Labor and Product Market Effects of Mergers

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Abstract

We use a two-level vertical supply chain model to examine the labor market effect of product market mergers under different labor market configurations. In the model, firms and workers collectively bargain over wages upstream, and firms sell differentiated products and engage in Bertrand competition downstream. We examine multiple channels through which a merger changes both firm and worker leverage, and explore how merger effects vary when production takes place in one or more labor markets. We conduct a series of numerical simulations to identify the situations in which mergers most affect worker welfare. We find that when product and labor markets completely coincide workers' welfare is reduced the most. Interestingly, consumer harm is often mitigated (and in some cases eliminated) as reduced wages are partially passed thru in the form of lower final goods prices. Finally, we find that merger simulations that focus only on downstream competition can frequently identify those mergers that harm workers.

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1 Introduction

The recent empirical literature finds that many employers are not passive participants in labor markets. Multiple studies have found that firms can substantially increase the number of employees they hire by raising the offered wage, a finding inconsistent with the infinite firm labor supply elasticity predicted by a model of perfect competition, Sokolova and Sorensen (2021). Another line of research finds evidence of rent sharing between workers and firms: firms experiencing profit shocks appear to share some of those rents with employees. If labor markets were perfectly competitive, firms would have no incentive to share rents with their employees. Labor economists have developed a number of models to explain the source of employer power, most prominently those viewing search frictions as the source of employer power (Burdett and Mortensen (1998) and Manning (2003)). With few exceptions, the existing theoretical models of employer power do not allow for employers to take into account the behavior of rival employers in setting wages [1]. Interestingly, a handful of recent empirical papers find that mergers of competing employers in highly concentrated employer markets reduced worker's wages (Prager and Schmitt, 2021; Arnold, 2021). These results suggest that in concentrated markets employers may behave strategically in setting wages: employers appear to lower their wages when facing fewer competitors in the labor market following mergers.

In response to growing evidence that some employers have power over workers and concerns that mergers could enhance this power, a number of scholars have suggested antitrust authorities should also consider how horizontal mergers affect workers in evaluating the competitive impact of mergers (see, for example, Naidu et al. (2018) and Marinescu and Hovenkamp (2019)). A major challenge facing antitrust economists in forecasting the labor market effects of mergers is that, to our knowledge, there is no established model-based methodological approach with which to forecast the labor market effects of mergers. Over

[1] A notable exception is Berger, Herkenhoff, and Mongey (2022) who model employers engaged in Cournot competition

the last forty years, industrial organization economists have developed tools to forecast the product market effects of horizontal and vertical mergers. For example, in markets where prices are set by producers charging a single price to a large number of consumers, competition is typically modeled as differentiated Bertrand (Werden and Froeb, 1994), and the impact of mergers can be simulated by forecasting how changes in product ownership affects equilibrium pricing. Alternatively, in markets where buyers and sellers are engaged in negotiations, price setting is typically modeled as the outcome of Nash bargaining (Gowrisankaran et al., 2015). In this modeling approach, a merger of sellers affects competition by increasing the bargaining leverage of sellers relative to buyers, likely resulting in an increase in prices paid to sellers. In this paper, we adapt modeling tools frequently used to study the competitive impact of horizontal and vertical mergers on the product market to simulate the labor market effects of mergers.

We use a two-level vertical supply chain to examine how a merger of producers affects both competition in the final goods market and the welfare of production workers. Our model, which is analytically similar to that used by Sheu and Taragin (2021), assumes that upstream workers collectively bargain over linear wages with downstream manufacturers who employ Leontief production techology to manufacturer differentiated products. We examine how mergers affect worker welfare using two related methods to model the employer/employee bargaining process. We use the approach first developed by (Horn and Wolinsky, 1988) to model collective bargaining between a union and a manufacturer where the firm and its workforce are profit/income maximizers and engage in negotiations over the rents generated by the employment relationship. In the first formulation the surplus available to an employed worker is defined as the difference in the negotiated wage and an exogenously determined outside option. In particular, workers do not explicitly consider manufacturers of substitute products as potential employers, and, as a result, the presence of these potential employers does not affect the threat point of workers. In this case, an anticompetitive merger only affects workers through changes in the final goods market. The merging parties will sell fewer goods at higher prices, and increase their bargaining leverage against workers through product market recapture. Next, we extend this model to allow the merger to also affect workers' leverage; that is, workers' option to work at other firms should workers fail to reach an agreement in negotiations. Specifically, we assume that all workers now also have the option to work at other firms manufacturing substitute products to those sold by the merging firms. This modification has two implications. First, other things equal, the merger's impact on non-merging parties affects workers' outside option. Increased final good prices by the merging firms causes the quantity demanded at non-merging firms to increase, and potentially increases workers' wages. Second, the merger reduces the set of potential employers available to workers. This reduction in leverage reduces the fraction of rents generated by the employment relationship that are captured by workers. Finally, to close the model we assume that downstream manufacturers sell differentiated products where prices are determined via a Bertrand game with logit demand (Werden and Froeb, 1994).

An advantage of our modeling approach is that it can accommodate a variety of configurations of product and labor markets corresponding to many types of mergers that frequently take place. In our paper, we present merger simulations corresponding to three market configurations that illustrate the different channels by which mergers of competing firms can impact the labor market. The first case we consider is a market where production and consumption of the merging firms' products take place in the same geographic region. In this scenario, the geographic market for labor services and the goods produced by the merging firms are identical. This scenario most closely corresponds to industries such as retailing or healthcare where the goods and services being produced must be consumed in the region where they are created. Moreover, these are the types of mergers where ex post merger evaluations have found evidence of mergers leading to reductions in workers' wages (Prager and Schmitt, 2021). The next cases we consider are situations where the product produced by the merging firms is tradable: consumption of the merging firms' product can take place in regions different than those where the product is produced. Specifically, we consider a model where production takes place in two regions (A and B), but where products can be consumed in either region. We focus on two variants of this scenario. In the first, we assume that the merging firms produce in the same geographic region and hire from the same labor pool, but compete with rivals producing in a different region where hiring takes place in a separate labor market. In the second variant, we examine the labor market impact of merger of firms producing in different geographic markets, but selling in a common final goods market. These tradable good scenarios correspond to markets where products are produced in a handful of regions but are sold into broader regional or national product markets.

To develop an understanding of how horizontal mergers affect the labor market in our model, we first conduct a large number of numerical merger simulations corresponding to different market configurations. For instance, for each of the three scenarios described above, we randomly draw firm level market shares for markets with different numbers of market participants. In addition, we also explore how mergers affect consumer and worker welfare as we allow the relative bargaining strength of a firm relative to its workforce to vary. Finally, we limit the set of markets we study to those where mergers are likely to generate consumer harm; that is, to be considered in our analysis a candidate market must pass the hypothetical monopolist test.

Next, we conduct a case study simulating mergers in the hospital industry where recent empirical work has found evidence of mergers harming workers (Prager and Schmitt, 2021). In this analysis, we first use publicly available data describing market configuration, margins, employment levels and wages to calibrate the demand parameters of our model and determine the relative bargaining power of workers to firms. Using the calibrated model, we then simulate the impact of hypothetical mergers in the hospital industry on downstream prices for hospital services and the wages of nurses and pharmacists using our model.

We have several key findings. First, we find that horizontal mergers in our simulated markets never increase workers' surplus. In our modeling framework there are three mechanisms whereby mergers can harm workers. Mergers of firms producing substitute products result in price increases. In turn, these price increases lower the quantity sold which lowers labor demand (and thus, worker surplus). In addition, a merger of substitute products increases firms' bargaining leverage because the merging parties will recapture any diversion resulting from a failure to reach an agreement with workers. Third, a merger can also affect workers' leverage by eliminating an independent employment option in local geographic market, and by changing the wages and quantities at non-merging parties. Interestingly, it is the removal of a choice from workers' outside option that is primarily responsible for reducing worker surplus in the simulations we study.

Second, we find that mergers in non-tradable goods markets appear to harm workers more than those in tradable goods markets. This occurs because in the non-tradable goods case all producers/employers benefit from the reduction in workers' leverage. This reduction in workers' leverage allows all employers to extract rents from workers. By contrast, in the tradable goods markets, many workers experience only an increase in firm leverage, and not a decrease in worker leverage. As a result, the effect of the change in leverage caused by the merger is dampened.

Third, the reduction in worker surplus resulting from many of our simulated mergers is partially transferred to consumers in the form of lower retail prices and increased consumer surplus. The reduction in wages that is transfered to consumers as a lower price appears to be driven by the relative bargaining power of workers relative to firms. In the randomly generated markets we study, in nearly half of the non-tradable goods mergers we simulate consumer surplus increases post-merger because of the reduction in worker wages that is passed through in the form of lower retail prices. This effect is most frequently observed when workers have relatively high levels of bargaining power. In the hospital case study, however, we find that firms rather than workers have very high bargaining power when we calibrate the model. As a result, in the hospital merger simulations, we find that mergers almost always harm both workers and consumers. This finding suggests that in markets where the worker/firm match generates significant rents and where wages are determined by Nash bargaining there can be potentially important welfare tradeoffs between workers and consumers resulting from mergers if workers capture a substantial share of rents in the pre-merger state.

Having shown that mergers can harm workers by reducing worker leverage and increasing employer leverage, it is natural to ask if existing merger simulation tools can be used to identify those mergers most likely to harm workers. To answer this question, we determined the fraction of mergers that would be flagged as unlikely to harm consumers by a conventional "downstream only" merger simulation scheme that would materially harm workers; that is, forecasting the downstream merger effect ignoring any impact on wages. We then categorize these mergers into those likely to harm consumers (predicted to lower consumer welfare by more than 1%) and those unlikely to harm consumers. Finally, we determine the fraction of mergers that were not predicted to harm consumers that in fact harmed workers under the full model (lowering worker surplus by either 1% or 5%). In the simulations we have conducted, we find that conventional screens almost always identify those mergers that would harm workers in tradable goods markets. However, in non-tradable goods markets we find that a significant proportion of simulated mergers (19%) that were not predicted to lower consumer surplus using a conventional merger simulation would result in reduction in workers' surplus of at least 5%.

Our paper is related to a rapidly growing literature that examines departures from perfect competition in labor markets. Most recent research uses one of two modeling approaches to study the impact of employer market power.[2] The first examines how the presence of

[2]The textbook model of labor market monopsony is one where a single employer of labor in an isolated geographic region (Robinson (1933)). In this model the employer facing an upward sloping labor supply curve, and must offer a single wage to all workers. As a result, as the firm expands employment it must raise the wage offered to all workers. For this reason, the marginal cost to the firm of expanding employment is larger than the wage paid to the marginal worker. This model, while the most well known model of monopsony, has not been the focus of much recent research which seeks to explain why employers have market power in labor markets with multiple employers.

search frictions in the labor market gives firms the ability to pay workers a wage less than their marginal product (Burdett and Mortensen (1998)). A key insight from this approach is that in steady state a firm's labor supply elasticity can be recovered by measuring a firm's recruitment elasticity (Manning (2003)). A large number of studies have estimated employer labor supply elasticities consistent with this explanation for employer market power. While estimated elasticities vary dramatically depending on the particular industry and identification strategy, varying between 0.1 and 5.8 (Staiger et al., 2010; Azar et al., 2022), overall the results from this literature reject the assumption of an infinite elasticity of a perfectly competitive labor market.

Our paper is most similar to those using a second research approach that examines how wages are generated in a model of bargaining (see, e.g., Jarosch et al. (2019) and Schubert et al. (2021)). In this framework, the employee/employer match generates rents, and a worker's wages will be a function of both the worker's opportunity wage and a fraction of the rents generated by the match. By contrast, if the labor force were perfectly competitive, any rents the firm earned would not be passed through to workers. A series of empirical papers have found evidence supporting the bargaining approach. Workers capture a significant share of rents: estimated wage elasticities to firm profitability vary between 0.02 and 0.29 (Card et al., 2018).

Finally, our paper adds to (and draws heavily from) the literature on merger simulation, see, Whinston (2007) and Asker and Nocke (2021) for a general description of these techniques. Most merger simulation research has focused on forecasting the impact of mergers in the product markets where the merger takes place, e.g.,Werden and Froeb (1994), Nevo (2001). Implicitly, these papers have assumed that mergers in product markets do not have impacts on input markets. Our paper most closely relates to recent research that has extended merger simulation to allow downstream mergers to also impact behavior in upstream markets Sheu and Taragin (2021) .

The remainder of our paper is organized as follows. Section 2 describes our modeling approach. Section 3 presents the results from our simulation study, Section 4 presents results from our hospital industry calibration and simulations, and Section 5 concludes.

2 Model

The effect of horizontal mergers in the product market are well known. Absent efficiencies, most models predict that prices rise and market output decreases. What is less understood is how horizontal mergers affect the employees of merging firms and workers at competing firms. Our research contribution is to examine the labor market effects of horizontal mergers by simultaneously modeling the effects of the merger on both the product and labor market.

We adopt the bargaining framework of Horn and Wolinsky (1988) that was originally developed to examine how a union and employer negotiated over wages. While unions only represent a small fraction of U.S. private sector employment,[3] using this approach we can accommodate a broad spectrum of wage setting processes by varying the bargaining power of workers relative to their employers. For example, by assigning all of the bargaining power to the employer, our model collapses to one where the employer can make a take-it-or-leave-it offer to the workers. Our model thus includes a special case in which workers receive no surplus and earn only their opportunity wage. Moreover, using this bargaining approach we examine how increases in workers' power (increased relative bargaining power) can potentially protect workers from the adverse effects of mergers. These results are particularly interesting given the recent interest in increasing the prevalence of unionization to protect workers from employer power.

In Horn and Wolinsky (1988) workers' opportunity wage is set exogenously. In particular, the model does not address how a change in the number of employment options available to

[3]The BLS estimates that the private sector unionization rate was 6.1% in 2021, see https://www.bls.gov/news.release/pdf/union2.pdf.

workers affects negotiated wages through a change in the outside option. Recent empirical work suggests changes in the number of potential employers in a region may have important impacts on wages. Local labor markets are estimated to frequently have relatively few potential employers for workers in a given occupation (Azar et al., 2020) and reductions in the number of potential employers are estimated to lower wage offers (Azar et al., 2022). For this reason, we also analyze a variant of the Horn and Wolinsky (1988) model used by Sheu and Taragin (2021) to analyze how a downstream merger affects both wages and product prices in a vertical supply chain. We make two major modifications of the Sheu and Taragin (2021) modeling approach to analyze employer/employee bargaining. First, we explicitly allow for employers producing competing products in the same geographic region to be viable employment options for workers (through the outside option). Second, we examine how a merger affects negotiations by removing an independently operated employment option from the local labor market. Following the approach of Jarosch et al. (2019), post-merger we eliminate workers' ability to obtain employment at another outlet of the merged firm if workers and the firm fail to negotiate a wage. That is, in post-merger negotiations, all outlets now owned by the merged firm are removed from the outside option. Together, these two modifications allow us to examine how changes in the set of employment options available to workers resulting from mergers affect worker welfare.

In the following sections, we present product demand (Section 2.1), the Bertrand equilibrium for product prices (Section 2.2), labor demand (Section 2.3), and the bargaining game for wages, including worker and firm outside options (Section 2.4).

2.1 Product Demand

We assume that product demand follows a standard logit demand framework. There is a finite set of products in the product market, $n \in N$. Each customer chooses a single unit of one product, or instead chooses an outside option, which could be a product outside the product market, or not consuming at all.

Let there by M consumers, and each consumer $i \in M$ receives utility

$$V_n^i = \delta_n - \alpha p_n + \epsilon_{in}$$

from choosing good $n \in \{N, 0\}$, where δ_n denotes the value of the good n to all consumers, p_n the price of good n, $-\alpha$ the dis-utility of spending money, and ϵ_{in} the idiosyncratic taste of consumer i for good n, which is not observed by the firm.

We assume that ϵ_{in} is distributed according to the Gumbel distribution. We also normalize utility from the outside option ($n = 0$) to be zero. Therefore, the consumer demand for product n is given by q_n, where

$$q_n = s_n M = M \frac{\exp(V_n)}{1 + \sum_{n \in N} \exp(V_n)}$$

Where $s_n = \frac{\exp(V_n)}{1+\sum_{n \in N} \exp(V_n)}$ is the share of consumers choosing product n.

2.2 Price Setting

We assume that product prices are set by firms in Bertrand equilibrium. Each firm may produce one or more products, such that the set of firms $J \subseteq N$. Let Z_j denote the set of products produced by firm $j \in J$.

Each product is produced using constant marginal cost technology c_n. Furthermore, a single unit of labor is required to produce each unit of product n. Each unit of labor costs w_n. This assumption implies that labor and capital (or other costs) are perfect complements, and each unit of product n costs $c_n + w_n$ to produce.

Firm j solves the following to maximize prices over all the products that it owns, $h \in Z_j$:

$$\max_{\{p_h\}_{h\in Z_j}} \sum_{h\in Z_j} (p_h - w_h - c_h)q_h. \tag{1}$$

Rearranging the firm's first order condition for product n yields the following expression for margin:

$$p_n - w_n - c_n = -\frac{1}{\alpha(1 - \sum_{h\in Z_j} s_h)} \tag{2}$$

The Bertrand equilibrium is the set of prices p_n for $n \in N$ such that equation 2 is satisfied for all n.

2.3 Labor Demand

We assume that there are $k \in K$ labor markets. In each labor market k, the number of workers is assumed to be L^k. Let the set of products produced in labor market k be denoted R^k were $R^k \subseteq N$. We assume that a given product r can only be produced in one labor market. In equilibrium, the quantity of labor demanded is equal to the quantity of product demanded under perfect complementarity. Therefore, the following must hold in equilibrium:[4]

$$q_r^* = s_r^*(\mathbf{w})M = \mathfrak{s}_r^*(\mathbf{w})L^k$$

Where $s_r^*(\mathbf{w})$ is the share of product r demanded by consumers given wage costs for all products in vector $\mathbf{w}$, and $\mathfrak{s}_r^*(\mathbf{w})$ is the share of workers producing product r given $\mathbf{w}$. We are implicitly assuming that worker labor supply is perfectly elastic such that $s^*{}_r L_k$ reflects the number of jobs available in labor market k producing product r. An implication of

[4]Note that the number of workers in each labor market k, L^k, may not be equal to the number of consumers, M. Therefore, it is not necessarily true that $s_r^* = \mathfrak{s}_r^*$, but relative shares inside the market will be the same.

this assumption is that there is no upward sloping supply of labor as in classic monopsony models, such as Robinson (1933). Rather, wages are determined through bargaining, and level of labor demanded is determined by output in the product market, which is affected indirectly by the negotiated wage.[5]

2.4 Wage Setting Through Bargaining

Wages are set using the Nash-in-Nash bargaining concept of Horn and Wolinsky (1988). Below we outline the payoffs and outside options of firms and workers, and the bargaining solution.

2.4.1 Firm Payoff

For each product that is produced, workers collectively bargain for a single wage, w_n, to be paid per unit of output produced. If a firm reaches an agreement with the workers in labor market k producing product n, the firm is able to produce product n and receives profit:

$$\pi_n = (p_n^* - w_n^* - c_n)q_n$$

where w_n^* is the wage solving the bargaining game outlined below, and p_n^* solves the Bertrand game outlined above.

2.4.2 Firm Disagreement Payoff

The assumption we make about the firm disagreement payoff is one commonly used in the literature, see, e.g., Draganska et al. (2010) or Gowrisankaran et al. (2015). If a firm fails to reach an agreement with the workers, product n cannot be produced. The firm, however,

[5]We avoid specifying a functional form for labor supply due to the difficulty in solving for labor market clearing and bargaining outcomes simultaneously.

continues to produce any other products that it owns, and in fact captures additional sales from consumers who substitute from the discontinued product n to other products owned by the firm ($h \in Z_j$).

The payoff to the multi-product firm failing to reach an agreement is therefore:

$$\sum_{h \in \{Z_j \setminus n\}} (p_h - w_h - c_h) \frac{s_h}{1 - s_n} q_n$$

Note that a single product firm will receive zero payoff following a failure to reach an agreement with workers.

2.4.3 Worker Payoff

Workers collectively bargain over the wage w_n that will cover all workers in labor market k producing product n, denoted L_n^k, which can also be written as $\mathfrak{s}_n(w_n)L^k$ where $\mathfrak{s}_n(w_n)$ is the share of workers producing product n, and L^k is the total number of workers in labor market k. Workers care about both the wage paid and the output, their payoff from an agreement with the firm being

$$w_n q_n = w_n \mathfrak{s}_n(\mathbf{w}) L^k$$

The number of workers L^k is taken to be exogenous. Workers do not directly bargain over $\mathfrak{s}_n$ but do take into account how a higher w_n will result in a lower $\mathfrak{s}_n$ through increased product prices p_n.

2.4.4 Worker Disagreement Payoff

The workers' disagreement payoff takes a significantly different form than the firm's disagreement payoff. Workers are constrained to find employment in the labor market they live in. As a result, in the event employees and employer negotiations break down, the workers' alternative options are limited to employers located in the same geographic area they live in. In addition, like Jarosch et al. (2019), we assume that firms will not make multiple job offers to workers. For this reason, it is not possible for workers to get jobs producing a product owned by the same firm following a failure to reach an agreement in collective bargaining.

A failure of a firm and its workforce to reach an agreement has two effects that are relevant for determining the workers' disagreement payoff. First, consumers substitute away from discontinued product n to other products produced by rival firms. As a result, demand for substitute products increases. This, in turn, increases the demand for workers at those firms producing substitute products. In general, however, production of these substitutes can take place in multiple labor markets. Workers who had previously worked at the firms producing product n can only consider working at firms located in their labor market k, or $l \in R^k \setminus \{n, l \in Z_j\}$. Since consumer demand follows the Gumbel distribution, diversion from product n to product l is given by $\frac{s_l}{1-s_n}$. Second, as noted above, following a merger, if workers fail to reach an agreement with the firm, they can only seek employment with non-merging firms. This assumption will tend to make workers worse off following a merger, since the set of products owned by firm j, or Z_j, will expand. The workers' outside option is as follows:

$$\sum_{l \in R^k \setminus \{n, l \notin Z_j\}} w_l \frac{\mathfrak{s}_{\mathfrak{l}}(\mathbf{w})}{1 - \mathfrak{s}_{\mathfrak{n}}(\mathbf{w})} \mathfrak{s}_{\mathfrak{n}}(\mathbf{w}) L^k$$

Note that the workers' outside option is increasing in the wages at other firms, and the attractiveness of substitute products to consumers. Under the Gumbel distribution this means that a worker producing a product with a small market share (less attractive product) has a better outside option than a worker working at a large firm (more attractive product), holding wages constant.

2.4.5 Bargaining Solution

Wages are assumed to be set in a Nash bargaining game. Worker surplus is given by the worker payoff from reaching an agreement minus the disagreement payoff, and likewise for firm surplus. The bargaining solution will maximize the product of worker and firm surplus, weighted by bargaining power, which is given by λ. The bargaining problem for each product $n \in N$ is therefore:

$$\max_{w_n} \left(w_n \mathfrak{s}_\mathfrak{n}(\mathbf{w}) L^k - \sum_{l \in R^k \setminus n, l \notin Z_j} w_h \frac{\mathfrak{s}_\mathfrak{l}(\mathbf{w})}{1-\mathfrak{s}_\mathfrak{n}(\mathbf{w})} \mathfrak{s}_\mathfrak{n}(\mathbf{w}) L^k \right)^{1-\lambda} \times \tag{3}$$
$$\left((p_n - w_n - c_n) s_n(\mathbf{w}) M - \sum_{h \in \{Z_j \setminus n\}} (p_h - w_h - c_h) \frac{s_h(\mathbf{w})}{1-s_n(\mathbf{w})} s_n(\mathbf{w}) M \right)^{\lambda}$$

We make two assumptions for tractability. First, we assume that, for a given bilateral negotiation, all other negotiations are held fixed, commonly referred to as "Nash-in-Nash" and developed by Horn and Wolinsky (1988). Second, we assume that firms view downstream prices as fixed when bargaining over wages. Note that in equilibrium, product prices $\mathbf{p}$ will depend on negotiated wages, but this relationship is not explicitly modeled in the bargaining game due to tractability (see e.g. Draganska et al. (2010)). This means that product prices and wages are set simultaneously in equilibrium.[6]

Recall that from above that:

$$q_r^* = s_r^*(\mathbf{w}) M = \mathfrak{s}_r^*(\mathbf{w}) L^k, r \in R^k$$

Substituting in $s_n(\mathbf{w})M$ for $\mathfrak{s}_\mathfrak{n}(\mathbf{w})L^k$, taking the derivative with respect to to w_n and

[6]Therefore although $\mathfrak{s}_\mathfrak{n}(\mathbf{w})$ and $s_n(\mathbf{w})$ are implicitly functions of wages through changes to the product price p_n, this relationship does not appear explicitly in the bargaining first order condition given in equation 4, but rather occurs due to the equilibrium conditions for product prices and bargaining over wages being solved simultaneously.

rearranging yields:

$$\lambda\left(w_n - \sum_{l\in R^k\setminus n, l\notin Z_j} w_h \frac{s_l(\mathbf{w})\frac{M}{L^k}}{1-s_n(\mathbf{w})\frac{M}{L^k}}\right) = \tag{4}$$
$$(1-\lambda)\left((p_n - w_n - c_n) - \sum_{h\in\{Z_j\setminus n\}} (p_h - w_h - c_h)\frac{s_h(\mathbf{w})}{1-s_n(\mathbf{w})}\right)$$

This equation indicates that in equilibrium, the ratio of the surplus of the manufacturer of product $n \in N$ and to the surplus of its workers must equal the ratio of their relative bargaining power ($\frac{\lambda}{1-\lambda)}$). This implies that workers and firms with an outside option closer to their payoff (lower surplus) will have more bargaining leverage and achieve a better bargaining outcome.[7]

A non-linear solver may be used to solve the system of $2|N|$ equations characterized by equations 2 and 4 for w_n^*, p_n^*. Post-merger equilibrium prices can be solved for by changing the ownership structure, or the set of products included in each set Z_j.

3 Numerical Simulations

Because our model cannot be analytically solved, we cannot derive how the equilibrium predictions of the model change in response to changes in the model's primitives. For this reason, we conduct a large number of numerical simulations to develop an understanding of how product market mergers will affect the welfare of workers and consumers across a broad set of markets in our modeling approach.

We are especially interested in how the impact of mergers varies in different configura-

[7]Note also that the ratio of the size of the labor market to the size of the product market ($\frac{M}{L^k}$) appears in the workers' outside option, reflecting the idea that the more workers are employed outside the product market, the less wages in the product market will affect their outside option.

tions of the labor markets available to workers and product markets facing producers that frequently confront antitrust agencies examining mergers. In the next sections, we describe these market structures (Section 3.1), the simulation methods used (Section 3.2), and the results of the simulations (Section 3.3).

3.1 Market Configurations

We simulate the labor and product market effects of mergers taking place in markets with three distinct configurations of the labor market and product market. These structures are depicted graphically in Figure 1.

The first configuration is one where the labor market and product market overlap completely. This means that all firms producing substitute products are physically located in the same labor market, and that all firms in the product market are also potential employers for workers working for firms in the product market. In the context of our model, this implies that product and labor market shares are the same. This configuration corresponds to industries producing products that must be consumed in the same geographic area in which they are produced, such as retail services or healthcare. We think this type of market is particularly important to study because compelling empirical work suggests that mergers in these type of industries can negatively effect workers Prager and Schmitt (2021). This market configuration is illustrated in the first panel of Figure 1.

Next we simulate mergers between local firms in a market in which substitute products are produced in multiple locations and traded widely across geography and where the merging firms produce in the same geographic market. This scenario is most likely to occur in manufactured goods markets where products are frequently shipped to regions outside of the local labor market where production takes place. This case is of particular interest because the change in concentration caused by a merger in the local labor market where production takes place could exceed the change in concentration in the final goods market.

As a result, the impact of mergers on the labor market may differ than that on consumers. This market structure is illustrated in the second panel of Figure 1.

Our final configuration corresponds to a national goods market structure as the previous paragraph, but one in which the merging parties produce in separate labor markets. This case is interesting because it is a product market merger that does not have obvious labor market effects (merging parties hire workers in separate geographic regions), but that nevertheless might affect workers due to changes to the firms' bargaining leverage. This market structure is illustrated in the third panel of Figure 1.

3.2 Simulation Methodology

To simulate the product and labor markets for our analysis, we treat as primitives the number of downstream firms $N \in \{3, \ldots, 6\}$ the bargaining power parameter $\lambda \in \{0, 0.1, 0.2, \ldots, 0.5\}$ and the pre-merger outside share $s_0 \in \{.05, .25, .45\}$. For each combination $z \in \{N \times \lambda \times s_0\}$, we sample 1,000 vectors of inside pre-merger market shares from a symmetric Dirichlet distribution with scale parameter equal to 2.5. We compute the price coefficient α by assuming that both pre- and post-merger, the outside option is manufactured by a vertically integrated single-product firm playing a Nash-Bertrand pricing game with wage $w_0 = 0$, margin $m_0 = \$5$, and then recover α from the equilibrium margin condition (equation 2). For the endogenous leverage model, we use the simulated shares and α to compute firm equilibrium pre-merger margins, and the bargaining power parameter and equation 4 to compute pre-merger equilibrium wages.[8] Finally, we assume that non-wage marginal costs comprise 10% of pre-merger margins, and then use these costs as well as equilibrium wages to recover pre-merger equilibrium prices.

In each of our simulated product markets, we randomly select two firms to merge and then calculate post-merger equilibrium wages and prices under the assumptions that a) one

[8] Wages for the exogenous leverage model, are calculated using a version of equation 4 where workers have no disagreement payoffs.

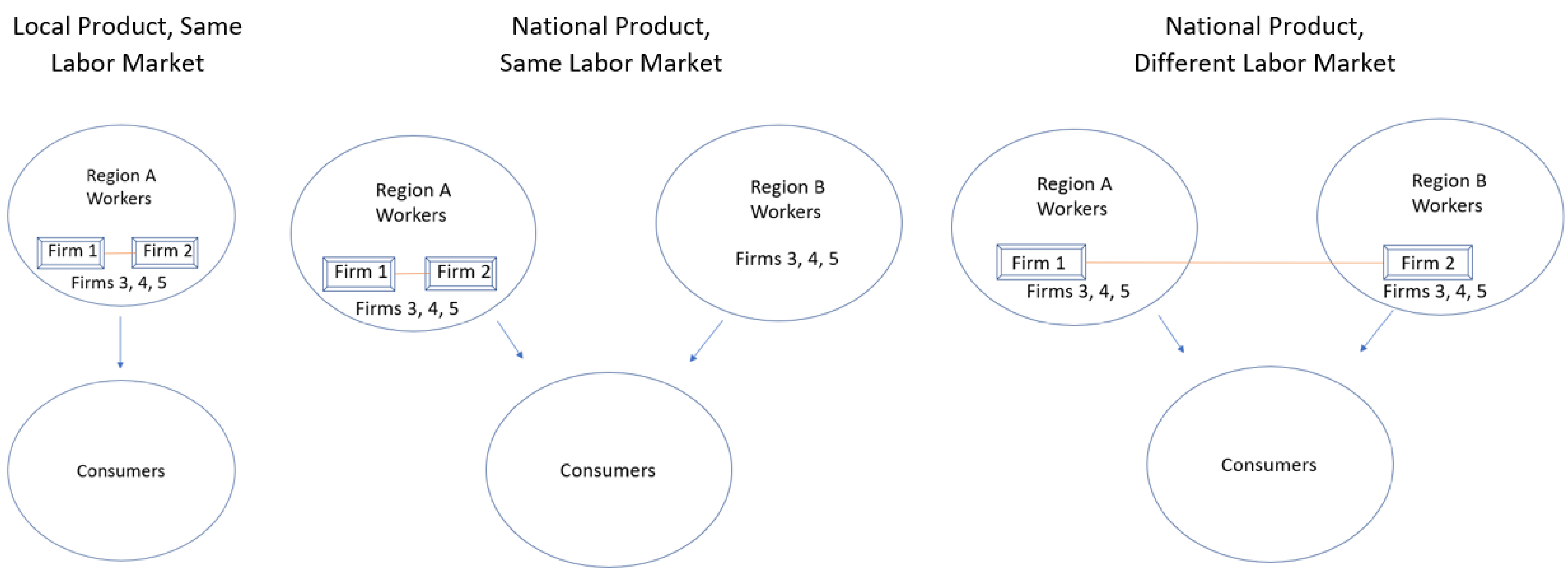

Figure 1 The figure displays the three market configurations considered. Horizontal mergers occur between firms 1 and 2. Non-merging firms are denoted 3, 4, and 5. Region A and B are labor markets. All firms produce in Region A, Region B, or both, and sell substitute products to consumers.

firm jointly sets prices on the merging parties' products and b) workers employed by one of the merging parties cannot switch to the other merging party if bargaining breaks down. We then exclude product markets that fail the Hypothetical Monopolist Test using a 5% "small but significant and non-transitory price increase", or where the mergers are unprofitable.[9] Approximately 13% of out simulated mergers are eliminated because they either occur in markets that fail the Hypothetical Monopolist Test or are unprofitable.

The first row of Table 1 gives the distribution of the number of firms sampled across all market configurations. Note that mergers are simulated between two firms, meaning that there is never a merger to monopoly. The number of labor markets is one for local product configuration, and two for national product configurations. In the next rows of Table 1 we see that we vary bargaining power parameters between 0.5 and 1 by units of 0.1, meaning that at most workers will obtain half of the surplus ($\lambda = 0.5$), and at worse, receive take-it-or-leave-it offers from firms ($\lambda = 1$). We also vary the market share of the outside option in the product market, setting it at 5%, 25% or 45%, yielding different market elasticities. Finally, in the last rows of Table 1, we see the distribution of the pre- and post-merger Herfindahl-Hirschman Index (HHI), and the change in HHI (Delta HHI). Due to restrictions on the sample described below, the mergers in our sample occur at relatively concentrated HHIs and produce relatively large changes in HHI, such that many might be of concern to antitrust authorities.[10]

[9] While a merger of firms producing substitute products in a downstream model holding input prices constant are always profitable, this result does not hold in two-level model like that studied here, see Sheu and Taragin (2021). In particular, in markets where labor has a very high levels of bargaining power, in some market configurations post-merger wages may incease so much that a merger becomes unprofitable. Because a priori unprofitable mergers should not be proposed, these mergers are not interesting to study in the simulations.

[10] Note that the change in HHI is higher in the local product configuration than the national product configurations because we assume that firms produce a different set of substitute products in each labor market, meaning that national product markets will tend to have double the number of products. Also, more local product markets tend to fail the hypothetical monopolist test and are dropped.

Table 1: Summary Statistics, By Market Configuration

Scenario	Variable	Markets	Min	p25	p50	p75	Max
All	# Firms	571,404	3	3	4	5	6
	# Labor Markets		1	1	2	2	2
	# Other		0	0	0	0	0
	Bargaining Power		0.5	0.6	0.8	0.9	1
	Nesting Parameter		0	0	0	0	0
	Avg. Upstream Price ($)		0	0.69	1.7	3.8	95
	Avg. Downstream Price ($)		3.3	5.3	7.4	10	119
	Market Elasticity		-1.9	-0.7	-0.48	-0.18	-0.07
Local Product,Same Labor	Pre-Merger HHI	165,110	1,670	2,333	2,869	3,630	8,944
	Post-Merger HHI		2,001	2,908	3,765	5,150	9,948
	Delta HHI		1	419	832	1,533	4,946
National Product,Different Labor	Pre-Merger HHI	207,627	1,670	2,285	2,824	3,637	9,177
	Post-Merger HHI		2,000	2,581	3,368	5,000	9,307
	Delta HHI		0	155	335	713	4,584
National Product,Same Labor	Pre-Merger HHI	198,667	1,670	2,286	2,820	3,636	8,993
	Post-Merger HHI		2,001	2,577	3,362	5,000	9,120
	Delta HHI		0	152	327	694	4,505

3.3 Simulation Results

To illustrate how different elements of the full model affect merger predictions, we calculate three partial simulations in addition to the full model. Figure 2 shows the frequency distributions of the percent change in worker, consumer, employer, and total surplus from the simulated mergers for each of the three market configurations described above, separately for the three partial simulations and the full model. In describing the simulations, “Downstream only” refers to whether the simulation allows only for a change in downstream prices due to the merger, while “Full” allows both prices and wages to adjust. Likewise, “Leverage” refers to whether the worker’s outside option, and therefore leverage, is endogenously determined, while under “No Leverage” the outside option is exogenously set equal to 0.

We begin by presenting the simulation results for the first market configuration where the labor market and product markets completely overlap in the first row of Figure 2. The first simulation (“Downstream Only, No Leverage”) is of a standard downstream merger, assuming Bertrand price effects where wages are fixed at the pre-merger equilibrium. This is a good proxy for what an antitrust economist would predict if forecasting the price effects of a merger, ignoring any effects the merger might have on wages. This simulation is the first of the four box and whisker plots in Figure 2. Since wages are fixed, the only potential impact on workers in this model is through a reduction in quantity. We see this effect is very small in all of the simulations we examined the first panel, including across all three market configurations, or rows, of the figure. Not surprisingly, both consumer and total surplus fall and employer surplus increases due to standard product market recapture effects.

The next simulation ("Full, No Leverage") calculates the change in consumer and worker surplus allowing wages to change post-merger under the assumption that the outside option for the workers is exogenously determined (and set to zero). In particular, the workers' outside option is not affected by the presence of other employers in the local labor market. Therefore, the objective function of the workers is $w_n q_n$. This means that the merger cannot affect the outside option of the workers either positively (through increased quantity produced at non-merging firms) or negatively (through decreased wages at non-merging firms). Empirically, we see very little difference between the downstream only simulations and the simulations where the outside wage is set to zero in terms of the frequency distributions of changes in surplus.

The third simulation ("Downstream Only, Leverage") is again the downstream only model with fixed wages, however, in this formulation, the pre-merger wages are assumed to be determined using our full model. Recall that in the full model, workers outside option is a function of the wages at all other potential employers in the local labor market. As a result, in this model the outside wage in the pre-merger state is endogenously determined. The fourth simulation ("Full, Leverage") assumes both pre-merger and post-merger wages are determined using the full model. The third and fourth simulations are therefore directly comparable in terms of pre-merger wages, allowing us to focus on the change due to a change in workers' outside options.

In examining the results from the merger simulations using the full model described in

Section 2, we see notable differences in the outcomes for firms and workers. These simulations are the fourth box and whisker plot ("Full, Leverage") in Figure 2. Workers are much more negatively affected by the merger when the merger is allowed to affect their outside option. Consumers, by contrast, are less worse off due to lower worker wages being partially passed through in the form of lower prices. In fact, in nearly 50% of merger simulations consumer surplus increases as the result of downstream mergers.

The second row of Figure 2 presents results using the same format but from simulations where the market configuration corresponds the case where there are two labor markets producing a tradable good and the merging firms produce in the same labor market (the case described in the second panel of Figure 1). The pattern of results is similar to the case of a single labor and product market shown in the first row of Figure 2. In particular, we see that workers are adversely affected by mergers only in the full model where the merger affects workers' leverage in bargaining. The magnitude of the effects on workers is, however, more muted. This could be due to the fact that a substantial fraction of workers are only affected by the merger through the product market, not directly through changes to their outside option.

Finally, the third row of Figure 2 shows the results for the final configuration, in which firms producing in separate labor markets merge. In this case, moving from downstream model to bargaining with fixed worker outside option, to the full model with an endogenously determined outside option, appears to make very little difference in the predicted effects of mergers for either workers or consumers. This finding is the result of workers' outside option not changing because the merging parties operate in separate labor markets. The wage impact of the merger is therefore entirely through the product market under any model. In all cases workers are somewhat harmed by the merger, but not nearly as much as consumers.

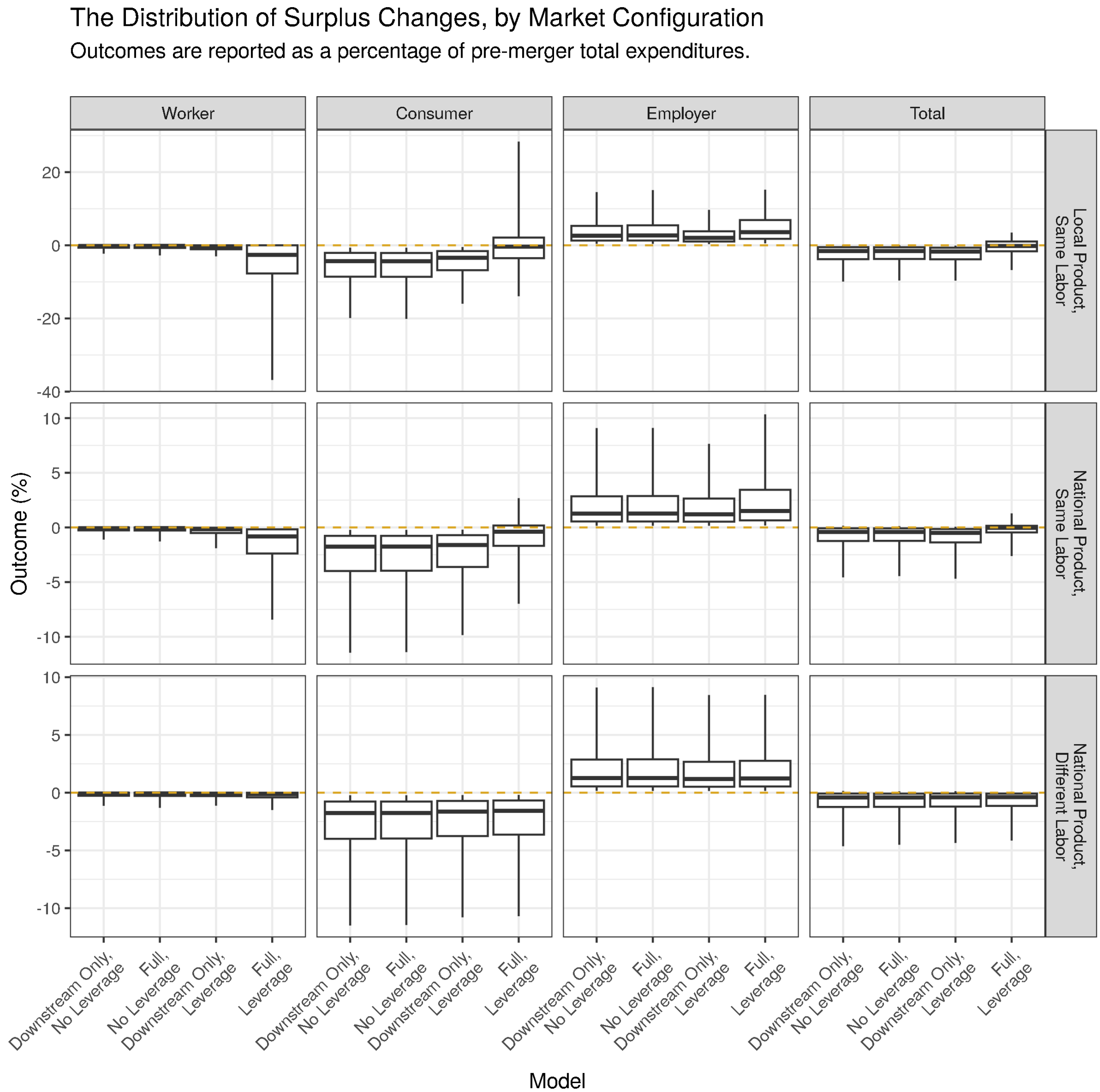

Figure 2 The figure displays box and whisker plots summarizing the effect of mergers on worker, consumer, firm and total surplus. Each row corresponds to a different market configuration described in 1 above. Each panel depicts outcomes from four different models, where "Downstream Only" implies only downstream price changes post-merger, and "Leverage" implies that worker outside options are endogenously determined, or fixed as in Horn and Wolinsky (1988). Whiskers depict the 5^{th} and 95^{th} percentiles of a particular outcome, boxes depict the 25^{th} and 75^{th} percentiles, and the solid horizontal line depicts the median.

3.3.1 Relationship Between Merger Effects and Bargaining Power

Bargaining power is an important input to the model since it determines the share of surplus received by the workers and their employers. The results presented in Figure 2 reflect markets where the relative bargaining power of firms varies between 0.5 and 1. Here we explore how the simulated effects of mergers vary as we change the relative bargaining power of workers and firms for the full model with an endogenous worker outside option for each of the three market configurations we consider. In Figure 3, the x-axis plots the ratio of firm to worker bargaining power ($\frac{(1-\lambda)}{\lambda}$), where 1 is equal bargaining power ($\lambda = 0.5$) and 0 corresponds to the firm having all the bargaining power ($\lambda = 1$).

As firm bargaining power increases, moving to the right on the graph, we see that mergers tend to have less of a negative effect on workers; that is, the change in worker surplus caused by the merger falls. This occurs because in those markets where pre-merger workers have substantial bargaining power, workers capture a large amount of surplus. Mergers in these markets result in a large transfer of surplus from workers to consumers and firms. By contrast, when workers have low levels of bargaining power, the loss in leverage caused by a merger has less of an effect because workers were previously capturing relatively little surplus. These results imply that increased worker bargaining power does not protect workers from a loss in surplus from a merger. Similarly, the decrease in consumer surplus resulting from the merger gets larger as firms' bargaining power increases. Consumers benefit less from the transfer of surplus from workers in the form of lower prices when pre-merger firm bargaining power is higher.

3.3.2 Relationship Between Worker and Firm Outcomes

If mergers do not affect worker wages, then we would expect worker and consumer interests to be aligned. Both should be harmed by anti-competitive mergers: increased final goods prices lower consumer surplus and harm workers through a reduction in labor demand. If, however,

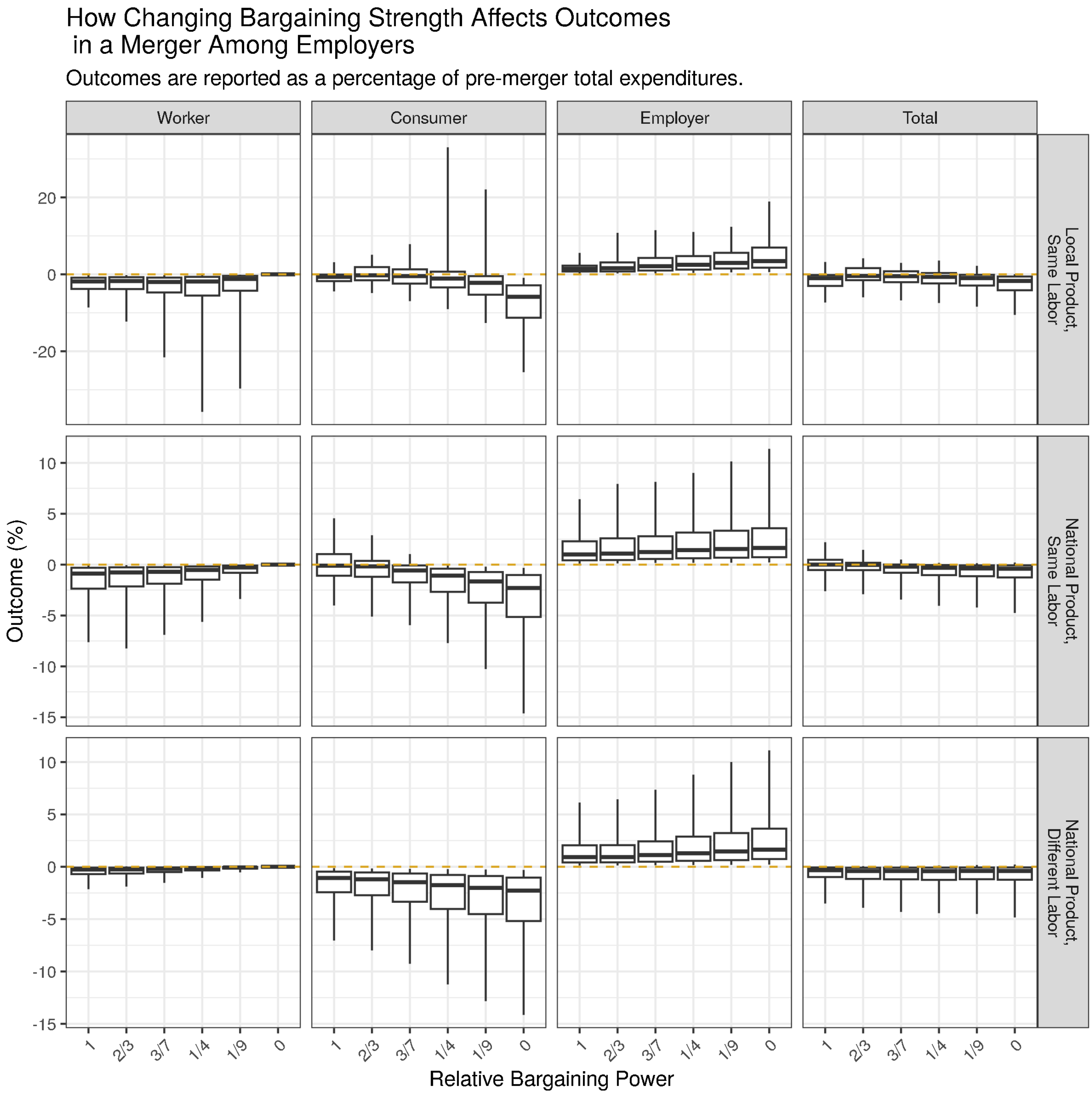

Figure 3 The figure displays box and whisker plots summarizing the extent to which mergers among two firms affect worker, consumer, firm, and total surplus as relative bargaining power changes from 0 (firms have the advantage) to 1 (workers and firms equally split surplus). Each row depicts the outcomes from one of three market configurations. Unlike Figure 2, we plot only the full model. Whiskers depict the 5^{th} and 95^{th} percentiles of a particular outcome, boxes depict the 25^{th} and 75^{th} percentiles, and the solid horizontal line depicts the median.

mergers directly affect worker wages (positively or negatively) and if, in turn, wage changes are passed through to consumers in the form of prices, then workers and consumers may view mergers of competing firms differently. To examine how worker and consumer interests align in our model, we have calculated the correlation between the change in consumer surplus with the change in worker surplus, employer surplus, and total surplus for a given merger separately for each of the market configurations we examined in the previous section in Figure 4.

Figure 4 presents Pearson correlation coefficients in percentages. Each row of the table corresponds to a different market configuration, while columns correspond to the correlation of the merger induced change in: consumer and worker surplus, consumer and employer surplus, and consumer and total surplus. In the first row, in which labor and product markets coincide, worker surplus is very negatively correlated with consumer surplus, implying that the mergers that most harm consumers are least likely to harm workers. Worker and consumer surplus are also negatively correlated in the case where products are produced in multiple labor markets and the merging parties produce in the same labor market. Finally, for those mergers that do not affect workers' leverage (where the merging firms produce in different labor markets), the change in worker and consumer surplus are weakly positively correlated. These findings suggest that if wages are set in a bargaining game like that specified here that policy makers may be forced to make a welfare trade-off in determining when to challenge mergers: mergers that harm workers may benefit consumers.

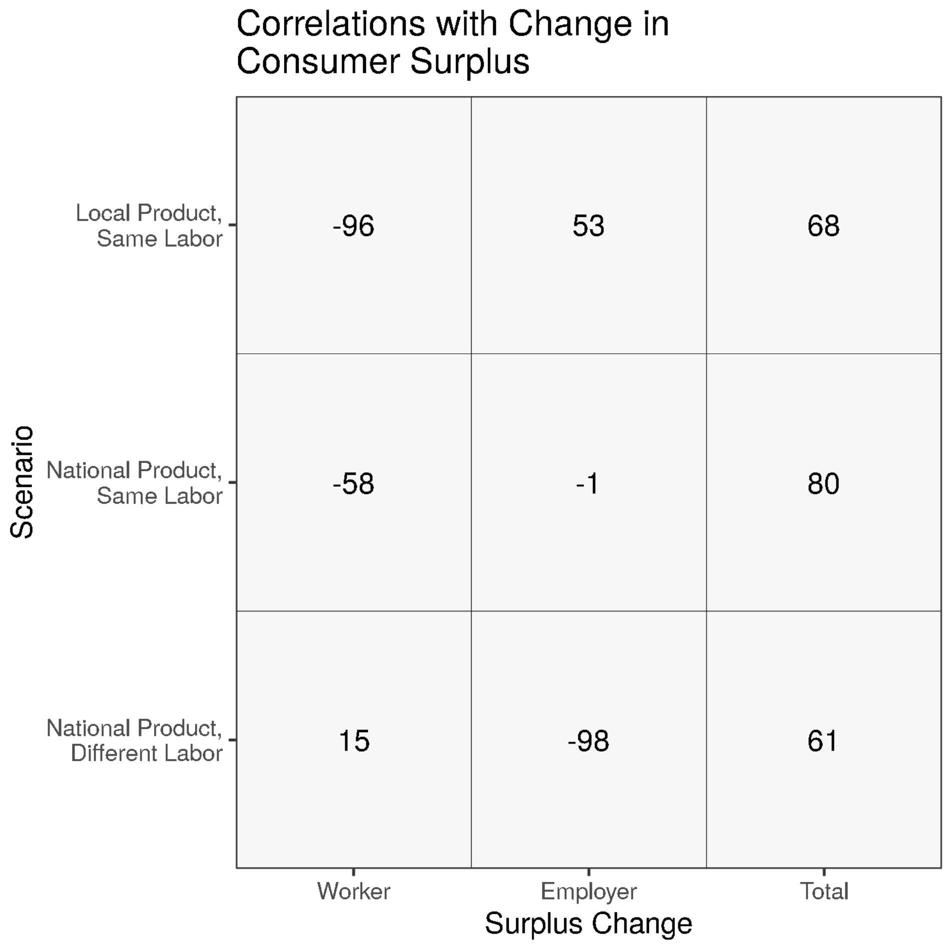

Figure 4 The figure displays Pearson correlation coefficients between the change in surplus due to a merger of consumers and workers, consumers and firms, and consumers and total, for 3 market configurations.

3.3.3 Can Conventional Merger Screens Identify Mergers That Harm Workers?

While the previous section demonstrated that mergers can both benefit consumers while harming workers, it may still be possible to use traditional merger simulation screens that focus exclusively on downstream competition to identify the mergers that harm workers. In our model, firms producing substitute products provide important employment options to workers through the determination of workers' outside option. The loss of one of these outside options, through a merger, reduces wages and, thus, worker surplus. If mergers that result in a large reduction in the outside option also are predicted to have large impacts on downstream competition (holding wages fixed), then traditional screens will correctly identify the mergers that harm workers.[11]

To determine the effectiveness of downstream merger screens in identifying mergers that harm workers, we conduct a test where we determine the fraction of mergers predicted unlikely to harm consumers by a conventional merger simulation scheme that would materially harm workers. Specifically, we calculate change in consumer surplus of a given merger ignoring any effect that the merger may have on wages. We then categorize these mergers into those likely to harm consumers (predicted to lower consumer welfare by at least 1%) and those unlikely to harm consumers. Finally, we determine the fraction of mergers that were not predicted to harm consumers that harmed workers (lowering worker surplus by either 1% or 5%). The results of this analysis are presented in Table 2. The first two columns of Table 2 give the probability that a merger lowers worker surplus by at least 1% or at least 5% conditional on the merger being predicted to lower consumer surplus less than 1% using the downstream only screen.

The results in the table show that more than 50% of mergers in this group would lower worker surplus by at least 1% where product and labor market coincide. However, the fraction of mergers harmful to workers is much lower, only 14%, for mergers where the product market is not geographically constrained. Using this screen, no mergers materially harm workers in the case of a merger across labor markets. Changing the threshold of worker harm to at least 5% reduces these percentages to 19% for mergers where the product and labor markets completely coincide, and to effectively zero for the other two cases. We interpret these findings as showing that conventional merger simulation screens can provide valuable information to identify most mergers likely to result in a substantial reduction in worker welfare, especially in tradable good markets where production takes place in multiple geographic markets.

[11] Our second market configuration reflects the idea that product markets may have a lower delta HHI than labor markets in that the product market includes products produced in other labor markets. This is an obvious case where we might expect product market screens to fail workers.

Table 2: Efficacy and incidence of error when using a downstream only model and a 1%, 5% enforcement threshold, by market configuration

		Efficacy		Incidence	
Product	Worker	> 1%	> 5%	> 1%	> 5%
Local	Same	0.52	0.18	0.77	0.88
National	Same	0.14	0.00	0.94	0.94
National	All	0.04	0.00	0.97	0.97
National	Different	0.00	0.00	0.94	0.94

Note:
'Efficacy' denotes the fraction of simulations where the full model predicts that a merger harms workers by either at least 1% or 5%, conditional on a downstream only model predicting no more than 1% consumer harm. 'Incidence' denotes the fraction of simulations where the partial model predicts that a merger yields more than 1% consumer harm, conditional on the full model predicting that a merger harms workers by either at least 1% or 5%.

Next, we examine the fraction of mergers that harm workers that are captured by product market screens. These results are presented in Table 2. We see that in the case of local products, our configuration that resembles retail or healthcare markets, conventional product market screens would capture 76% of mergers we predict to reduce worker surplus by more than 1%, and 87% of mergers predicted to reduce worker surplus more than 5%. These capture rates are higher, 94%, in markets with goods sold nationally. We conclude that product market screens are useful, though imperfect, in identifying mergers that may harm workers in our model.

4 Application to Hospital Mergers

In the previous section, we use the approach taken by Sheu and Taragin (2021) to randomly generate markets and then simulate the effects of mergers between randomly selected firms.

An advantage of this approach is that we can examine mergers taking place in broad variety of market configurations and in situations where workers and firms have different levels of bargaining power (λ) in wage negotiations across markets. This allows us to see how the qualitative predictions of the model vary across a large set of market configurations. For example, the simulations show that when workers have relatively high bargaining power and the geographic market for labor and products overlap (Figure 3), mergers frequently harm workers and benefit consumers as reduced wages are partially passed through in the form of lower prices. A potential weaknesses of relying on these randomly generated markets is that we do not know which of the markets we have simulated correspond to markets seen in the economy or where mergers have actually occurred.

To address this concern, we conduct some additional merger simulations calibrated using data from the U.S. hospital industry. Specifically, we use our model to simulate the impact of hospital (or hospital system) mergers on both downstream prices (hospital services) and nurse and pharmacist wages. As part of this exercise, we show how our model can be used to simulate the impact of mergers using data that would likely be available in a merger investigation. The hospital industry is particularly interesting venue to examine with our model for at least four reasons. First, it corresponds to the scenario where our earlier simulations find that labor market effects are most common: where goods are produced and consumed locally. Second, an extensive literature shows that the hospital mergers can result in substantial increases in inpatient prices (Garmon (2017), Cooper et al. (2019), and Brand et al. (2024)), and hospital merger enforcement has consumed a substantial fraction of the FTC's merger enforcement activities over the last decade.[12] In addition, recent research findings show that mergers in highly concentrated hospital markets can result in reduced wages for nurses (Prager and Schmitt (2021)). Finally, there is publicly available data describing both hospital markets and nurse and pharmacist wages that allow us to predict

[12]The FTC's recent actions in hospital markets are documented on a web page describing enforcement in healthcare markets available here: `https://www.ftc.gov/news-events/topics/competition-enforcement/health-care-competition`.

merger effects for a large number of markets.

4.1 Calibration

Here, we describe how we calibrate our model using data from the hospital industry, and then use the model to simulate all possible hypothetical mergers for markets with more than one hospital pre-merger where we observe sufficient data for calibration. We begin by specifically describing how we use data on observed hospital shares, margins, and worker wages to infer demand parameters and worker's relative bargaining power (λ). Next, we briefly describe the data used to construct shares, margins, and wages, and how we define the markets that are used in the calibration and merger simulation. Finally, we present the results of the merger simulations.

4.1.1 Methodology

Our first task is to identify the demand parameters in the model as a function of margins and shares assuming the market is in equilibrium pre-merger exploiting the structure of the model. We first exploit Equation 2, the employer's first order condition. Given one employer's margin and market share,[13] this equation allows us to recover the demand parameter reflecting customer sensitivity to price, α. Given α, we can then recover equiblrium margins for all other firms in the market using observed market shares for each firm and each firm's first order conditions. Demand parameters δ_j reflecting the relative customer demand for each hospital are inverted from market shares, margins, and α.

Given equilibrium employer margins, we use the bargaining first order condition in Equation 4 above to infer λ. In contrast to the numerical simulations described above, here we allow the bargaining parameter λ to vary by firm and labor market based on the ratio of the firm's gains from trade (downstream margin) and the workers' gains from trade (diversion-

[13] We take the margin of the largest firm for which margin is available.

weighted difference between current wage and alternative wages). Intuitively, the higher a firm's margin is relative to wages, the higher the firm's bargaining power parameter must be to satisfy the bargaining first order condition in Equation 4. Likewise, the lower the workers' outside option, including outside share and outside wage, the lower λ must be to reconcile workers' lower bargaining leverage.

4.1.2 Data Inputs

We construct our sample using the Centers for Medicare and Medicaid Services' (CMS) Healthcare Cost Report Information Center (HCRIS). Under federal law, all hospitals that bill Medicare are required to provide HCRIS with annual reports including major types of costs, revenues, number of patient admissions, and numbers of different types of employees. Thus, this data source allows us to identify virtually all acute care inpatient hospitals in the U.S. The major data constraint we face is having sufficient information describing hospitals to calibrate the model as described above. In our application, this requires that we observe firm level market shares, margins, and wages for each significant hospital in a specified geographic market. In our simulations, we focus on the set of hospitals observed in 2006 as in this year we have complete data for a large fraction of hospitals. We also use information from the American Hospital Association's annual survey to identify the owner of a hospital (e.g. if the hospital is in a system) and the HSA the hospital is located in.

Shares. The first input we need is market shares which requires us to identify the product and geographic market that hospitals operate in when competing for workers and consumers. We rely on the Dartmouth Atlas Project's narrowest definition of a geographic hospital market: the Hospital Service Area. The Dartmouth Atlas Project defines the HSA as the local health care markets for hospital care. It corresponds to a collection of ZIP codes whose residents receive most of their hospitalizations from the hospitals in that area. Hospitals located in the same HSA should be competing for the same patients.[14] We define market shares according to relative employment of nurses and pharmacists in HCRIS. Because we have assumed that nurses and pharmacists are proportional to output (hospital services), the share of nurses and pharmacists employed by a hospital should be equal to the proportion of hospital services produced by the hospital. Concentration and market structure is described in under "Market Conditions" in Table 3. The median merger market has 9 firms and a delta HHI of 154.

Margins. Next, we need to construct hospital margins. In constructing margins, we are assuming that all variable inputs other than nurses' wages (which are determined endogenously in our model) are purchased at constant margin cost. Margins are estimated using HCRIS and CMS data following Garmon (2017) and Dafny (2009), the details of these calculations are provided in the data appendix. Most hospitals are estimated to have margins between 50% and 70%.[15] As part of this calculation, we use total, operating, and capital cost data from HCRIS, and find that at the median hospital marginal costs (other than nurse and pharmacist wages) are approximately $110,000 per year per nurse or pharmacist.

Wages. Following Prager and Schmitt (2021), we estimate wages and employment of nurses and pharmacists using HCRIS. The median nurse or pharmacist in our sample earns $71,000 in 2006. We also need to specify the outside option for workers: the wage a worker would earn if they were forced to work in a non-hospital setting. We assume that a worker who had to leave the hospital setting would work in a different sector but would continue to work as a nurse or pharmacist. However, by being forced to change industries, the displaced nurse/pharmacist would probably face some wage penalty when moving to the new industry.

[14] We do not conduct a formal market definition exercise as described in the Horizontal Merger Guidelines, and are not suggesting that HSAs correspond to antitrust markets. We use the HSA as a reasonable approximation of a local market that can be used to analyze many markets in a single analysis to illustrate the predictions of our model across a variety of market configurations seen in the real economy.

[15] We do not use margins less than 1% or greater than 100%, which occurs for 88 of our 1001 hospitals.

Table 3: Pre-Merger Summary Statistics for 2006 Health Service Area Mergers (n=1402)

variable	Min	p25	p50	p75	Max
Market Conditions					
Number of Nurses and Pharmacists in Market	2.5	146	399	1,117	1,583
Number of Employers in Market	2	3	8	17	31
HHI	903	1,924	3,079	5,023	9,867
Delta HHI	0.12	18	177	1,429	5,000
Calibration Inputs					
Downstream Margin in Percent	22	52	64	68	88
Non-Labor Operation Costs per Worker in $100k/year	0.55	1.1	1.1	1.3	2.3
Wage in $100k/year	0.43	0.65	0.71	0.71	0.9
Outside Wage in $100k/year	0.24	0.37	0.4	0.4	0.51
Calibraion Outputs					
Consumer Price Sensitivity (Alpha)	-9.9	-0.69	-0.43	-0.38	-0.07
Downstream Margin per Worker in $100k/year	0.16	1.8	2.4	3.4	19
Downstream Price per Worker in $100k/year	1.6	3.5	4.2	5.1	21
Employer Bargaining Power (Lambda)	0.37	0.9	0.93	0.94	0.99

That is, the worker would not enter the new industry at that industry's mean wage, but at some fraction reflecting some displacement effect. To construct this measure, we first use the BLS OES to estimate (at a national level) the relative wage of nurses and pharmacists working in hospitals relative to those working in all other sectors which is 0.93. We then apply the displacement wage scarring estimates Lachowska et al. (2020) to the worker's out-of-market outside option. Specifically, we assume that having to find employment outside of the hospital market will lead to a displacement wage penalty of 40%, but our results are robust to penalties of 30% to 50%.[16] We then multiply this fraction by the mean nurse and pharmacist wage in hospitals operating in the HSA. We find that workers' outside wage weighted displacement cost is $40,000. For further details, please see the Appendix.

[16] Earnings in another sector may also have a different utility value by revealed preference.

4.1.3 Calibrated Parameters

The calibration outputs are provided in the final section of Table 3. We calibrate a median price sensitivity parameter α of around -0.5. We calibrate median downstream margin per nurse or pharmacist per year to be $240,000, while the price of output produced per nurse and pharmacist per year is $420,000.

We find that employers have relatively high bargaining power, with the vast majority of hospitals having $\lambda > .8$.[17]

4.1.4 Potential Mergers

As shown in Table 4, we observe complete information on 1,001 hospitals in 334 HSAs in 2006. Using these data, we can analyze 1392 potential mergers, generated from the set of all pairwise combinations of hospital systems with hospitals not in the same system but in the same HSA. In addition, we have also obtained data and simulated mergers for ten of the consummated mergers studied by Garmon (2017).[18] We analyze these mergers separately to examine if there are any important differences between mergers that actually took place and simulated mergers; that is, if realized mergers have very different characteristics than randomly generated mergers. Details are provided in the Data Appendix.

4.2 Results

We have simulated the impact of horizontal mergers on consumers, worker, producer welfare from the population of potential mergers (shown with the orange and green markers) and

[17] As noted above, these estimates of bargaining power depend on our specification of the workers' outside of market alternative share and wages, as well as margins. However, welfare changes in percentage terms are not sensitive to these choices.

[18] These mergers take place in a number of years and are identified in the data appendix.

Table 4: Number of HSAs, Hospitals, and Mergers with a Given Number of Hospitals

Hospitals per HSA	HSAs	Hospitals	Mergers
2	211	422	211
3	63	189	152
4	26	104	128
5	12	60	85
6 or more	22	226	816
Total	334	1001	1392

Note:
For any given number of hospitals, the table gives the number of HSAs containing that many hospitals, the number of hospitals in HSAs containing that number of hospitals, and the number of simulated mergers in HSAs containing that number of hospitals. For example, there are 211 HSAs that contain 2 hospitals.

for the ten realized mergers from Garmon (2017) as shown in Figure 5.[19] The figure plots the percentage change in worker, consumer, producer, and total surplus measured relative to the pre-merger state against the magnitude of the merger as measured by the change in market concentration (ΔHHI). Reassuringly, we see that the mergers observed in Garmon (2017) are clearly within the support of the randomly generated mergers, suggesting that the distribution of randomly generated mergers are similar to realized mergers. In addition, we have simulated merger effects using a traditional merger simulation model that assumes wages are unaffected by the merger (referred to as downstream only, shown in green) and our full model where nurses' wages and hospital prices are affected by the mergers (referred to as the full model, shown in orange).

Not surprisingly, the figure shows that mergers that result in larger increases in market concentration are predicted to generate more harm for consumers and workers (and benefit

[19]Change in consumer surplus is defined as $100 * \frac{\frac{log(\sum_j e^{\delta_j + \alpha p_j^{'}})}{\alpha} - \frac{log(\sum_j e^{\delta_j + \alpha p_j})}{\alpha}}{\frac{log(\sum_j e^{\delta_j + \alpha p_j})}{\alpha}}$. Percent change in employer surplus is defined as $100 * \frac{\sum_j s_j^{'} m_j^{'} - \sum_j s_j m_j}{\sum_j s_j m_j}$ Percent change in worker surplus is defined as $100 * \frac{\sum_j s_j^{'} w_j^{'} - \sum_j s_j w_j}{\sum_j s_j w_j}$
.

firms) in both the downstream only and the full model. The figure also shows that by allowing wages to be endogenous mergers almost always result in larger, often much larger, reductions in worker welfare than in the downstream only model, where harm to workers results entirely from reduced output. In addition, as can be seen in the second panel of Figure 5, consumer harm in the full model is almost always smaller than in the downstream only model. This occurs because when mergers also affect wages directly through bargaining, some of the harm of the merger is born by workers (in the form of lower wages) will benefit consumers in the form of lower final good prices than would be predicted by the downstream only model. That said, in virtually all of the mergers we simulate (90%), our model implies that mergers in the hospital industry that significantly increase market concentration harm both workers and consumers.

It is interesting to compare these results to the general simulations we calculated that examined hypothetical mergers in markets where workers had different levels of bargaining power (λ) for the scenario most comparable to hospital labor and product markets (Local Product/Same Labor). In those simulations, we found that our model predicts that when workers had relatively high levels of bargaining power the pass-thru of reduced worker wages resulting from a merger could actually increase consumer welfare. For instance, when the ratio of the firm to the workers' bargaining power was 2/3 ($\lambda = .6$), we found that most simulated mergers resulted in increases in consumer surplus. While consumers benefiting from mergers that harm workers is a theoretical possibility, our simulations suggest this is unlikely in U.S. hospitals because our calibration indicates that workers appear to have relatively low bargaining power in setting wages. That is, the hospital mergers we simulate correspond to the results of the general merger simulations those shown in the last cells in Figure 3 (relative bargaining power between 1/9 and 0, or λ between .9 and 1).

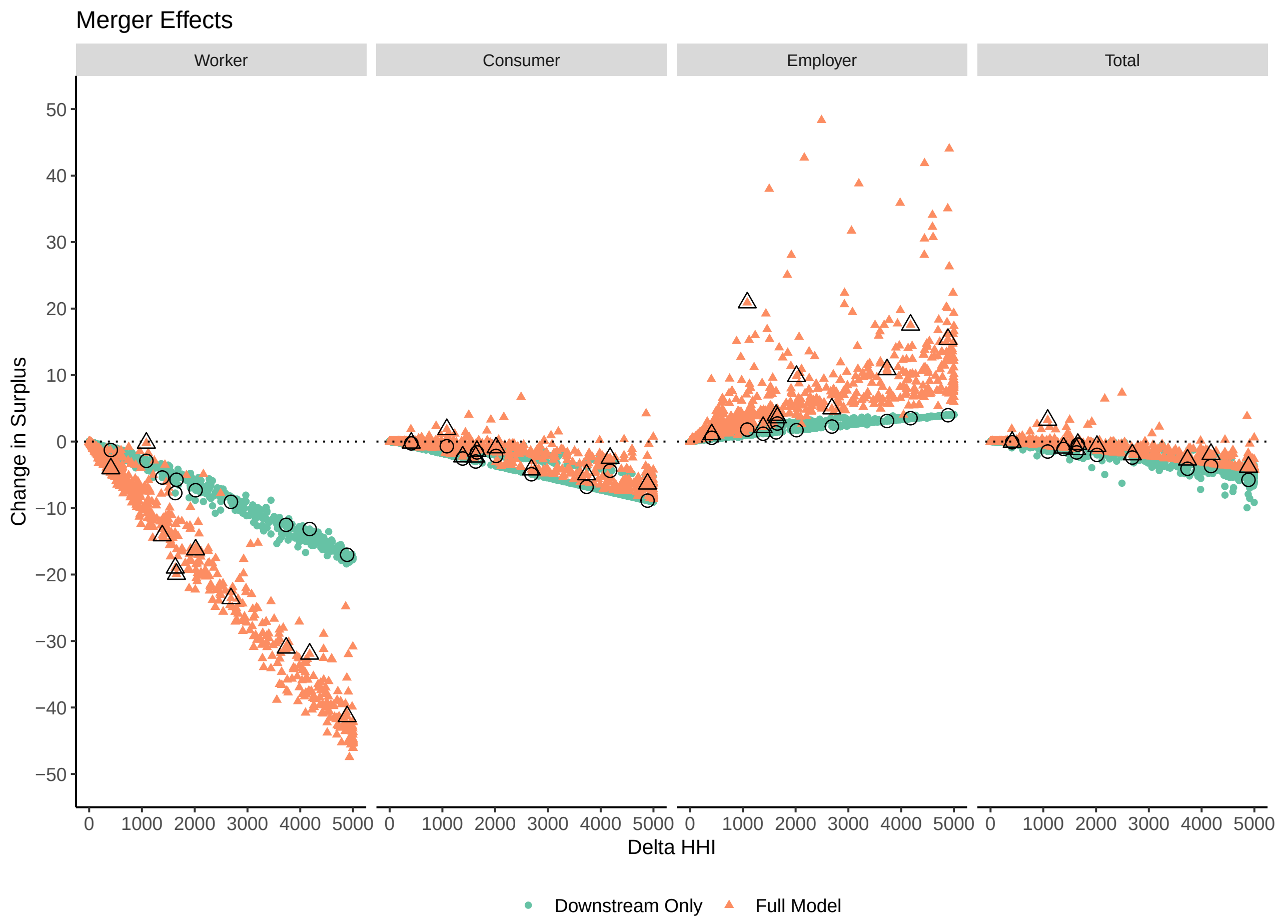

Figure 5 The figure displays worker, consumer, employer, and total surplus effects of the mergers in percentage terms, including the effect of changes to shares. Each dot or triangle represents one merger, with black borders indicating simulations for mergers that actually occurred. All effects are plotted against Δ HHI.

5 Conclusion

Recent empirical literature refutes the hypothesis that employers are passive participants in labor markets. Estimated short-run labor supply elasticities facing employers are far less than the infinite elasticity predicted by a model of perfect competition (Sokolova and Sorensen (2021)). Moreover, a series of studies have demonstrated that employees at firms earning unexpectedly higher profits earn more than those at less profitable firms suggesting that firms share rents with workers Card et al. (2018). While these lines of research demonstrate that firms have power over workers, they are silent on whether reductions in the number of employment options open to workers have a material impact on worker welfare. Interestingly, a handful of recent papers find that mergers of competing employers in highly concentrated employer markets can harm workers (Prager and Schmitt, 2021; Arnold, 2021). These findings suggest that horizontal mergers may also harm workers possibly by allowing employers to internalize substitution in the employment market to reduce the compensation of workers. To better understand how horizontal mergers may affect labor markets, we develop a modeling framework to forecast the labor market effects of mergers making use of conventional tools that have previously been used to analyze the product market effects of horizontal and vertical mergers.

We model the interaction between product and labor markets using a a two-level supply chain where employers and workers negotiate over wages in a Nash-in-Nash game upstream, and firms produce differentiated products and engage in Bertrand price competition downstream. In this model, the primary impact of horizontal mergers on workers is through changing workers' relative leverage in negotiations with employers. By removing an independent employment option from workers, a merger reduces workers' outside option which allows firms to capture more surplus. Interestingly, in this model, in certain market configurations, horizontal mergers can both harm workers and increase consumer welfare as reduced wages are partially passed through to consumers as lower retail prices. However, this effect only dominates when workers have relatively high bargaining power relative to firms. In our analysis of the hospital industry, we found that workers had relatively low levels of bargaining power and that workers and consumers were harmed by mergers.

It is important to note that our modeling approach differs substantially from the classic labor monopsony model of Robinson (1933) prominently featured in labor economics textbooks. In Robinson (1933) a monopsonist reduces the quantity of labor demanded to lower the market clearing wage. As a result, mergers in a Robisnson-style model that increase monopsony power should significantly decrease both wages and employment. In the bargaining framework we use, the primary impact of merger on workers is in reducing the share of rents generated by the employer/employee match received by labor (paid as wages). We think our modeling approach more closely matches recent empirical work that finds that mergers primarily reduce workers' wages rather than the level of employment Prager and Schmitt (2021).

In future work, we will expand our analysis to include other market configurations. In particular, we plan to explore how expanding the set of jobs available to workers within a labor market beyond those provided by employers in the product market affected by a merger impacts the labor market effects of mergers.

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6 Data Appendix

6.1 Sample Construction

For our analysis of hospital mergers, we simulate all possible mergers between active, short-term, critical access, or children's hospitals where we observe sufficient data and where mergers are possible [20] within the local geographic market (Health Service Area) in 2006, resulting in a sample of 1392 potential mergers.[21] Our primary sample restriction is only including HSA's with multiple independently owned hospitals so that mergers are possible. This restriction results in a sample of 2114 hospitals located in 541 HSAs. In order to calibrate our model and simulate mergers, we require that each hospital in an HSA report a market share and a wage data for nurses and pharmacists. Unfortunately, some data is often missing for at least some hospitals (especially very small hospitals) in HSAs with many hospitals. Because very small hospitals are unlikely to be important in price setting, we simply ignore hospitals in the merger simulations that are very small (accounting for less than 3/% of patient discharges in an HSA) if those hospitals are missing on the data inputs critical to model calibration and merger simulation. If this data is missing for hospitals with greater than a 3% market share, we drop the HSA (and all of its hospitals) from the merger simulation exercise. Selecting HCRIS data on these critical inputs reduces our final sample is to 1001 hospitals in 334 HSAs as reported in Table 4 above.

The sample of realized mergers is drawn from Garmon (2017). Garmon (2017) estimates the price effects of 26 consummated mergers that may have affected competition. In particular, he considers geographic markets that are much larger than the HSAs we consider in our analysis. Limiting the set of mergers to those between mergers in the same HSA results in 12 mergers. Limiting to short-term, critical access, or childrens' hospitals where we observe

[20] Our universe of hospitals consists of all hospitals appearing in the HCRIS data in 2006 that are active, short-term, critical access, or children's hospitals. This sample includes 4872 hospitals located in 3271 HSAs.

[21] We choose 2006 because it is the year that allows us to estimate hospital margins for each hospital system following the methodology developed by Dafny (2009) and Garmon (2017).

Table 5: List of Actual Mergers

Year	Acquiring Hospital	Acquired Hospital
1997	Moses H Cone Memorial Hospital,The	Wesley Long Community Hospital
1997	Duke University Hospital	Durham Regional Hospital
1997	New Hanover Regional Medical Center	Columbia Cape Fear Memorial Hospital
1998	Cape Fear Valley Medical Center	Columbia High Smith Rainey Mem Hospita
2007	Pottsville Hospital and Warne Clinic	Good Samaritan Regional Medical Center
2009	St Josephs Mercy Health Center Inc	Healthpark Hospital
2010	Phoebe Putney Memorial Hospital	Palmyra Medical Centers
2010	University Hospital S U N Y Health Science Center	Community-General Hospital Of Greater Syracuse
2011	Yale-New Haven Hospital	Hospital Of St Raphael
2011	Regional Hospital Of Scranton	Moses Taylor Hospital

Note:
The hospitals listed here were studied in Garmon, and met the data requirements to be included in our sample.

sufficient data yields our final sample of 10 mergers.

We only simulate mergers that take place between hospitals operating in the same HSA. HSA information is mapped to hospitals in HCRIS by zip code using information from the American Hospital Association Annual Survey and the CMS provider of service files.[22] We also obtain system identifiers from AHA and CMS data to establish pre-merger ownership structure in each market. When system is missing we impute that the hospital as independent. HSAs are obtained from Dartmouth's HSA crosswalk file.[23]

Table 5 gives the names of the hospitals involved in actual mergers.

6.2 Data for Model Calibration

We calculate the margin of downstream firms using commercial price, costs, and discharges from HCRIS, and case-mix index from CMS following Dafny (2009) and Garmon (2017). Margins predicted to be < 1 or $> .01$ are marked as missing. We convert the percent margin of the acquiring firm into a level margin using information on operating costs and wages from HCRIS. Note that in converting the percent margins following Dafny (2009) and Garmon

[22] CMS provider of service data from Adam Sacarny retrieved from `https://sacarny.com/data/`, and AHA Annual Survey data from 2006 available at `https://www.ahadata.com/aha-annual-survey-database`.

[23] `https://data.dartmouthatlas.org/supplemental/`

(2017) calculations to level margins at the worker year level, we remove the costs associated with nurse and pharmacy wages from the hospital's marginal costs because those wages are endogenously determined in our model. In calibrating α, we use the margin of the largest firm in the HSA for which margin is available. From there we obtain the margins of all other firms in the market from the downstream first order conditions.

The workers' gains from trade depend on the workers' next best alternative were they to lose their job. We specify the workers' outside share to be equal to the share of employment of nurses and pharmacists outside of hospitals at the national level, or 52%. In order to obtain worker outside option shares, we take the number of nurses and pharmacists, defined as SOC codes 29-1051, 29-1141, 29-1171, and 29-2061, employed outside the hospital industry, defined as NAICS code 622000, in the BLS occupation and employment statistics data nationally. We take this national share and impute it for each labor market.

We specify the workers' outside wage to be equal to the mean wage available at a hospital in the market, times the ratio of hospital to non-hospital wages at the national level (93%), multiplied by the expected displacement wage as estimated by Lachowska et al. (2020), or approximately 60%. To be consistent with our bargaining model it is important that the outside option (including diversion and wage) be lower than the current wage in order for gains from trade to be positive. However, our choice of outside share and wage for the worker does not affect the results because this data only affects the calibration of employer bargaining power λ.[24]

[24] Note that this lowering of the outside option wage could also reflect preferences, or the expected probability of obtaining a job outside the market.