Estimating the Impact of a Hospital Merger Using the Difference-in-Difference of Prices

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October 18, 2010

Abstract

This paper comments on "The Price Effects of Hospital Mergers: A Case Study of Sutter-Summit Transaction," by Steven Tenn. I exposit a simple model of differentiated products competition and consider the implications of Tenn's findings in the context of this model. I find that Tenn provides compelling evidence that the merger led to a price increase at Summit Hospital. The causes of the price increase and the welfare implications of the merger are less clear, particularly since anecdotal evidence suggests that quality increased at Summit Hospital post-merger. A difference-in-difference analysis using quality and quantity data can shed more light on the consequences of the merger.

1 Introduction

In "The Price Effects of Hospital Mergers: A Case Study of the Sutter-Summit Transaction," Steven Tenn estimates the price impact of the 1999 acquisition of Summit Hospital by the Sutter regional hospital system. Summit was located in Berkeley, California where Sutter also had a facility, Alta Bates Hospital. Despite the proximity of Summit to Alta Bates, an antitrust challenge of the merger was viewed as difficult because the metropolitan area contained many other hospitals. The California Attorney General, but not the U.S. Federal Trade Commission, filed suit against the merger. However, the lawsuit was unsuccessful and the merger ultimately proceeded. Given that the case was investigated but not stopped it

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was, by definition, close to the margin. This makes it interesting to examine from a policy and academic standpoint.

Tenn analyzes the merger, making use of two datasets that are unique in containing prices. One dataset includes prices over 5 years (1997-2001) and for all California hospitals but is available for only three insurers. The other dataset covers only three years (1999-2001) and the two Berkeley hospitals, but includes information for each of the five major private insurers. Most of the literature on hospital mergers has proxied for prices using indirect measures such as revenues per patient (see Ho, 2006; Capps et al., 2003, for example). The ability to use data that reflect actual prices paid represents a large step forward in plausibility.

Using a difference-in-difference approach, Tenn finds that prices at Summit increased 28%– 44% depending on the insurer, but that there was no significant impact on the price of Alta Bates. Tenn also examines the price change at Summit and Alta Bates before the merger, from 1997 to 1999. He finds no significant trend in either Summit or Alta Bates prices in the pre-merger period, suggesting that his main results are not caused by secular trends.

In my opinion, Tenn provides a thorough empirical investigation of the price impact of the merger. Given available data, the difference-in-difference framework that he employs is probably the best empirical method. Moreover, Tenn has laid out a convincing and robust case that prices increased at Summit following the merger.

Yet, this approach is not without its limitations. In particular, both the link between market power and price increases at Summit and the ultimate welfare impact of the merger are not certain from this analysis. In order to examine precisely what we can and cannot conclude from his analysis, I exposit a simple model of competition and mergers. I then use the model to evaluate the implications of Tenn's results on market power and pricing.

2 Model of competition and mergers

I start with a straightforward model of differentiated products discrete choice demand, adapted from Pakes and McGuire (1994) and Berry (1994). The model imposes a lot of

structure, not all of which makes economic sense for this market. Nonetheless, I believe that the model can illustrate some of the main potential impacts of this merger. Suppose there are J hospitals and I consumers in the market at time t. Let utility for each consumer i and hospital j be

$$u_{ijt} = q_{jt} - \alpha p_{jt} + \varepsilon_{ijt}, \tag{1}$$

where q_{jt} is quality, p_{jt} is price, α is a price coefficient, and ε_{ijt} is a $i.i.d.$ type 1 extreme value unobservable term. The outside option, not seeking treatment at a hospital, has utility $u_{i0t} = \epsilon_{i0t}$. I assume that hospital quality $q_{jt} = \bar{q}_j + \xi_{jt}$, consisting of a time-invariant mean quality component $\bar{q}_j$ and an $i.i.d.$ deviation from the mean, ξ_{jt}. I assume further that all components of quality are known.

For a given vector of prices, market shares will have the multinomial logit functional form,

$$s_{jt}(p_1, \ldots, p_J) = \frac{exp(q_{jt} - \alpha p_j)}{1 + \sum_{k=1}^{J} exp(q_{kt} - \alpha p_k)}.$$

Let c_t denote marginal costs, which are constant but potentially time-varying, and let fixed costs for hospital j be denoted F_j. Consider a stand-alone hospital j. Profits for the hospital at time t are:

$$\pi_{jt}(p_1, \ldots, p_J) = I(p_j - c_t)s_{jt}(p_1, \ldots, p_J) - F_j. \tag{2}$$

I assume that hospitals jointly choose prices in a Bertrand equilibrium every period. Caplin and Nalebuff (1991) show that this model has a unique Nash equilibrium. At this equilibrium, the vector of prices jointly satisfy the FOCs defined by differentiating profits for each hospital. For a stand-alone hospital, the FOC at time t would be

$$I(-(p_j - c_t)s_{jt}(1 - s_{jt})\alpha + s_{jt}) = 0.$$

Dividing by Is_{jt} and rearranging terms yields

$$1 - \alpha(p_j - c_t) + \alpha(p_j - c_t)s_{jt} = 0. \tag{3}$$

In equilibrium, (3) and analogous FOCs for other firms have to be jointly satisfied. Let $(\hat{p}_{1t}, \ldots \hat{p}_{Jt})$ denote the equilibrium vector of prices at time t.

Now, let us consider the impact of a merger. For ease of notation, let us assume that the merger occurs between two stand-alone hospitals, j and k, although the the merger of a hospital system and a stand-alone hospital (as in the Sutter - Summit transaction) is not fundamentally different. One can write the profits for the jk system as:

$$\pi_{jk,t}(p_1, \ldots, p_J) = I(p_j - c_t)s_{jt}(p_1, \ldots, p_J) + I(p_k - c_t)s_{kt}(p_1, \ldots, p_J) - F_j - F_k. \quad (4)$$

The FOC for the hospital system with respect to price j that is analogous to (3) is:

$$1 - \alpha(p_j - c_t) + \alpha(p_j - c_t)s_j + \alpha(p_k - c_t)s_{kt} = 0. \quad (5)$$

Consider now the case where hospital quality is unaffected by a merger. In this case, the price impact of the merger will depend on the existing vector of qualities as well as the α coefficient. A high α corresponds to elastic demand and hence a low ability to raise prices above marginal costs. For simplicity, consider an industry structure where each hospital is individually owned. There are three relevant properties that stem from the model:[1]

1. If $q_{jt} > q_{kt}$ then $\hat{p}_{jt} > \hat{p}_{jt}$.

2. For a given marginal cost and vector of quality levels, the equilibrium price vector will be decreasing in α.

3. The change in the price vector resulting from a merger between two hospitals will be decreasing in α.

Now consider the case where quality might vary following a merger. In general, an antitrust authority may care not just about prices but also about total welfare. Consumer welfare at time t is given by:

$$CW_t = \log\left(1 + \sum_{k=1}^{J} exp\left(q_{kt} - \alpha\hat{p}_{kt}\right)\right), \quad (6)$$

and thus is increasing in quality. Modeling the choice of quality is more difficult than modeling the choice of price because one has to specify which factors lead to higher quality hospitals, which generally requires a dynamic model of investment in quality (see Pakes and McGuire,

1994). Evaluating the impact of mergers on quality is even more difficult but also conceptually possible (see Gowrisankaran, 1999a,b).

Although understanding the impact of the merger on quality is well beyond the scope of this comment, consider the possibility that if hospital j has higher quality than hospital k, then by acquiring hospital k, hospital j may be able to transfer over some of its quality. In this case, given that the increase in quality translates into higher welfare from (6), many mergers that raise prices might still be permissible under an optimal antitrust policy.

3 Implications of results

The above model is too simple to capture many important features of the hospital industry. Notably, I do not model the role of health plans as intermediaries between hospitals and patients, the fact that hospitals are horizontally differentiated by location, or marginal cost differences across hospitals. Nonetheless, I believe that the model is useful as a tool to understand the implications of Tenn's results as to pricing and welfare.

Consider first the difference-in-difference design. Differencing over time is necessary to the extent that c_t varies over time; differencing over hospitals is necessary to the extent that $\bar{q}_j$ varies across hospitals. Table 1 of Tenn's paper models the impact of the merger on prices at Summit relative to Alta Bates with the most basic difference-in-difference specification. In this table, Tenn assumes that any variation in prices at Summit relative to Alta Bates is due to the merger. In the context of the model presented above, this model is a valid test of whether the merger increased prices only given some further special assumptions: (1) ξ_{jt} must be identically 0 so that there is no random fluctuation in price; (2) quality cannot vary with the merger; and (3) prices from the merger vary only at Summit, not at Alta Bates. Of these reasons, (3) is the most problematic, because, to my knowledge, there is no clear fundamental model that would predict a price rise at one hospital but not the other.

Tenn addresses concerns (1) and (3) with Table 2. In particular, Table 2 uses the set of hospitals in California (rather than Sutter) but outside the Bay Area as a control group, effectively to control for c_t. To control for the random fluctuation in hospital prices due to

variations in ξ_{jt}, Tenn employs a two-step estimator. The estimator is roughly equivalent to a random effects estimator, with a normally distributed random effect for each hospital and time period. This random effect is identified, because the data are at the level of the patient and there are multiple patients for each hospital and time period.[2]

Thus, from Table 2, one can conclude that if the time-varying hospital-specific shocks relative to California were from the same distribution post-merger as pre-merger, then the merger caused a big price increase at Summit but no significant change in price at Alta Bates. I believe that these assumptions are reasonable – there was no evidence of a secular pre-merger trend in prices at either hospital and no evidence that the merger coincided with some shock specific to Summit or Sutter. Hence I generally believe that the merger caused the Summit price increase.

Yet, this analysis does not resolve the questions of why prices rose only at one hospital and of whether the merger harmed consumer welfare. In particular, the findings do not fit my base model where quality is invariant – this model would predict that prices should rise at *both* hospitals. This suggests that it is useful to consider what else could possibly be occurring with these data.

I believe that any attempt to resolve this puzzle needs to take into account the fact that Summit Hospital was perceived as low quality before the merger. In particular, Tenn presents significant evidence that Summit charged low prices but still did not attract nearly as many patients as Alta Bates did.[3] In addition to this choice-based evidence, there is substantial evidence from documents that people considered Summit to be of lower quality than Alta Bates.[4] To this end, I exposit two potential explanations.

3.1 Could price increase follow from harmonization of prices?

One possibility is that, following the merger, Sutter harmonized its prices across hospitals and that the increase in price at Summit was a result of price harmonization. Intuitively, Sutter should want to price its hospitals differently than would Summit. In particular, if Summit Hospital were of low quality, then, a stand-alone Summit may want to charge a relatively low

price to attract patients. Following the merger, Sutter would want to raise prices at Summit because the business stealing effect is less important as some of the business would go to Alta Bates and other Sutter hospitals.

The harmonization effect comes directly out of the theoretical model. In particular, the post-merger price $\hat{p}_{jt}$ that satisfies the FOC (5) for hospital j will also satisfy the analogous FOC for hospital k. Thus, in the post-merger equilibrium, $\hat{p}_{jt} = \hat{p}_{kt}$ regardless of the quality of the two hospitals. The underlying reason is that the relative business-stealing harm from raising price for either hospital is the same. Importantly, this harmonization is true regardless of how many other competitors are in the market – it would hold if the only two relevant hospitals in the market were Sutter and Summit or if the market included 20 other hospitals. Additionally, prices would be harmonized in the case of very elastic demand (when the merger might not raise prices much) and also inelastic demand (when it would raise prices a lot).

Exact price harmonization would not hold for more general models with variation in costs or horizontal differentiation (such as differences in location) across hospitals. Nonetheless, I believe that the overall takeaway is important: harmonization of prices may occur regardless of the price elasticity of demand or of the degree of competition of the market. Thus far, I have considered a model where hospital systems can costlessly choose different prices at different hospitals. In many real world situations, there may be bureaucratic and negotiations costs from choosing different prices for different hospitals within the system, and hospitals may find it optimal to choose the same prices for every hospital. This is a separate, but equally valid, reason for price harmonization.

Moreover, the fact that prices were harmonized does not, by itself, prove that the merger raised prices. One possibility is that Sutter compensated for higher prices at Summit by lowering the prices at other Sutter hospitals. While it might be difficult to detect whether there was a price decrease at Sutter – because such a decrease would probably be relatively diffuse – it is worth considering this possibility in the data.

3.2 Could price increase be counterbalanced by quality increase?

A second possibility is that Sutter increased the quality of Summit following the merger and that this counterbalanced the increase in price at Summit, in part or in full. Tenn does not present any evidence on the post-merger quality change at Summit. A Berkeley resident friend of mine commented that "I have no pre-merger experience [at Summit]. My father was there [treated at Summit] once post-merger and I felt quite positive about the place.... Like everyone else I had thought Summit was an inferior place, so was pleasantly surprised."

If this view is accurate, it is possible that Sutter increased the quality at Summit following the merger. From the model, a higher quality hospital will have a higher price, and thus, if a hospital raises quality, it would raise prices. Notably, this price increase would occur regardless of the gain in market power stemming from the merger. Moreover, this quality increase will increase utility, and could potentially even more than compensate for the higher prices at Sutter.

Thus, the fact that the merger increased prices but may have increased quality suggests that market power may not be the driving force for the price increase. In future studies, it would be very useful to investigate whether there was an empirically verifiable increase in quality.

There are two methods that one might consider. A direct approach would be to look at variation in observable quality measures over time, with a difference-in-difference approach. Alternately, a demand-based method would examine the quantity for these hospitals, prior to and after the merger. If Summit's patient volume increased – or even stayed the same following the price increase – this would certainly be suggestive of the fact that quality increased. This intuition can be formalized by estimating a discrete choice model for hospitals, such as Gaynor and Vogt (2003), which would back out the quality change from the merger from the change in quantity and price, and then analyze the extent to which the merger affected welfare by changing both quality and price.

4 Conclusions

Tenn's study uses novel data to provide convincing evidence that the acquisition of Summit Hospital by Sutter increased prices at Summit Hospital. In contrast, there is no evidence that prices at Summit's nearby Alta Bates Hospital increased. The causes of the increase in prices are more uncertain. It could be that the price increase resulted solely from an increase in market power. However, other plausible explanations are that Summit's quality increased significantly or that Sutter was harmonizing its prices across hospitals.

The large price increase and uncertain cause of the price increase suggest the need to study this merger in more detail. Other evidence besides the price increase could bear on this. The evidence would include the post-merger evolution of quality and quantity at Summit. It would also be helpful to understand the reasons why prices rose at Sutter but not at Summit. The large price increase suggests the general need to more carefully consider mergers for antitrust scrutiny that are currently deemed "marginal" by antitrust authorities.

Finally, Tenn did not discuss how the impact of the merger compared to the impact that was predicted by industry participants. To the extent that Summit and/or Sutter issued pre-merger public documents that highlight the impact of the merger on prices, it would be very useful to examine whether their predictions were ultimately borne out or not.

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Notes

[1]Formal proofs of these properties are beyond the scope of this comment. See Anderson et al. (1992) for an excellent theoretical treatment of multinomial logit models under oligopoly.

[2]Tenn might consider some relatively minor variations of their estimator following Donald and Lang (2007), who argue for a slightly different specification with this type of data.

[3]More formally, applying the method of Capps and Dranove (2004), Tenn finds that Summit attracted only one-third as many patients from similar zip codes as did Alta Bates, when weighting hospitals by the zip codes from which they draw patients.

[4]Tenn could further this finding in two ways: first, by documenting the extent to which Summit Hospital was of low observable quality, using data such as risk-adjusted mortality or patient safety measures; and second, by verifying that Summit's low demand was not the result of capacity constraints or not offering certain services.