:

### Consumer's Problem

$$\max U_i(E_i, G_i) \quad \text{subject to} \quad P_E E_i + P_G G_i \leq I_i \quad (1)$$

where  $I_i = wL_i + rK_i + \theta_{iG}(P_G G - wL_G - rK_G) + \theta_{iE}(P_E E - wL_E - rK_E)$   
and  $i = x, y$ .

Since utility increases in  $E_i$  and  $G_i$ , the weak inequality ends up binding. In addition, since the gas market is competitive, the third term in the income equation is zero. Meanwhile, firms minimize their cost of production given their target levels of production.

### Firm's Problem

$$\min wL_j + rK_j \quad \text{subject to} \quad F_j(L_j, K_j) = j, \text{ for } j = E, G. \quad (2)$$

Notice that these target levels are not necessarily determined by profit-maximization motives. For monopoly or any other market structure it matters not how the actual target levels are chosen; our methodology gives a measure of inefficiency based on the observable production levels the firms choose and market prices.

Now we give our definition of cost-minimizing market equilibrium.

**Definition.** A *cost-minimizing equilibrium* is then defined as a set of relative prices  $P_E/w$ ,  $P_G/w$  and  $r/w$ ; consumer's demands for goods  $E_x$ ,  $G_x$  and  $E_y$ ,  $G_y$ ; firm's demands for factors  $L_E$ ,  $K_E$  and  $L_G$ ,  $K_G$ ; and output levels  $E$  and  $G$  such that (i) consumers maximize their utility levels given the prices of goods, (ii) firms make nonnegative profits and minimize their costs of production given the prices of factor inputs; and (iii) all markets clear. That is,

$$\text{Product Markets:} \quad E_X + E_Y = E ; G_X + G_Y = G \quad (3)$$

$$\text{Factor Markets:} \quad L_E + L_G = L ; K_E + K_G = K \quad (4)$$

$$\text{Nonnegative Profits:} \quad P_E E \geq wL_E + rK_E ; P_G G = wL_G + rK_G. \quad (5)$$

An important result from general equilibrium theory is the set of conditions necessary for Pareto optimality of the economy.<sup>38</sup> We will first state them and explain

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<sup>38</sup> For the intuition and derivation of these necessary conditions, see generally Francis Bator, *The Simple*

intuitively why these conditions are necessary:

$$(i) \quad MRS_x = MRS_y \quad (6)$$

$$(ii) \quad MRTS_E = MRTS_G \quad (7)$$

$$(iii) \quad MRS_x = MRT = MC_G/MC_E. \quad (8)$$

To begin with, what can we say about a Pareto optimal state of the economy? At an optimal state, consumption should be efficient in the sense that the consumers should not be able to trade their consumption goods with each other and achieve a Pareto improvement. In addition, production should be efficient in the sense that the firms should not be able to trade their factor inputs and achieve a Pareto improvement on society's production levels. And finally, we also want to make sure the product-mix is efficient in the sense that society should not elect to produce a unit of gas instead of some additional amount of electricity if a consumer prefers more electricity to gas in his consumption. The above conditions are simply abstractions of these intuitions.

$MRS_x$  refers to the marginal rate of substitution of electricity for gas for  $x$ , and it represents the rate at which  $x$  is willing to give up electricity for gas, holding his utility constant. This is also equal to the ratio of marginal utilities for each good:  $MU_{x,G} / MU_{x,E}$ . The first condition says that at optimum,  $x$ 's willing rate of substitution must equal that of  $y$ 's. Let us see why this is true. Without loss of generality, suppose that  $MRS_x = 2$  and  $MRS_y = 1$  at some point. This state cannot be optimal.  $x$  is willing to give up as much as 2 units of electricity to obtain 1 unit of gas, and  $y$  is willing to make a one-to-one trade and still able to maintain her current utility level. Then  $y$  can choose to trade one unit of her gas to extract two units of electricity from  $x$ . This exchange will not change  $x$ 's utility but will increase  $y$ 's utility since  $y$  would have achieved the same level of utility with just one unit of electricity and now she ends up with one extra unit. Since this is a strict improvement for  $y$  without hurting  $x$ , the new state is a Pareto improvement to the original state, contradicting our assumption that the current state is Pareto optimal. Thus we must have  $MRS_x = MRS_y$ .

The second condition refers to the marginal rate of transformation, and the analysis is similar to the first one. The marginal rate of technical substitution measures the rate at which the firm can replace one input, say labor, by the other, capital while maintaining the same production level. If  $MRTS_E = 2$ , this means, Firm  $E$  can produce the same amount of electricity while trading in two units of labor for one unit of capital. It is then easy to see why we need  $MRTS_E = MRTS_G$  at optimum. For example, if  $MRTS_E = 2$  and  $MRTS_G = 1$ , then Firm  $E$  can maintain its current production level by taking one additional unit of capital and giving up two units of labor. Since Firm  $G$  can trade at a one-to-one ratio and maintain its current level of production, Firm  $G$  can increase its production level by offering one unit of its capita to Firm  $E$  and receiving two units of labor. This is an

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*Analytics of Welfare Maximization*, 47 AMER. ECON. REV. 22 (1957).

overall improvement to the current state, and thus it violates the optimal condition. Therefore, we must have  $MRTS_E = MRTS_G$  at optimum.

The third condition equates  $MRS_x$  with  $MRT$ , the marginal rate of transformation.  $MRT$  represents how many units of electricity must be sacrificed in order for society produce gas; this incorporates the marginal costs of production for both. That  $MRT$  should equal to the ratio of  $MC_G$  and  $MC_E$  can be explained by the fact that is  $MC_G$  the cost to society of producing one additional unit of gas (by expending some combination of labor and capital) and  $MC_E$  the cost to society of producing one additional unit of electricity. A more interesting question is why  $MRS_x$  should equal  $MRT$ . If  $MRS_x = 2$  but  $MRT = 1$ , for example, that means  $x$  is willing to give up as much as 2 units of electricity to obtain 1 unit of gas. Since the costs to society are equal for production of gas and production of electricity at the margin, it would have been better to have forgone the production of the last unit of electricity and instead devote this resource to producing an additional unit of gas. This would have made  $x$  happier since his utility level would have been the same with giving up two units of electricity and obtaining one unit of gas, but with society's alternate production plan he need only give up one unit of electricity and obtain one unit of gas. Therefore, we need  $MRS_x = MRT$ . Analogously,  $MRS_y = MRT$  and in the end society's marginal rate of transformation must be equal to the marginal rate of substitution for every consumer in the economy.

In addition to these necessary conditions, we derive a few more conditions from the consumers' and the firms' optimization problems. The firm's cost minimization problem relates the marginal rate of technology substitution with wages and rental rates. As for the consumer's problem, since the consumers make their consumption decisions based on the market prices, the first-order condition from the consumers' problem tells us that:

$$MU_{x,G} / MU_{x,E} = P_G / P_E \quad (9)$$

Since  $MRS_x = MU_{x,G} / MU_{x,E}$ , if we combine (9) with (8), we have

$$P_G / P_E = MC_G / MC_E. \quad (10)$$

And  $P_G = MC_G$ , since the market for gas is competitive. Hence for Pareto optimality,<sup>39</sup> we must also have

$$P_E = MC_E. \quad (11)$$

It is in this sense that we should view marginal cost pricing not only as a result of perfect competition but also as a necessary condition for society to achieve Pareto optimality.

We now turn to the computation of  $\rho$  in this two-sector model. Suppose the given economic state of the model is a cost minimizing market equilibrium where  $P_E / P_G \neq MC_E / MC_G$ , and suppose in equilibrium  $x$  consumes  $(\hat{E}_x, \hat{G}_x)$  and  $y$  consumes  $(\hat{E}_y, \hat{G}_y)$ .  $\rho$  is the

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<sup>39</sup> Likewise, since consumers make decisions about how much labor and capital to offer to the firms based on wage and rental rates, the optimization condition from the firm's problem dictates that the marginal rate of technical substitution of capital for labor be equal to the ratio of  $w/r$ .

minimum  $\alpha$  between 0 and 1 where the given two-sector model with reduced social endowments  $\alpha K$  and  $\alpha L$  can produce sufficient electricity  $\check{E}$  and natural gas  $\check{G}$  such that:

$$U_x(\check{E}_x, \check{G}_x) \geq U_x(\hat{E}_x, \hat{G}_x) \quad (12)$$

$$U_y(\check{E}_y, \check{G}_y) \geq U_y(\hat{E}_y, \hat{G}_y) \quad (13)$$

$$\check{E}_x + \check{E}_y = \check{E}; \check{G}_x + \check{G}_y = \check{G}. \quad (14)$$

$$\check{E} = F_E(\underline{L}_E, \underline{K}_E); \check{G} = F_G(\underline{L}_G, \underline{K}_G) \quad (15)$$

$$\underline{L}_E + \underline{L}_G = \alpha L; \underline{K}_E + \underline{K}_G = \alpha K \quad (16)$$

These equations and inequalities define the optimization problem for determining  $\rho$  and we can solve them using the Lagrange multiplier method.

<<INSERT FIGURE 4 HERE>>

We can illustrate this with Figure 4. The outputs  $(\hat{E}, \hat{G})$  produced in a cost minimizing market equilibrium lie on the PPF, as a consequence of competitive factor markets and production at minimum cost.  $\alpha_1$  is the output  $(\hat{E}, \hat{G})$  produced in the cost minimizing market equilibrium.  $\alpha_2 = (\check{E}, \check{G})$  and satisfies (12)-(16). The social endowments used to produce  $\alpha_2$  are  $\rho K$  and  $\rho L$ , where  $K$  and  $L$  are the original social endowments of capital and labor. If the slope of the PPF is  $P_E^*/P_G^*$ , then  $\rho$  is the ratio  $G_N/G_0$  and the economic cost is  $(1-\rho)[wL + rK]$ .<sup>40</sup> The existence of such  $\alpha$  is guaranteed since solutions to (12)-(16) are guaranteed for  $\alpha = 1$  by virtue of the existing market allocations. The uniqueness is also assured since we choose the minimal such  $\alpha$ . In practice,  $\rho$  must be estimated from market data, and in Part VI we show how this is done.

A natural question at this point is how this dollar amount would compare to the dollar amount of the deadweight loss triangle. As it turns out, there are no systematic relationships between these two figures. The economic wastes from the applied general equilibrium model can be lower, higher, or equal to the dollars corresponding to the deadweight loss costs.

Before we conclude this Part, we make a side remark. We showed above that marginal cost pricing was a necessary condition for Pareto optimality. Supra-competitive pricing, of course, is not the only instance where (11) is violated: firms practicing predatory pricing violate (11) also by artificially setting prices below marginal costs. Thus, this perspective on marginal cost pricing illuminates an important aspect of predatory pricing: *the harm in predatory pricing is that by selling goods at a price below marginal cost, the firm destroys Pareto optimality in society in much the same way monopoly pricing does.*

<sup>40</sup> This computation is given in Donald J. Brown & G.A. Wood, "the Social Cost of Monopoly," COWLES FOUNDATION DISCUSSION PAPER No. 1466 (2004).

This observation challenges the current approach towards predatory pricing in antitrust law established in *Brooke Group Ltd. v. Brown & Williamson Tobacco Corp.*<sup>41</sup> Under this standard, an incumbent monopolist cannot be held liable for predatory pricing unless plaintiff can show not only that the monopolist priced goods below marginal cost but also that the monopolist had a reasonable prospect of recouping the incurred costs. Judge Easterbrook reasoned in another case that “if there can be no ‘later’ in which recoupment could occur, the consumer is an unambiguous beneficiary even if the current price is less than the [marginal] cost of production.”<sup>42</sup> Our model shows that a monopolist who practices predatory pricing incurs social cost even absent the prospect of driving out competition or the prospect of recouping the costs. This symmetry between monopoly pricing and predatory pricing should not come as a surprise in light of the fact that predatory pricing, too, offers consumers false alternatives in terms of consumption goods, just as monopoly pricing does. Due to the lowered pricing, consumers may elect to consume a particular good over another even though the consumed good may be more costly to produce.

## V. APPLICATION TO THE *GRINNELL* TEST

In this Part, we consider how we can implement our model to measure monopoly power. One definition of monopoly power in the literature of antitrust economics is the existence of substantial market power for a significant period of time. For cases involving Section 2 of the Sherman Act, courts use the *Grinnell* test: the offender must have both “(1) the possession of monopoly power in the relevant market and (2) the willful acquisition or maintenance of that power as distinguished from growth or development as a consequence of a superior product, business acumen, or historic accident.”<sup>43</sup> The determination of the second element depends on the intent of the monopolist and will necessarily turn on the factual background of the case; the court will have to look at the business practice and exclusionary conduct. The first element, however, is an empirical question and its determination must turn on the history of price and demand data over a period of time. That is, in order for the courts to apply the *Grinnell* test they must review a history of the alleged monopolist’s pricing behavior to ascertain the existence of monopoly power. The difficulty with inference of monopoly power is that neither the cost curves nor the demand curves are generally known; market data only provide us with the equilibrium behaviors of consumers and firms. Nonetheless we can combine some of the results from advanced microeconomic theory with our model to determine the existence of monopoly power.

Let us consider how this would work and what it is that we want to find. If a given industry is relatively competitive, then the price will be close to the marginal cost, the social cost from the firms’ behavior will be small and the resulting  $\rho$  will be close to 1. If we can calculate  $\rho$  and find that it is significantly smaller than 1, then this is evidence that the market is not competitive, and we can infer monopoly power accordingly. But in

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<sup>41</sup> 509 U.S. 209 (1993).

<sup>42</sup> A.A. Poultry Farms, Inc. v. Rose Acre Farms, Inc., 881 F.2d 1396, 1401 (7th Cir. 1989).

<sup>43</sup> United States v. Grinnell Corp., 384 U.S. 563, 570-71 (1966).

order to calculate  $\rho$ , we must solve the minimization problem defined by Equations (12)-(16) and we have neither the utility functions nor the firm's production functions to work with. Instead we only have a history of market data, which tells us how consumers' behaviors<sup>44</sup> have changed over time with firms' varying prices and how firms' production levels have changed over time with varying factor prices. Since these data only provide us with the equilibrium behaviors, they are incomplete in that the utility functions of consumers and the production functions of firms are not observable. Microeconomic theory tells us how we can use observed equilibrium consumptions, factor demands of firms and market prices to approximate these functions from the equilibrium inequalities. At this point we can solve the problem defined by (12)-(16) and impute the economic costs of monopolization in terms of Debreu's coefficient of resource utilization.

The equilibrium inequalities consists of: the Afriat inequalities for each consumer; her budget constraint in each observation; Varian's cost minimizing inequalities for each firm; the market clearing conditions for the goods and factor markets in each observation; and the nonnegative profit conditions for each firm in each observation.<sup>45</sup> The Afriat inequalities follow from the Consumer's Problem in (1) and consist of a finite number of linear inequalities derived from a finite number of observations on a consumer's demands. Suppose we are given a history of demand pattern  $\mathbf{x}_1, \mathbf{x}_2, \dots, \mathbf{x}_n$  at market prices  $\mathbf{p}_1, \mathbf{p}_2, \dots, \mathbf{p}_n$ . Each  $\mathbf{x}_i$  is a bundle of goods at the household level, and each  $\mathbf{p}_i$  is a vector of prices. We say that the Afriat inequalities are solvable if there exist a set of utility levels and marginal utilities of income for each observation,  $\{(V_1, \lambda_1), \dots, (V_n, \lambda_n)\}$ , such that given any pair of observations,  $i$  and  $j$ , we have

$$V_i \leq V_j + \lambda_j \mathbf{p}_j \cdot (\mathbf{x}_i - \mathbf{x}_j) \quad \text{and} \quad V_j \leq V_i + \lambda_i \mathbf{p}_i \cdot (\mathbf{x}_j - \mathbf{x}_i). \quad (17)$$

Afriat's celebrated theorem<sup>46</sup> is that if we can find the solutions to these  $V_i$  and  $\lambda_i$ , then we can find a concave, monotonic and continuous utility function  $U(\mathbf{x})$  such that  $U(\mathbf{x}_i) = V_i$  and rationalizes the data.

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<sup>44</sup> We assume these data are available at the household level.

<sup>45</sup> For discussions on Afriat's and Varian's inequalities, see S.N. Afriat, *The Construction of Utility Function from Expenditure Data*, 8 INT'L. ECON. REV. 67 (1967); Hal R. Varian, *The Nonparametric Approach to Demand Analysis*, 50 ECONOMETRICA 945 (1982).

<sup>46</sup> A utility function  $U$  is said to *rationalize* the data  $\{(\mathbf{p}_1, \mathbf{x}_1), \dots, (\mathbf{p}_n, \mathbf{x}_n)\}$  if for all  $i$ ,  $U(\mathbf{x}_i) \geq U(\mathbf{x})$  for all  $\mathbf{x}$  such that  $\mathbf{p}_i \cdot \mathbf{x} \leq \mathbf{p}_i \cdot \mathbf{x}_i$ . Afriat's theorem is that the data is rationalized by a concave, monotonic and continuous utility function  $U$  if and only if the Afriat inequalities are solvable; and a rationalizing  $U$  can be constructed from each solution of the Afriat inequalities. For the derivation of Afriat's inequalities, we use the Kuhn-Tucker formulation of the F.O.C for utility maximization subject to a budget constraint, assuming that the utility function is strictly concave, monotone and the indifference curves do not cut the boundary of the positive orthant, e.g., Cobb-Douglas. Then the optimal  $x$  and Lagrange multiplier,  $\lambda$ , are a saddle-point of the Lagrangian (see Intrilligator's text on Mathematical Economics). The Afriat inequalities are a trivial corollary of this fact. The surprising part is the converse theorem, i.e. if the Afriat inequalities have a solution then there is a utility function that rationalizes the data, see the proof in Varian, *supra* note 45. For Varian's cost-minimizing inequalities it is the same argument, where the optimization problem is cost minimization subject to an output constraint.

Varian's cost minimizing inequalities use a similar concept. They follow from the Firm's Problem from (2) and consist of a finite number of linear inequalities derived from a finite number of observations on a firm's outputs  $f_1, f_2, \dots, f_n$ ; factor demands:  $\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_n$ ; and factor prices:  $\mathbf{q}_1, \mathbf{q}_2, \dots, \mathbf{q}_n$ . Varian showed that if we can find a set of numbers,  $\{\beta_1, \dots, \beta_n\}$ ,<sup>47</sup> such that given any pair of observations,  $i$  and  $j$ , we have

$$f_i \leq f_j + \beta_j \mathbf{q}_j \cdot (\mathbf{y}_i - \mathbf{y}_j) \quad \text{and} \quad f_j \leq f_i + \beta_i \mathbf{q}_i \cdot (\mathbf{y}_j - \mathbf{y}_i), \quad (18)$$

then we can construct a continuous, monotonic, quasi-concave cost function such that the firm's decisions are consistent with the cost-minimization problem.<sup>48</sup>

We can combine these results with our model to estimate  $\rho$  from market data. Given a history of observations on the two-sector model, the equilibrium inequalities are solvable linear inequalities in the utility levels and marginal utilities of households and the marginal costs of firms, for parameter values given by the observed market data—that is, market prices, factor endowments, consumption levels, and share holdings in firms—if and only if this is a history of cost minimizing market equilibria. The solution determines a utility function for each household and a production function for each firm that is consistent with the market data in each observation. Using these utility functions and production functions we can solve the minimization problem for  $\rho$  defined by equations (12)-(16).

## VI. CONCLUSION

In this Article, we join with Robert Bork and William Baxter in proposing Pareto optimality as the embodiment of the goals of antitrust law. As such, it implicitly defines the proper benchmark for assessing the social cost of monopoly as the Pareto optimal state that utilizes minimal economic resources to provide the same level of consumer satisfaction as realized in the monopolized state. These wasted real resources provide a measure of the social cost of monopoly free from the vagaries of the social surplus measure used in conventional deadweight loss analysis of monopoly pricing, such as assuming a constant and equal marginal utility of income across consumers. Our model uses applied general equilibrium theory, which allows for the effects of monopolization on multiple sectors in the economy, an empirical determination, in a series of historical observations, of allegations of monopoly power, as required by the *Grinnell* test, and a reappraisal of predatory pricing.

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<sup>47</sup>  $\beta_i$  turns out to be the reciprocal of the marginal cost at each observation.

<sup>48</sup> A production function  $f$  is said to rationalize the data if for all  $i$ ,  $f_i(\mathbf{y}_i) = f_i$  and  $f_i(\mathbf{y}) \geq f_i(\mathbf{y}_i)$  implies  $\mathbf{q}_i^i \cdot \mathbf{y} > \mathbf{q}_i^i \cdot \mathbf{y}_i$ . That is,  $y$  minimizes the cost over all bundles of factors that can produce at least  $f_i$ . Varian's theorem is that the cost minimizing inequalities are solvable if and only if there exists a continuous monotonic quasi-concave, i.e., diminishing marginal rate of substitution along any isoquant, function that rationalizes the data. See Varian, *supra* note 45.

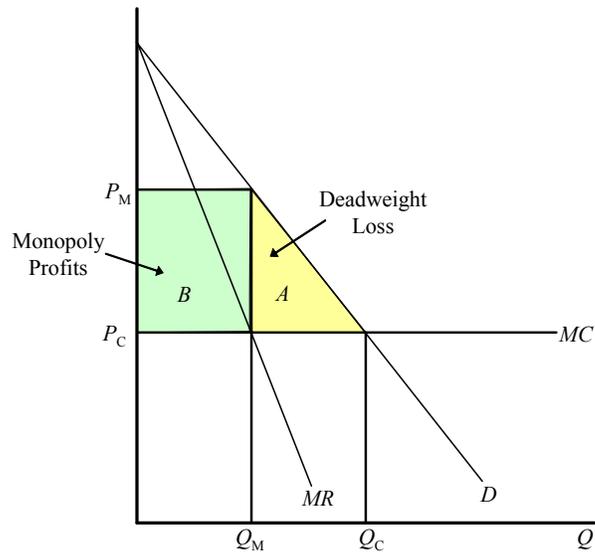


Figure 1. Partial Equilibrium Analysis

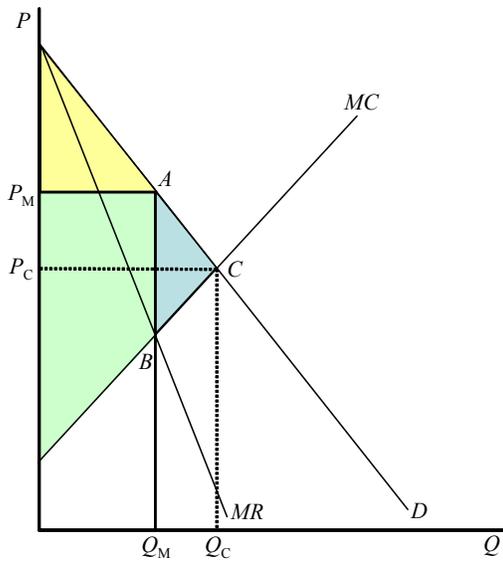


Figure 2a. Monopoly and Competition in the Twidget Market

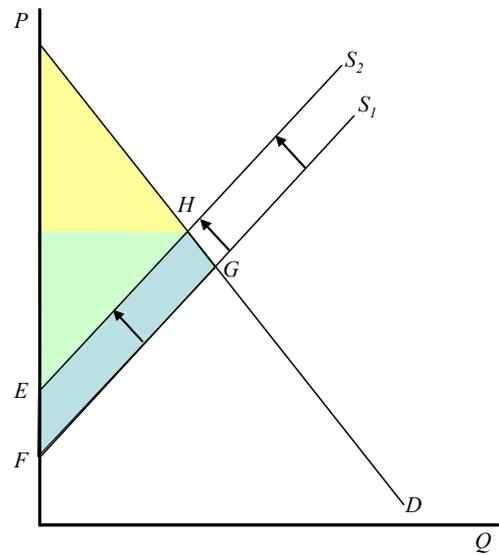


Figure 2b. Competitive Widget Market

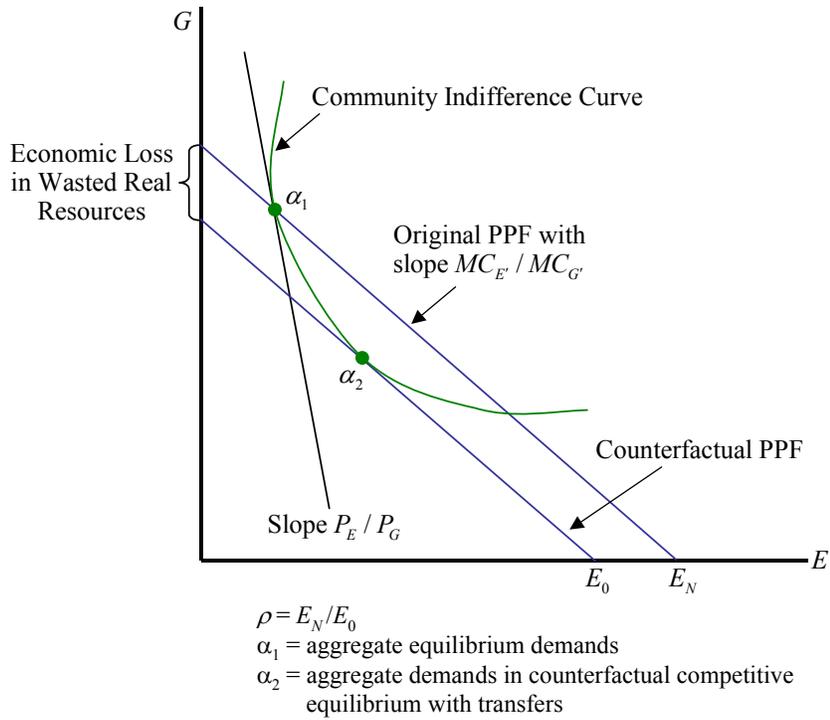


Figure 3. General Equilibrium Analysis

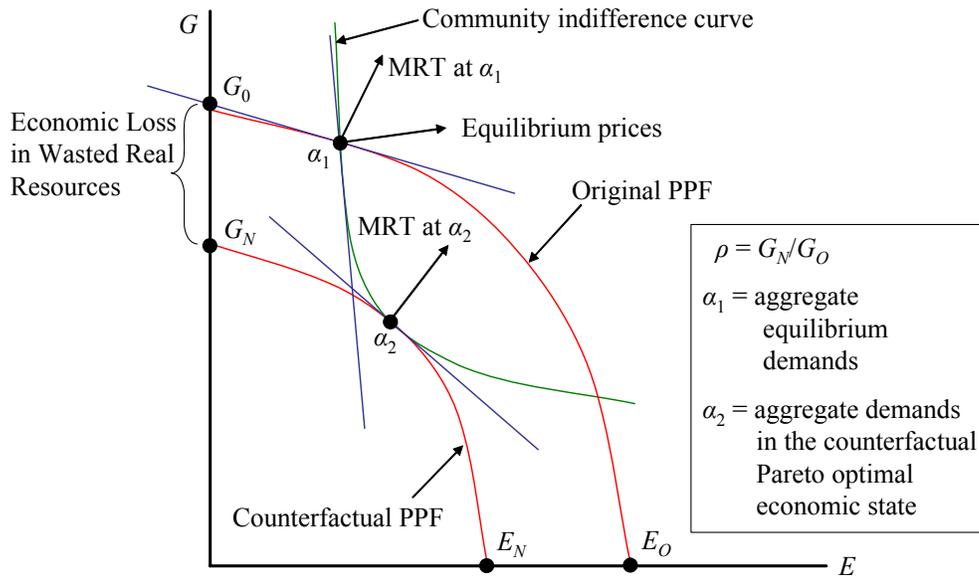


Figure 4. The Social Cost of Monopoly