COMPETITION, CONSUMER WELFARE AND MONOPOLY POWER

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Competition, Consumer Welfare and Monopoly Power*

Donald J. Brown† and G.A. Wood‡

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Abstract

An applied general equilibrium analysis of monopoly power is proposed as an alternative to the partial equilibrium analyses of monopoly pricing current in antitrust economics. This analysis introduces a new notion of market equilibrium where firms with monopoly power are cost-minimizing price-takers in competitive factor markets and make supracompetitive profits in equilibrium, i.e., the monopoly price exceeds the marginal cost of production.

We asume that the primary goals of antitrust policy are the promotion of competition and the enhancement of consumer welfare. To that end, we use Debreu's coefficient of resource utilization to determine the counterfactual competitive price levels in monopolized markets and then impute the economic costs of monopolization.

Keywords: Monopoly power, Antitrust economics, Applied general equilibrium analysis

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1 Introduction

Applied general equilibrium models are numerical, empirically based Arrow–Debreu models where firms are profit-maximizing price-takers in both the product and factor markets. As is now well known — see Cornwall (1977), Bohm (1994) and more recently Dierker and Grodal (1998) — the Arrow–Debreu general equilibrium model, with its indeterminate absolute price level, cannot accommodate price-setting, profit-maximizing firms.

As a result, the partial equilibrium analysis of monopoly pricing, current in antitrust economics, cannot be extended to the Arrow–Debreu model. Our analysis derives from the subtle but important distinction between price-setting profit-maximization and monopoly power, i.e., the power to raise price above the competitive level and make supracompetitive profits. 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 appear to be setting prices to maximize monopoly profits.

The existence of monopoly power is one of the two essential elements of the Grinnel test, a test that is applied in all section 2 cases of the Sherman Act — see the development of section 2 doctrine in Hylton (2003). To extend the applied general equilibrium paradigm to encompass the existence of monopoly power, we introduce a new notion of market equilibrium. In this equilibrium, firms with monopoly power are cost-minimizing price-takers in competitive factor markets and make supracompetitive profits, i.e., the monopoly price exceeds the marginal cost of production.

The empirical specification of these "cost-minimizing market equilibria" is presented as a family of multivariate polynomial inequalities, with market data as parameters, where the unknowns are the marginal costs of producers, the utility levels of consumers and the marginal utilities of income of consumers. If these inequalities have a solution then we can construct utility functions and production or cost functions such that in each observation the market data is consistent with the notion of a cost-minimizing market equilibrium. In general, the solution is not unique, giving rise to a range of model outcomes. Also there may be no solution, i.e., our model is refuted by the data.

If there are solutions then they imply bounds on the Lerner index, a standard proxy in antitrust economics for measuring monopoly power. Hylton (2003) asserts that measuring monopoly power with the Lerner index overstates the monopoly surcharge and that the "correct" price-cost margin is the difference between the observed monopoly price and the (unobserved, counterfactual) competitive price level.

We assume that the primary goals of antitrust policy are the promotion of competition and the enhancement of consumer welfare. To that end we use Debreu's coefficient of resource utilization and the solutions of the equilibrium inequalities to bound the unobserved counterfactual competitive price levels in monopolized markets, and then impute upper and lower bounds on the economic costs of monopolization.

This paper is divided into several sections. In the next section, we discuss our model in the context of applied general equilibrium analysis. The family of multivariate polynomial inequalities characterizing the empirical implications of cost-minimizing market equilibria are presented in the third section. The fourth section of the paper is devoted to deriving the counterfactual competitive outcomes in monopolized markets and computing the associated economic costs of monopolization from the equilibrium inequalities and Debreu's coefficient of resource utilization. The final section is a brief discussion.

2 Applied General Equilibrium Analysis

Scarf (1967) published a landmark paper on computing approximate fixed points of a continuous mapping of a compact, convex subset of $\mathbb{R}^n$ into itself. In 1973, he published a monograph on computing equilibria in the Arrow–Debreu model of a decentralized market economy. In the decade following the publication of Scarf's monograph, Shoven and Whalley, students of Scarf wrote a number of papers applying general equilibrium theory to policy evaluations in the fields of public finance, international trade, development economics and energy economics.

Applied general equilibrium analysis — see Shoven and Whalley (1992) — uses numerical, empirically-based general equilibrium models where real market data is used to specify the parameters of production and demand functions in an Arrow–Debreu model. This model is solved, using Scarf's algorithm or one of its many variants, for different values of policy variables such as taxes and quotas. These counterfactual equilibria are then used to evaluate the welfare implications of concrete policy alternatives and appraise the effects of policy on the allocation of real resources.

This methodology has not been successful in evaluating policy where firms are price-setting profit-maximizers — see Ginsburg (1994) and Kletzer and Srinivasan (1994). The failure is due to the so-called price normalization problem. Simply put, in a model such as the Arrow–Debreu general equilibrium model where the absolute price level is indeterminate, profits are normalized using one of the commodities as numeraire, i.e., some price normalization rule is applied. But the resulting profit functions for different price normalizations are not monotone transformations of each other. Hence, in effect, each price normalization gives rise to a different objective of the firm and therefore different optimal behavior. Consequently, the welfare of consumers with equity in the monopoly firms depends on the arbitrary choice of numeraire. Interested readers should see footnote 1 in Dierker and Grodal (1998) to dispel the belief (hope) that the price normalization problem can be solved by introducing fiat money into the Arrow–Debreu model.

Dierker et al. (1985) extended the Arrow–Debreu general equilibrium model of a decentralized market economy to allow for some price-setting firms. These firms take the output levels of their products as well as the prices for factors as given, minimize the costs of production, and set prices of their products according to some specific pricing rule. Competitive firms use the marginal cost pricing rule, but their model allows for a wide variety of pricing rules for other firms such as average cost pricing or mark-up over cost pricing. It is important to note that the technical assumptions they impose on their pricing rules to guarantee existence of an equilibrium explicitly rule out monopoly pricing as described in antitrust economics. Hence the price normalization problem is due to the conjunction of price-setting and profit maximization.

The Grinnel test for section 2 cases of the Sherman Act has two elements. The first element requires proof that monopoly power exists, e.g., the monopoly price exceeds the marginal cost of production. The test does not require proof of price-setting, profit maximizing behavior on the part of the monopolist. The latter behavior is a sufficient but not a necessary condition for the existence of monopoly power. Consequently we propose a notion of market equilibrium consistent with the first element of the Grinnel test. That is, firms with monopoly power are assumed to be cost-minimizing price-takers in competitive factor markets, make supracompetitive profits in equilibrium, i.e., the monopoly price exceeds the marginal cost of production, but we do not assume that they are profit-maximizing price-setters in their product markets.

We formulate our general equilibrium model following Shoven and Whalley (1992) — see Sections 3.2 and 3.2 and, in particular, Chapter 6 on Harberger's two-sector general equilibrium analysis of capital taxation. There are M consumers, N commodities, and two factors of production (capital and labor). 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. There are N firms, each firm produces a single output with a smooth, monotone and strictly quasiconcave production function. Competitive firms maximize profits and are price-takers in the product and competitive factor markets. They produce at minimum cost and price output at marginal cost. Firms with monopoly power have unspecified price-setting rules for output, but are assumed to be cost-minimizing price-takers in competitive factor markets. In equilibrium they make supracompetitive profits, i.e., the monopoly price exceeds the marginal cost of production. In equilibrium all markets clear.

We now give a formal definition of a cost minimizing market equilibrium in the two-sector general equilibrium model. This model has two goods, two factors, two firms and two types of consumers. 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 the monograph of Shoven and Whalley (1992). Here we follow the notation in Brown and Heal (1983).

The inputs or factors are capital (K) and labor $(\dot{L})$. The outputs or goods are natural gas (G) and electricity (E). Each household has a utility function denoted U_x and U_y. Endowments and shareholdings in firms 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, or equivalently, cost functions C_G and C_E. Let $K = K_x + K_y$ and $L = L_x + L_y$.

We make the same assumptions regarding firms and households as Bator (1957), with one exception: we do not assume constant returns to scale in both firms, but firms are assumed to exhibit diminishing marginal rate of substitution along any isoquant, that is, the production functions are strictly quasi-concave. Under these assumptions, we construct the Edgeworth–Bowley box for production and the social production possibility frontier, PPF.

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. The marginal rate of transformation (MRT) at a point $(\tilde{G}, \tilde{E})$ on the PPF is simply the absolute value of the slope of the frontier at that point and will be denoted $P_{\tilde{E}}/P_{\tilde{G}}$. A point $(\tilde{G}, \tilde{E})$ is said to be production efficient if it lies on the PPF.

Each point $(\tilde{G}, \tilde{E})$ on the PPF determines a unique point in the Edgeworth–Bowley box for production, that is, the point on the efficiency locus corresponding to the tangency of the isoquants defined by $F_E(L_E, K_E) = \tilde{E}$ and $F_G(L_G, K_G) = \tilde{G}$. The slope of their common tangent line at this point will be denoted as w/r and is the marginal rate of technical substitution (MRTS) at this point.

We shall use repeatedly that the MRT at a point $(\tilde{G}, \tilde{E})$ is the ratio of the marginal costs; that is $P_{\tilde{E}}/P_{\tilde{G}} = [\partial C_E(w/r, \tilde{E})/\partial E]/[\partial C_G(w/r), \tilde{G})/\partial G]$.

A consumer's demand for goods derives from utility maximization subject to her budget constraint:

$$\frac{\partial U_i/\partial E_i}{\partial U_i/\partial G_i} = \frac{P_E}{P_G} \tag{1}$$

$$\begin{aligned} P_E E_i + P_G G_i \quad &= \quad I_i = wL_i + rK_i + \theta_{iG}(P_G G - wL_G - rK_G) \\ &\quad\quad + \theta_{iE}(P_E E - wL_E - rK_E), \text{ for } i = x, y. \end{aligned} \tag{2}$$

A firm's demand for factors derives from cost minimization subject to its output constraint:

$$\frac{\partial F_j/\partial L_j}{\partial F_j/\partial K_j} = \frac{w}{r} \tag{3}$$

$$F_j(L_j, K_j) = j, \text{ for } j = E, G. \tag{4}$$

A cost minimizing equilibrium is 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 firms make nonnegative profits and all markets clear. That is,
Product Markets:

$$E_x + E_y = E \tag{5}$$

$$G_x + G_y = G \tag{6}$$

Factor Markets:

$$L_E + K_G = L \tag{7}$$

$$K_E + K_G = K \tag{8}$$

and firms make nonnegative profits:

$$P_E E \geq wL_E + rK_E \tag{9}$$

$$P_G G \geq wL_G + rK_G. \tag{10}$$

Because of Walras' Law, equation (8) is redundant. This model is indeterminate in the sense that there are fewer equations (11) than unknowns (13). Despite the indeterminacy, this system of equations and inequalities imply a family of equilibrium inequalities for a history of observations on market data that allows us to empirically infer the existence of monopoly power.

3 Empirical Implications of Cost-Minimizing Market Equilibria

Brown and Matzkin (1996) introduced the Walrasian equilibrium inequalities as a means of testing the Walrasian model of a competitive economy with market data. Here we propose an analogous family of polynomial inequalities that characterize a history of cost minimizing market equilibria in an economy with competitive factor markets. 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. A numerical example for the two-sector model is given in Appendix E of Brown and Wood (2004).

The Afriat inequalities consist of a finite number of polynomial inequalities derived from a finite number of observations on a consumer's demands: $x_1, x_2, ..., x_n$ at market prices: $p_1, p_2, ..., p_n$. For each pair of observations, i and j, there is a pair of inequalities

$$\begin{aligned} V_i &\leq V_j + \lambda_j p_j \cdot (x_i - x_j) \text{ and} \\ V_j &\leq V_i + \lambda_i p_i \cdot (x_j - x_i), \end{aligned}$$

where V_i is the utility level and λ_i is the marginal utility of income in observation i. A utility function U is said to rationalize the data $\{(p_1, x_1), ..., (p_n, x_n)\}$ if for all i, $U(x_i) \geq U(x)$ for all x such that $p_i \cdot x \leq p_i \cdot x_i$. Afriat's celebrated 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. Moreover, a rationalizing U can be constructed from each solution of the Afriat inequalities. See Afriat (1967) and Varian (1982) for further discussion.

Varian's cost minimizing inequalities consist of a finite number of polynomial inequalities derived from a finite number of observations on a firm's outputs: $f_1, f_2, ..., f_n$; factor demands: $y_1, y_2, ..., y_n$; and factor prices: $q_1, q_2, ..., q_n$. For each pair of observations, i and j, there is a pair of inequalities:

$$\begin{aligned} f_i &\leq f_j + \beta_j q_j \cdot (y_i - y_j) \text{ and} \\ f_j &\leq f_i + \beta_i q_i \cdot (y_j - y_i), \end{aligned}$$

where β_i is the reciprocal of the marginal cost in observation i. A production function f is said to rationalize the data if for all i, $f(y_i) = f_i$ and $f(y) \geq f(y_i)$ implies $q_i^i \cdot y \geq q_i^i \cdot y^i$. That is, y_i minimizes the cost over all bundles of factors that can produce at least f_i. Varian (1984) proves the important result that the cost minimizing inequalities are solvable if and only if there exists a continuous monotonic quasiconcave, i.e., diminishing marginal rate of substitution along any isoquant, function that rationalizes the data.

Using the equilibrium inequalities, we can give nonparametric estimates of the Lerner index of a firm minimizing the cost of production in a model where all firms are price-takers in competitive factor markets. It suffices to consider the firm producing electricity in the two-sector general equilibrium model. Suppose this firm is alleged to have abused its market power in the previous year — think of California before the recall election of Gray Davis. During the year we observe that on three occasions the firm produced different outputs at the prevailing market prices. We observe the outputs, factor demands, and factor prices on each occasion. We do not know the firm's cost or production function, but if the firm is producing its output at minimum costs in competitive factor markets, then the following figure must hold for the unobserved isoquants of the production function.

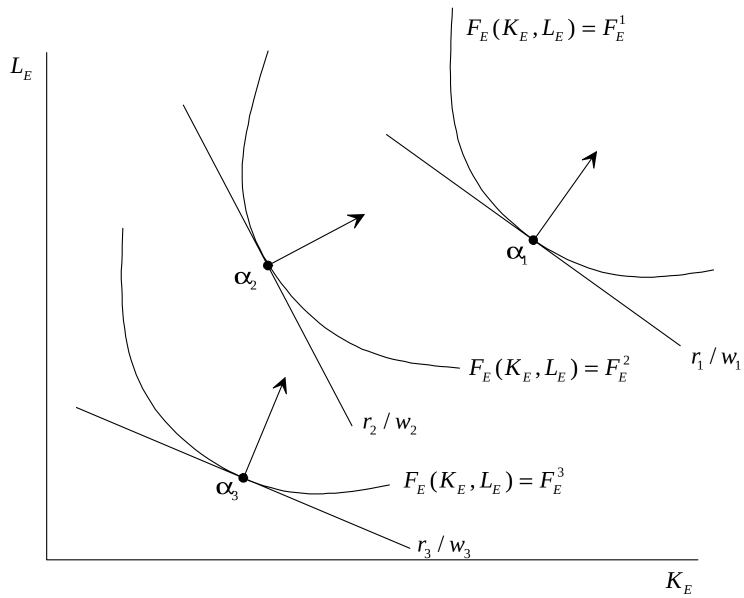


Figure 1

We have three isoquants where $F_E^1 > F_E^2 > F_E^3$. The slopes or factor price ratios are: r_1/w_1, r_2/w_2, and r_3/w_3. The factor demands are: (K_E^1, L_E^1), (K_E^2, L_E^2), and (K_E^3, L_E^3), denoted α^1, α^2, and α^3 in the figure.

Using Varian's cost minimizing inequalities, we have:

$$F_E^3 < F_E^2 + \lambda_2[(w_2 L_E^3 + r_2 K_E^3) - (w_2 L_E^2 + r_2 K_E^2)] \tag{11}$$

$$F_E^1 < F_E^2 + \lambda_2[(w_2 L_E^1 + r_2 K_E^1) - (w_2 L_E^2 + r_2 K_E^2)] \tag{12}$$

where λ_2 is the reciprocal of the marginal cost, MC_E^2, of producing F_E^2. Solving for MC_E^2, we obtain:

$$MC_E^2 > \frac{(w_2 L_E^2 + r_2 K_E^2) - (w_2 L_E^3 + r_2 K_E^3)}{F_E^2 - F_E^3} \equiv B_{\min}^2 \tag{13}$$

$$MC_E^2 < \frac{(w_2 L_E^1 + r_2 K_E^1) - (w_2 L_E^2 + r_2 K_E^2)}{F_E^1 - F_E^2} \equiv B_{\max}^2 \tag{14}$$

The right-hand side of (13) may be negative, as seen in the next figure, and hence uninformative. These bounds imply bounds on the Lerner index: $(MC - P)/P$.

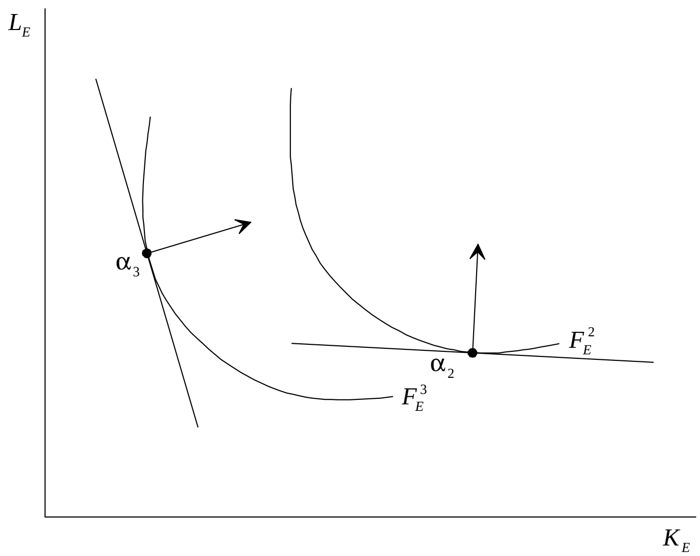


Figure 2

4 The Economic Costs of Monopolization

In 1951, Debreu published his classic analysis of the economic loss associated with nonoptimal economic states (in the sense of Pareto). He identified 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." To measure the economic loss, he posed a cost minimization problem dual to Pareto's maximization of social welfare. That is, given an economic state, use the community indifference curve containing that state as a constraint and minimize the fraction of total economic resources that supports an economic state on the given community indifference curve. This minimal fraction ρ is called the coefficient of resource utilization. ρ takes values in $(0, 1]$ and $(1 - \rho)\times$ social endowment is a measure of the wasted resources constituting the opportunity cost of the inefficiencies in the original economic state. It is easy to show that this new economic state is Pareto optimal relative to the new (reduced) social endowment. Hence it follows from the second welfare theorem that the new state can be realized as a competitive equilibrium with lump sum transfers. The "true" measure of monopoly power is the margin between the monopoly price and the counterfactual competitive price in the new equilibrium state.

We illustrate the computation of ρ with the two-sector model. Suppose the given economic state of the model is a cost minimizing market equilibrium where $P_E/P_G \neq MC_E/MC_G$. As shown in Bator (1957) this violates one of the necessary conditions for Pareto optimality in the two-sector model.

Suppose in equilibrium household x consumes $(\tilde{E}_x, \tilde{G}_x)$ and household y consumes $(\tilde{E}_y, \tilde{G}_y)$. ρ is the minimum α between 0 and 1 where the given two-sector model with reduced social endowments αK and αL can produce sufficient electricity $\bar{E}$ and natural gas $\bar{G}$ such that:

$$U_x(\bar{E}_x, \bar{G}_x) \geq U_x(\tilde{E}_x, \tilde{G}_x) \tag{15}$$

$$U_y(\bar{E}_y, \bar{G}_y) \geq U_y(\tilde{E}_y, \tilde{G}_y) \tag{16}$$

$$\bar{E}_x + \bar{E}_y = \bar{E} \tag{17}$$

$$\bar{G}_x + \bar{G}_y = \bar{G} \tag{18}$$

$$\bar{E} = F_E(\bar{L}_E, \bar{K}_E) \tag{19}$$

$$\bar{G} = F_G(\bar{L}_G, \bar{K}_G) \tag{20}$$

$$\bar{L}_E + \bar{L}_G = \alpha L \tag{21}$$

$$\bar{K}_E + \bar{K}_G = \alpha K \tag{22}$$

We denote the Lagrange multipliers for constraints (21) and (22) in the constrained minimization problem defining ρ as $\bar{w}$ and $\bar{r}$. These "shadow prices" are used by Debreu to give an intrinsic valuation of the economic costs of inefficiency. He defines the opportunity or economic cost in real terms as the vector $\langle(1-\rho)K, (1-\rho)L\rangle$ and the economic loss as $(1-\rho)[\bar{w}L + \bar{r}K]$.

In practice, ρ must be estimated from market data. Here we use the equilibrium inequalities. 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, if and only if this is a history of cost minimizing market equilibria. Each solution determines a utility function for each household and a production function for each firm that rationalizes the market data in each observation. Hence for a given history of observations and a solution of the equilibrium inequalities we can solve the minimization problem for ρ defined by equations (15)–(22). Keeping the observations fixed we compute the minimum ρ, $\rho_{\min}$, and the maximum ρ, $\rho_{\max}$, over the set of solutions to the equilibrium inequalities. Hence the "true" ρ is in the interval $[\rho_{\min}, \rho_{\max}]$.

A clever illustration of the coefficient of resource allocation was suggested by T.N. Srinivasan. Suppose both firms in the two-sector model have constant returns to scale. Then each firm has constant marginal cost. Using the fact that the MRT is the ratio of the marginal costs at each point on the PPF, we see that the PPF is a straight line. The outputs (E^*, G^*) produced in a cost minimizing market equilibrium lie on the PPF, as a consequence of competitive factor markets and production at minimum cost. Suppose in equilibrium household x consumes (E^*_x, G^*_x) and household y consumes (E^*_y, G^*_y), the community indifference curve passing through the point (E^*, G^*) is the boundary of the set of points $(\hat{E}, \hat{G})$ where

$$U_x(\hat{E}_x, \hat{G}_x) \geq U_x(E^*_x, G^*_x) \tag{23}$$

$$U_y(\hat{E}_y, \hat{G}_y) \geq U_y(E_y^*, G_y^*) \tag{24}$$

$$\hat{E}_x + \hat{E}_y = \hat{E} \tag{25}$$

$$\hat{G}_x + \hat{G}_y = \hat{G} \tag{26}$$

$$E_x^* + E_y^* = E^* \tag{27}$$

$$G_x^* + G_y^* = G^* \tag{28}$$

Hence we have the following figure:

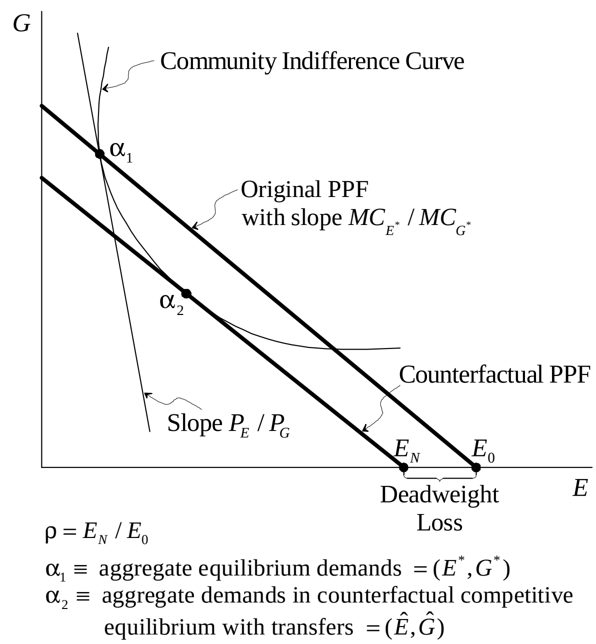


Figure 3

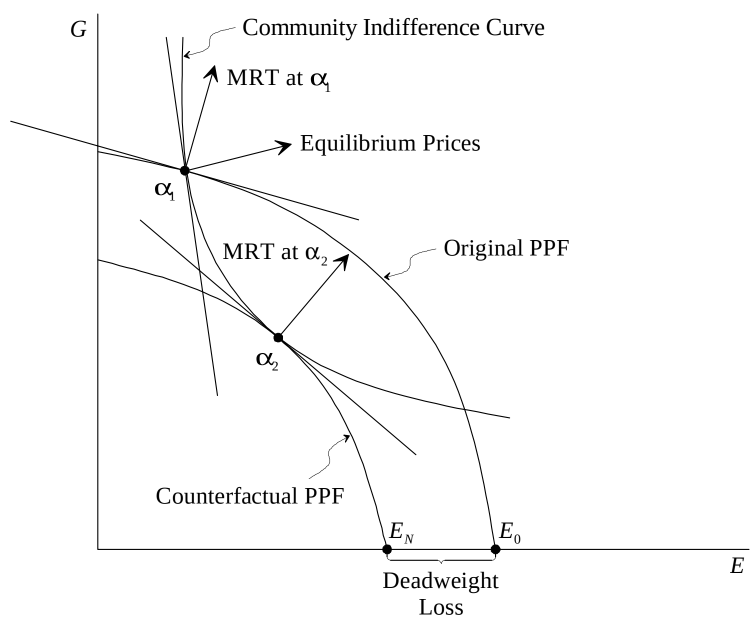
α_1 is the output (E^*, G^*) produced in the cost minimizing market equilibrium. $\alpha_2 = (\hat{E}, \hat{G})$ and satisfies (23)–(28). The social endowments used to produce α_2 are ρK and ρL, where K and L are the original social endowments of capital and labor. If the slope of the PPF is P_E^*/P_G^*, then the economic cost is $P_E^*(E^* - \hat{E}) + P_G^*(G^* - \hat{G})$, and ρ is the ratio E_N/E_0. This example requires some restrictions on tastes and technology.

The estimation procedure described above defines an infinite dimensional optimization problem, i.e., the choice variables are utility functions of households and production functions of firms consistent with the market data. In fact, we can reduce the computation of $\rho_{\min}$ and $\rho_{\max}$ to a nonlinear programming problems where now the choice variables are simply vectors in some appropriate Euclidean space, $\mathbb{R}^L$. The "trick" is to use the second welfare theorem of general equilibrium theory. For the two-sector or more generally the Arrow–Debreu general equilibrium model, the theorem states that an economic state is Pareto optimal if and only if this state can be realized as a competitive equilibrium with lump-sum transfers of income between households.

Recall that Debreu's theorem on the coefficient of resource utilization for the two-sector model states that the economic state, where the social endowments of capital and labor are ρK and ρL, is Pareto optimal for the original utility levels. See Figure 4.

Consequently, we augment the cost-minimizing equilibrium inequalities with the Walrasian inequalities, characterizing a competitive equilibrium, derived by Brown and Matzkin (1966), where now the competitive prices for goods and factors are also unknowns. In the Walrasian inequalities, social endowments are tK and tL, where t is unknown but constrained to be between 0 and 1. We also need the inequalities given in (23) and (28) defining the community indifference curve in Figure 4.

A solution to this system of polynomial inequalities defines a family of utility functions, production functions, household demands, factor demands, prices for goods and factors and ρ, the value of t. The resulting two-sector model is in a cost minimizing market equilibrium in the sample periods and in the out-of-sample, counterfactual period. The counterfactual Pareto optimal economic state with lump-sum income transfers defines a competitive equilibrium for the reduced social endowments ρK and ρL, where aggregate demands of E and G lie on the community indifference curve. A numerical example is given in Appendix E of Brown and Wood (2004).



$\rho = E_N / E_0$

$\alpha_1 \equiv$ aggregate equilibrium demands

$\alpha_2 \equiv$ aggregate demands in counterfactual competitive equilibrium with transfers

Figure 4

5 Discussion

Partial equilibrium analysis is a powerful methodology for analyzing the behavior of firms is an isolated market, if the impact on prices in other markets is negligible. 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. To quantify these general equilibrium effects, it is necessary to have applied general equilibrium models where some firms may have monopoly power.

The distinction between market power and monopoly power is a matter of degree. Since most firms in the U.S. have some market power, as defined by the ability to price above marginal cost, a quantitative measure of monopoly power is also needed. One definition of monopoly power in the literature of antitrust economics is the existence of substantial market power for a significant period of time. That is, in order for the courts to apply the Grinnel test they must review a history of the alleged monopolist's pricing behavior to ascertain the existence of monopoly power.

Given a history of observations on the relevant markets, we propose the cost-minimizing market equilibrium notion and the attendant family of equilibrium inequalities as an applied general equilibrium model where some firms may have monopoly power. As Hylton argues, the Lerner index overstates the degree of monopoly power. The true measure is the margin between the monopoly price and the unobservable, counterfactual competitive price level. Using the solutions of the equilibrium inequalities and Debreu's coefficient of resource utilization, we are able to compute upper and lower bounds on the margin between the monopoly price and the counterfactual competitive price in each observation.

The partial equilibrium welfare analysis of monopolization uses the sum of consumer and producer surplus to give an approximate measure of gains and losses. The welfare analysis of policy changes in the parametric applied general equilibrium analysis, surveyed by Shoven and Whalley (1992), uses interpersonal cardinal welfare comparisons by summing equivalent or compensating variation across consumers. These indices are in sharp contrast to the coefficient of resource utilization, that is an exact, ordinal measure of the economic costs of monopolization in terms of wasted real resources, relative to a counterfactual competitive equilibrium providing the same level of satisfaction to consumers achieved in the cost-minimizing market equilibrium with monopoly power.

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