ECONOMIC ANALYSIS GROUP
DISCUSSION PAPER

Analyzing Mergers Using Capacity Closures

By

Nicholas Hill*

EAG 08-8 August 2008

---

* Economist, Economic Analysis Group, Antitrust Division, U.S. Department of Justice. Email: nicholas.hill@usdoj.gov. Thanks are due to Beth Armington, Dennis Carlton, Tim Daniel, Jay Ezrielev, Andy Hanssen, Ken Heyer, Greg Leonard, Bill Nye, Russ Pittman, Joe Simons, Greg Werden, Bobby Willig, Peter Woodward, and above all, Rene Kamita. The views expressed in this paper are not purported to represent those of the United States Department of Justice.

Abstract

In this paper I describe a method for analyzing mergers in industries in which it is more cost effective to close capacity than to idle it. The method can be used to define markets, to assess the likelihood of competitive effects and to evaluate divestitures. I also discuss the method's data requirements and how it can be modified to deal with the types of issues that often arise during an antitrust investigation.

1 Introduction

The goal of this paper is to describe a method for analyzing proposed mergers. The method, which I shall call the capacity closure method, takes as its central assumption that permanently closing capacity is the most cost effective way to increase price. For industries in which this assumption is justified, the capacity closure method is a simple way to analyze competitive effects, market definition and the impact of prospective divestitures.

The rest of this paper is organized as follows. Section 2 gives an overview of how the capacity closure method can be used to predict a transaction's competitive effect. Section 3 provides details on implementing the capacity closure method. Section 4 describes how the capacity closure method can be used to delineate markets, analyze the but-for world and vet divestitures. Section 5 discusses the capacity closure method's data requirements. Section 6 presents some simple extensions of the capacity closure method.

2 An Overview of the Capacity Closure Method

Consider a situation in which two firms that manufacture a homogenous product (and nothing else) propose to merge, and assume for simplicity that the product constitutes an antitrust product market as defined in the U.S. Horizontal Merger Guidelines. Assume further that the product's production technology has sufficiently high fixed costs that it is always more profitable to reduce output by closing facilities than by reducing output across facilities.

A competition agency is charged with reviewing the merger and determining, to the best of its ability, whether the merged firm would find it profitable to anti-competitively raise price by closing facilities.[1] If the merger is approved, the combined firm would have $i = 1, \ldots, n$ facilities. Each facility i can produce q_i units of output and has a per unit cost of production of $c_i(q_i)$. Let S denote the set of all possible combinations of the merged firm's n facilities. For any $s \in S$, let $\theta(s)$ denote the total capacity of the facilities in s. Finally, let $p(z)$ denote the price if z units of capacity are closed, with the current price denoted $p(0)$. To economize on notation, I shall write p_s for $p(\theta(s))$ and p_0 for $p(0)$.

Let us first consider the question of whether the merged firm would find it profitable to shut a set $s \in S$ of its facilities. The benefit of closing the facilities in s is a higher price on the merged firm's remaining sales. The cost of closing the facilities in s is the profit that they would have earned on the facilities in s. Formally, let $c(s)$ and $q(s)$ denote the firm's cost per unit of output and total output, respectively, if the facilities in s are closed. The price after the facilities in s have been closed is p_s. The merged firm's profit if it were to close the facilities in s would be

$$\pi(s) = [p_s - c(s)]q(s) \tag{1}$$

Closing the facilities in s is profitable if $\pi(s)$ exceeds the firm's current profit.

Now let us expand the firm's decision problem in a natural way. Specifically, let us assume that the merged firm will identify the set of facilities s^* whose closure maximizes the firm's profit and close those facilities.[2] That is, the firm solves the problem

$$\arg\max_{s \in S} \pi(s) = [p_s - c(s)]q(s) \tag{2}$$

[1] I discuss analyzing the incentives of the stand-alone firms in section 4. For the moment, assume for simplicity that the stand-alone firms have no incentive to raise the price by closing facilities.

[2] Note that the optimal set of facilities to close may be the empty set. Also, while s^* need not be unique, I assume that it is for simplicity.

and closes the facilities in the resulting s^*

If the competition agency—or any other interested party—can identify the optimal set of closures s^*, it can predict the price change $\Delta_p(s^*) = p_{s^*} - p_0$ that is likely to result from the merger. Given a functional form for $p(\cdot)$ and adequate data, it can do this—i.e., identify s^*—by calculating $\pi(s)$ for all $s \in S$.[3] In the following two sections, I discuss in detail how precisely this can be done. In particular, I present two functional forms for $p(\cdot)$ and discuss the capacity closure method's data requirements.

3 Implementing the Capacity Closure Method

The following two subsections present two functional forms for $p(\cdot)$. The first functional form is derived under the assumption that the price elasticity of demand is constant. The second functional form is derived under the assumption that demand is linear. These two forms of demand are frequently used in merger cases and elsewhere. There are many other functional forms that $p(\cdot)$ could take though, and the reader is welcome to experiment with them.

3.1 The Constant Elasticity of Demand Model

An increase in the price of the merged firm's product will have two effects: the demand for the product will decrease and the supply of the product will increase. If the merged firm wishes to raise the price of its product by Δ_p, it can do so by closing an amount of capacity sufficient to absorb the fall in demand and increase in supply associated with Δ_p.[4] Given a method for estimating the demand and supply responses associated with any price increase Δ_p, one can therefore calculate the amount of capacity that must be closed to implement it. Conversely, given a set of mills s with capacity $\theta(s)$, one can calculate the price increase $\Delta_p(s)$ that would result from closing those mills.

The key to calculating an estimate of $\Delta_p(s)$ then is specifying the relationship between price and demand and supply. A natural specification for the change in demand given a change in price Δ_p is

$$\Delta_p \eta_d Q_d(p_0) \tag{3}$$

where η_d is the price elasticity of demand for any price and $Q_d(p_0)$ is the level of demand at the current price p_0. Note that the price elasticity of demand is assumed to be constant!

When specifying the supply response to an increase in price, one approach is to disaggregate the supply response into two parts: the response of domestic competitors and the response of importers.[5]

The response of domestic competitors to a price increase can itself take several, non-exclusive forms, but I shall assume for ease of exposition that it takes the form of bringing excess capacity to bear.[6] In particular, let us assume that domestic producers hold ε units of excess capacity and let $\beta(\Delta_p) \in [0, 1]$ denote the proportion of these units that are brought to bear in the event of a price increase Δ_p. The general expression for the increase in supply by domestic competitors is:

[3] This can be computationally burdensome if n is large. However, one can reduce significantly the computational burden by exploiting the fact that closing high cost plants is more profitable than closing low cost plants.

[4] That is, starting from an equilibrium price p_0, the firm can make some $\hat{p}$ into an equilibrium if it can close enough capacity to counteract the decrease in demand and increase in supply associated with moving from p_0 to $\hat{p}$.

[5] For expositional clarity I shall assume that the geographic market includes all other domestic producers of the product and no foreign producers of the product, but that there is a non-trivial amount of imports.

[6] Other possible responses include the repatriation of exports and the expansion of productive capacity.

$$\beta(\Delta_p)\varepsilon \tag{4}$$

For ease of exposition I shall make the conservative assumption that the domestic competitors constitute a competitive fringe so that $\beta(\cdot)$ is equal to 1. Note, however, that this term can be allowed to vary with Δ_p to reflect the fact that the marginal cost of bringing excess capacity to bear is typically not constant.

Importers of the product can respond to a price increase in a number of ways, but I shall assume that they do so by increasing imports. Denote the current level of imports as I and the price elasticity of import supply as $\eta_I \geq 0$. The change in imports in response to a price increase is[7]

$$\Delta_p \eta_I I \tag{5}$$

Bringing together the demand response and supply responses and equating them to a capacity closure $\theta(s)$ yields

$$\Delta_p(s)\eta_d Q_d(p_0) + \varepsilon + \Delta_p(s)\eta_I I = \theta(s) \tag{6}$$

Solving this equation for $\Delta_p(s)$ yields

$$\Delta_p(s) = \frac{\theta(s) - \varepsilon}{\eta_d Q_d(p_0) + \eta_I I} \tag{7}$$

If one can obtain estimates of ε, η_d, $Q_d(p_0)$, η_I and I, one can calculate $\Delta_p(s)$ for any $s \in S$. Once $\Delta_p(s)$ has been calculated, p_s can be calculated as:

$$p_s = p_0 + \frac{\theta(s) - \varepsilon}{\eta_d Q_d(p_0) + \eta_I I} \tag{8}$$

3.2 The Linear Demand Model

The constant elasticity of demand model assumes that the price elasticity of demand is a constant function of the price. An alternative assumption is to assume that demand is a linear in price:

$$Q_d(p) = a - bp \tag{9}$$

Under this assumption, the elasticity of demand is

$$\eta_d(p) = -\frac{bp}{a - bp} \tag{10}$$

It is easy to verify that demand becomes more elastic as the price increases.

Given $\eta_d(p_0)$, $Q_d(p_0)$ and p_0, one can calculate the values of a and b using equations 9 and 10. Once these values have been calculated, the solution strategy is to specify a method for calculating $Q_d(p_s)$ when one does not know p_s. Once this has been done, p_s is calculated as:

$$p_s = \frac{a - Q_d(p_s)}{b} \tag{11}$$

The trick is calculating $Q_d(p_s)$ when one does not know p_s. One approach is to calculate $Q_s(p_s)$, the quantity supplied under p_s, and assume that the market is in equilibrium (i.e., $Q_s(p_s) = Q_d(p_s)$.

[7]Note the implicit assumption that the price elasticity of import supply is a constant function of the market price.

One can calculate $Q_s(p_s)$ as the sum of the supply by domestic producers and the supply of imports. Supply by domestic producers can be estimated as the sum of competitors' current production $q_c(p_0)$, competitors' excess capacity ε and the merged firm's current production $q_d(p_0)$ minus the capacity closed by the merged firm $\theta(s)$.[8] One approach to estimating the supply of imports is to assume that they are a linear function of the market price:

$$I = c + dp \tag{12}$$

Provided that one can estimate the current level of imports and the price elasticity of import supply η_I, one can estimate the values of c and d. Bringing all of the pieces together, the demand is

$$Q_d(p_s) = Q_s(p_s) = (q_c(p_0) + \varepsilon + q_d(p_0)) - \theta(s) + (c + dp_s) \tag{13}$$

Inserting this quantity into the linear demand function and solving for p_s gives

$$p_s = \frac{a - (q_c(p_0) + \varepsilon + q_d(p_0) - \theta(s) + c)}{b + d} \tag{14}$$

Thus, given any set of facilities $s \in S$, one can calculate p_s.

4 Variations on a theme: market definition, the but-for world and divestitures

An attractive feature of the capacity closure method is its flexibility: it can be easily adapted to define markets, analyze the but-for world, and evaluate divestitures. Two simple modifications allow the method to be used to test whether a candidate market is indeed an antitrust market. First, S is defined as the set of all facilities in the candidate market. In essence, this modification replaces the merged firm with a hypothetical monopolist. Second, any supply response by competitors in the candidate market is removed from the calculation of p_s, since all competitors in the candidate market are now part of the hypothetical monopolist. That is, $\beta(\cdot)$ is set equal to zero. Having made these changes, the candidate market is an antitrust market if p_{s^*} is larger than p_0 by some amount, say 5%.

Once a market has been defined, one can use the capacity closure method to test whether the merger is likely to lead to a price increase. If the method predicts that the merger will result in a price increase, one may wonder if the prediction is an artifact of parameter values that are biased towards finding harm. A crude one-sided test of the parameter values is to test whether, under these values, the stand-alone firms have an incentive to raise the price in the but-for world. If they do, one may conclude that the parameter values are indeed biased toward finding harm given that the stand-alone firms presumably find their current facility portfolios to be profit-maximizing. Thus, analyzing the but-for world can act as a valuable check on one's parameter values.

To use the capacity closure method to analyze the incentives of a stand-alone firm one proceeds as for the merged firm but defines S as the facilities owned by that firm alone. Nothing else needs to be changed.

If a competition agency determines that a merger is likely to lead to an anticompetitive price increase, it may wish to identify a divestiture that will allow the firms to merge and capture any

[8]The price change will be negative if competitors hold more excess capacity than the merged firm closes. This difficulty can be resolved by adopting a less conservative functional form for $\beta(\cdot)$, though closing the facilities in s is unlikely to be profitable if $\theta(s) < \varepsilon$.

(merger-specific) efficiencies while removing the merged firm's incentive to raise price. Using the capacity closure method, one can, for each $s \in S$, calculate whether a firm that owned the facilities in s would find it profitable to raise the price. Any $s \in S$ for which the merged firm would not find it profitable to raise price is a set of mills that can be owned by the merged firm without raising antitrust concerns. The competition agency can then select its preferred s—e.g., the s that disrupts the transaction's efficiencies the least—and require the merged firm to divest any facilities that the stand-alone firms own that are not in s.

Alternatively, the competition agency can use the capacity closure method to test whether leaving the merged firm with only $R \subset S$ facilities removes its incentive to raise price. One can do this by testing whether there exists an $r \in R$ such that $p_r > p_0$. If no such r exists, then a divestiture that leaves the merged firm with only those facilities in R is a sufficient remedy. This approach is useful if a divestiture package has been proposed by the merging parties, its customers or other market participants.

5 Data Requirements

5.1 Facility costs

The capacity closure method requires data on the costs of all the facilities owned by the merging parties if it is to be used to analyze competitive effects, the but-for world and divestitures. If market definition is also to be addressed, these data are needed for all facilities in the proposed market.

The method's basic assumption—that capacity is reduced by closing facilities—short circuits the usual debate about what constitutes a variable cost, since any cost that will not be incurred once the facility is closed should be classified as variable.[9] The cost data necessary to estimate c_i for each facility can therefore generally be provided by the merging parties with little effort. Indeed, it is often the case that the required cost data are found in ordinary course of business documents, which can significantly shorten the time needed to begin analyzing a merger.

5.2 Closing costs

Given the capacity closure method's core assumption, the costs of closing a facility must be considered. These closing costs often include—but are not limited to—severance packages, environmental clean up, inventory write-off and demolition. Once the relevant closing costs have been identified, they are most easily incorporated into the analysis by introducing them as a lump sum loss in the profit function.

Closing costs should be treated as facility specific whenever possible as there is often significant variation in these costs across facilities. In the event that one cannot form an independent evaluation of each facility's closing cost, one may wish to apply the same generic closing cost to each facility or to assign each facility a closing cost that is a function of the facility's capacity.

Two final points on closing costs should be made. First, one must verify that closing a facility is in fact costly: in some cases the sale of the land on which a facility is located will generate enough income to cover closing expenses. Second, it is reasonable to treat closing costs as an annuity. If this approach is taken, the per period cost of servicing the annuity is deducted from the firm's per period profit.

[9] In practice, with the exception of taxes and depreciation, all of a facility's costs generally end up being classified as variable.

5.3 Capacity, output, imports and prices

Reliable data on each in-market facility's capacity and output can usually be gathered directly from producers or industry trade groups. Reliable data on the current level of imports are often more difficult to gather, but potential data sources include known importers, industry trade groups and National governments.

Obtaining data on p_0 is not as always as straightforward as it sounds, since even homogenous products are often sold in different forms.[10] However, it is typically the case that some estimate of p_0 can be formed from data provided by the merging firms. If this is not possible, it may be possible to estimate p_0 using data collected by an industry trade group or by speaking with customers of the merging firms.

5.4 Other parameters

In addition to the basic data already mentioned, the capacity closure method requires data on the values of a number of other variables (e.g., η_d, I, etc.). The values of these variables can typically be estimated or approximated using data gathered from the merging parties, competitors, customers or industry trade groups. Since the predictions of the models depend upon these parameter values, it is wise to undertake some sensitivity testing. Re-running the capacity closure method using different input parameters allows one to test the robustness of its predictions and to identify particular variables whose values are of critical importance (so that, e.g., their true values can be investigated more intensively).

6 Extending the Capacity Closure Method

One way to extend the capacity closure method is to impose different assumptions about the demand function. Such extensions change the calculation of the function $p(\cdot)$. I shall not discuss this class of extensions further because, though such an extension may be necessary in rare cases, the two demand functions already described should generally suffice.

A different class of extensions is those that change the calculation of the profit function, $\pi(\cdot)$, but not the price function $p(\cdot)$. Extensions in this class are easy to implement and can address the sorts of economic issues that frequently arise during merger cases. In the subsections below I provide two examples of such extensions to highlight the fact that the capacity closure method can be easily modified to accommodate the facts of a particular merger.

6.1 Long-term contracts

It is often the case that some customers of the merging firms hold contracts that insulate them from price changes for a fixed length of time. When such contracts are long enough and numerous enough, they can significantly affect the incentives of the merged firm.[11] The effects of long-term contracts can be incorporated into the capacity closure method by adjusting the impact of a price increase on the merged firm's profits. Specifically, the price increase associated with a capacity closure is applied only to the merged firm's unprotected sales.

Consider, for example, a merger in which α percent of the merged firm's sales are protected from price increases by long-term contracts. As before let s denote a set of facilities to be closed, let $q(s)$ denote the firm's sales if it closes the facilities s and let $c(s)$ denote the per unit cost of

[10] Newsprint, for example, is sold in different basis weights

[11] Such contracts also affect the incentives of the stand-alone firms, of course.

producing $q(s)$. The price after the facilities in s are closed is of course p_s. The post-merger average price, denoted $\bar{p}(s)$, is

$$\bar{p}(s) = (1 - \alpha)p_s + \alpha p_0 \tag{15}$$

The merged firm's profit after closing the facilities in s is

$$\pi(s) = [\bar{p}(s) - c(s)]q(s) \tag{16}$$

Notice that the presence of α does not affect the calculation of $p(\cdot)$ and so adds no meaningful complication to the task of identifying the set of optimal closures s^*.[12]

6.2 Recapture

Recapture can be an issue in a merger involving homogenous product A if one of the merging parties also produces a product B that is a substitute for A but is not a close enough substitute to be included in the antitrust market. In such a case, an increase in the price of product A will trigger increased demand for product B. If the merged firm were to capture some of the increased sales of product B, it would soften the blow of having lost some sales of product A. The degree to which the blow would be softened will depend upon such factors as the relative margins earned on the two products and the price elasticity of demand for product B with respect to the price of product A.[13]

Consider a case in which both of the merging firms produce product A and one of the merging firms also produces product B. Suppose further that product A is a relevant product market, that product B is product A's closest substitute, and that product B is a relevant product market. Let $d(s)$ denote that sales that will switch from product A to product B in the event that the facilities in s are closed (and the price of product A rises from p_0 to p_s), let σ_B denote the merged firm's market share for product B and let m_B denote the merged firm's margin on the sales of product B. The effect of recapture on the merged firm's incentive to close facilities that produce product A can be incorporated by adding to $\pi(s)$ the quantity

$$m_B \sigma_B d(s) \tag{17}$$

Note two assumptions that are implicit in the equation above. First, the merged firm's margin on product B is assumed not to change when the demand for product B increases (i.e., the market for product B is assumed to be competitive). This assumption can easily be relaxed to incorporate a price effect in the market for product B. Second, the merged firm is assumed to capture transferred sales in proportion to its market share. This may be inappropriate if customers would punish the merged firm by purchasing product B from rival suppliers. It may also be inappropriate if some of the producers of product B (including the merged firm) do not have capacity available to expand their production of product B. If this assumption is deemed inappropriate for either of these reasons, it too can be easily modified.

7 Conclusion

I have described a simple method for performing merger simulations for industries with high fixed costs and homogenous products. The method can be used to identify antitrust markets, to perform competitive effects analysis, and to evaluate divestitures. The method requires only data that are

[12] As before, s^* is simply the $s \in S$ that maximizes $\pi(s)$.

[13] Bear in mind that product B cannot be *too* close a substitute for product A or it would belong in the market.

typically available to antitrust agencies. Finally, I have shown how the method can be modified to incorporate the types of issues that often arise in merger cases.