The Labor-Market Impacts of a Large Merger: Evidence from the Security Guard Industry*

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Abstract

In 2016, AlliedBarton and Universal Protection Service merged to form Allied Universal, the largest provider of security guard services in the world and third-largest employer in the United States. This paper studies the labor-market impacts of this merger by combining online job posting data from Lightcast with publicly available labor-market data for the US. Using variation in exposure to the merger across counties, I find that counties more exposed to the merger experience wage increases relative to less-exposed counties. A one-standard deviation increase in the predicted change in concentration due to the merger is associated with a 2.4 percent increase the market-level wage, with no impacts on employment or job churn. These impacts are due to changes both at the merging party and competitors, with large competitors responding in complex ways, such as changing salary transparency and increasingly advertising job benefits. A two-sided bargaining model in which the merger led to higher billing rates for security guards can rationalize the findings. Data on federal security contracts from usaspending.gov provides further evidence consistent with this channel. *JEL Codes:* G34, J21, J30, J42

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1 Introduction

In recent years, antitrust agencies have paid increased attention to anticompetitive practices in labor markets. For example, the Federal Trade Commission (FTC) and Department of Justice (DOJ) released new merger guidelines in 2023 that specify that mergers between buyers, particularly of labor, raise anticompetitive concerns. This guideline was put into action when the FTC issued a complaint against the merger of Kroger and Albertsons in 2023, two of the largest grocery store chains in the United States. As part of the complaint, the FTC argued that the merger would lead to a significant reduction in competition for unionized grocery store workers. Concurrent with increased policy interest, there has been a resurgence in work finding significant evidence of monopsony power in labor markets (see Manning (2021); Card (2022); Azar and Marinescu (2024) for recent reviews).

Recent work studying antitrust in labor markets has found that mergers that generate large concentration changes lead to declines in earnings (Prager and Schmitt, 2021; Arnold, 2021). These papers utilize variation in concentration changes across many mergers as identifying variation. In this paper, I take a different approach by evaluating a single merger as a case study. I argue that the case-study approach allows one to make a number of contributions relative to prior work. First, in many of the largest mergers that face antitrust concerns, there may be impacts on both product and labor markets, and how changes in one side of the market impact welfare on the other side of the market may be highly context dependent.[1] A case-study approach allows one to understand the particular institutional details of both sides of the market, which can help with interpreting empirical results and drive modelling choices. Second, prior work abstracts from complex interactions between different types of firms. Again, a case study allows one to identify key competitors to study how these interactions operate in practice. There is little empirical evidence to date on either labor and product market interactions or the nature of strategic interactions between firms in labor markets. Evidence on both of these margins is important for antitrust evaluation of employer consolidation, but more broadly, are crucial questions in the literature on imperfect competition in the labor market.

In this paper, I study the merger between AlliedBarton and Universal Protection Service, which formed Allied Universal, currently the largest security service firm in the world and the third-largest employer in the United States. This merger is an ideal case study for a variety of reasons. First, the scope of the merger is large, with both firms being national firms that operate in many counties. My identification strategy utilizes variation in exposure to the merger across counties to identify the labor-market impacts of the merger. Second, the nature of the product market in the security guard industry is relatively straightforward, allowing for progress on understanding the link between product-market power and labor-market power. Security firms negotiate with firms or government departments over a billing rate to charge for each hour of security services. While in many industries the marginal product of a worker is not only difficult to measure empirically,

[1] For example, in the Kroger and Albertsons merger the complaint primarily focused on anticompetitive impacts that could increase grocery prices, with labor-market impacts discussed as an additional concern

but difficult to understand conceptually, in the security market it is straightforward. The marginal product is the billing rate of the worker. Third, while there are many security guard firms, there are a few dominant players that routinely compete in many regions. This makes issues of product-market power and labor-market power potentially central to this industry. It also allows one to make progress on understanding the nature of strategic interactions in the market by identifying a group of firms that compete frequently with one another. How large competitors differentially respond to the merger relative to smaller competitors will be a key focus of the empirical analysis.

In the first part of the paper, I use data on online job postings from Lightcast to document two important facts about the security guard labor market. The four largest security guard firms in my period of study are AlliedBarton, Universal Protection Service, G4S, and Securitas. Despite prior work showing large employers pay higher wages (Brown and Medoff, 1989), these large security firms pay lower wages on average. After controlling for job title and the location of the position, posted wages are about 20 percent lower in the large security firms relative to all other security guard postings. Second, comparing the merging parties (AlliedBarton and Universal) to the next two biggest firms in the industry (Securitas and G4S), wages are highly correlated across counties in the US. While wages are still correlated between the merging parties and all other firms posting for security guards, the correlation is much weaker. This empirical evidence, as well as the institutional details of the industry, motivate studying outcomes in the paper differentially by these large, frequent competitors and all other firms hiring security guards.[2]

In the second part of the paper, I utilize the Quarterly Census of Employment and Wages (QCEW) and the Quarterly Workforce Indicators (QWI) to understand how differential exposure to the merger at the county level impacts labor-market outcomes in the security guard industry. To measure exposure, I again utilize information from Lightcast to understand the geographic distribution of the companies. As a baseline measure of exposure, I compute the change in the Herfindahl-Hirschmann Index (HHI) implied by the merger at the county level, using the fraction of job postings associated with a firm as the share measure. Using predicted changes in concentration as measure of exposure to a merger is a common method in antitrust evaluation of mergers and has previously been utilized to study product-market impacts of national mergers (Dafny et al., 2012; Ashenfelter et al., 2015).

Utilizing a dynamic difference-in-differences design with the change in concentration as the continuous treatment variable, I find that a one-standard deviation increase in exposure (a HHI increase of about 0.036) is associated with a 2.4 percent increase in the market-level wage.[3] One possibility is that this increase in wages is due to the changing composition of the workforce. It is possible that the merger impacts employment, leading to overall changes in the quality of workers.

[2]Focusing on large security service firms as the main competitors of the merging party is similar to the analysis in the Staples and Office Depot merger which contrasted competition from office supply superstores such as Staples, Office Deport and Office Max vs. other companies that also hold office supplies, such as Target and Walmart, but whose primary business is not office supplies (Ashenfelter et al., 2006).

[3]Often in antitrust settings the HHI index is multiplied by 10,000. In this case, the change in HHI associated with a one-standard deviation would be about 360. The merger guidelines associate a change of 100 as a large enough change to warrant potential concern, though this conclusion depends also on the overall concentration in the market.

However, I find no impact of the merger on employment. Turning to the Quarterly Workforce Indicators (QWI) to measure churn, I find that exposure is not associated with either the number of hires or number of separations in the market. Therefore, while prior work has found changes in employment and churn, I find no evidence of this for the AlliedBarton and Universal Protection Service merger. Together, these results stand in stark contrast to prior work that finds decreased wages in response to increased concentration in labor markets. An increase in wages is inconsistent in models in which the only impact of the merger is to increase monopsony power.

The next part of the paper focuses on strategic interactions by considering how the merger differentially impacts specific types of firms. It is not possible to study this question in either the QCEW or QWI, which contain only market-level outcomes. While administrative matched employer employee data would be useful for this analysis, generally disclosure requirements would make it impossible to study impacts at particular firms. A key strength of the Lightcast data is that it allows one to identify individual firms in the analysis. In the Lightcast data, I first document that there are large non-wage changes for job postings at Allied Universal after the merger. First, there is an immediate drop in pay transparency in postings. The fraction of job postings that contain salary information drop from 30 percent to around 10 percent after the merger. However, instead of posting salary information, Allied Universal starts advertising job benefits. The fraction of postings that mention medical and dental benefits jumps from around 20 percent prior to the merger, to about 90 percent after the merger.

Given these large direct impacts on job posting characteristics, the next part of the paper studies spillovers on other firms. While prior work generally considers strategic interactions in relation to a single variable, such as price or wages, it is possible these behaviors are more complex in practice, such as changing overall hiring practices. Therefore, I next study whether the large direct impacts on transparency and advertised benefits spill over to other firms in the market. For this analysis, I find important heterogeneity by whether the firm is a major competitor or not. For G4S and Securitas, I find that these companies decreased transparency in postings in places with high exposure to the merger. A one-standard deviation increase in exposure is associated with a 2.8 percentage point decline in the fraction of postings that contain salary information. However, for all other firms, I find no such strategic impact. In fact, transparency actually increases in these other firms in places highly exposed to the merger. Therefore, it is not the case that the places with high exposure are simply places experiencing decreases in transparency over time. The direction of the impact depends crucially on whether the firm is a frequent competitor or not.

Turning to benefits, I again find important heterogeneity across competitors. In places with high exposure to the merger, G4S and Securitas increasingly advertise the same benefits as Allied Universal, with a one-standard deviation in exposure associated with a 3.0 percentage point increase in the fraction of postings that mention medical and dental benefits. However, for all other firms, I find a precise zero impact on the fraction of postings that mention benefits. Lastly, turning to wages, I find that all competitors increase wages in places with high exposure. For G4S and Securitas, a one-standard deviation in exposure is associated with a 2.6 percent increase in wages, while it is

associated with a 1.7 percent increase in wages for all other firms, both of which are similar to the market-level results utilizing the QCEW. Given the findings on transparency, however, these point estimates could be biased by selection into the sample. I follow Lee (2009) to construct bounds on the estimated effect. For the G4S and Securitas results, the bounds are between 1.6 and 3.6 percent, implying even worst-case selection patterns would still imply a significant increase in wages. For all other firms, the bounds are less informative and do contain zero.

In the last part of the paper I explore mechanisms for the increase in wages following the merger. To do so, I illustrate a simple model to rationalize the results. The model is similar conceptually to imperfect competition models used for antitrust analysis when prices are negotiated (Miller, 2014; Gowrisankaran et al., 2015). In the product market, purchasing firms negotiate with security firms on the billing rate given the number of security guards needed for the contract. The key distinction in my setting is that wages are also determined through a bargaining problem between the workers and the security firms.[4] In the model, there are two channels that can rationalize the finding of a significant increase in wages for more exposed areas. First, as often argued by firms, the merger may improve efficiency. This increases profits of the firm from completing the contract, which workers utilize to bargain for higher wages. Second, the firm may impact negotiations in the product market. If two firms merge, this reduces the outside option of the firm purchasing the security services as they can no longer pursue separate contracts at the two providers. This reduction leads to a higher billing rate for the contract, increasing profits at the firm, again leading to higher wages.

The last part of the paper explores further outcomes to distinguish these two potential mechanisms. First, if the key channel is a decrease in costs for Allied Universal through efficiency gains, then Allied Universal should grow in the exposed markets by offering lower billing rates that take advantage of its cost advantage. Therefore, the last part of the paper first studies the impact on the market share of Allied Universal before turning to the impact on billing rates. To study the market share of Allied Universal, I estimate whether places more exposed to the merger see an increase in the share of postings that are for Allied Universal. I find that exposed areas actually see a decline in the fraction of postings for Allied Universal, a finding inconsistent with decreased costs.[5]

To find direct evidence on billing rates, I utilize data from USA spending which collects information on government federal contracts by industry. There are two significant limitations of this data. First, this data is a small subset of the total contracts in the security guard industry. Second, the information does not include billing rates directly, instead reporting the total amount spent on a given contract. With these limitations in mind, I find that the amount spent on contracts increases significantly in more exposed areas. Depending on the specification, a one-standard de-

[4]Recent work by Kroft et al. (2021) also studies a model with imperfect competition in both the product and labor market, using procurement data from the construction industry to structurally estimate their model.

[5]This is not due to the fact that places with high exposure are places that had more AlliedBarton and Universal Protection Service job postings initially, and therefore less room to grow than places with fewer of these postings. In both more-exposed vs. less-exposed counties, I find that the fraction of postings attributed to Allied Universal decreases over time, but it decreases faster in the more exposed areas.

viation in exposure is associated with a 13-36 percent increase in the amount spent on a security guard contract. While this is only a small subset of the market for security guards, this result is consistent with increased billing rates driving increased wages in the security guard industry and inconsistent with increased efficiencies.

To summarize, this paper finds that the AlliedBarton and Universal Protection Service merger led to significant increases in wages in the security guard industry, but little changes in either employment or churn. Beyond wages, the merger also led to changes in pay transparency and advertised benefits due to strategic responses from Allied Universal's largest competitors: G4S and Securitas. I argue the wage impacts are most consistent with increased market power in the product market, as it does not appear Allied Universal expands or decreases billing rates after the merger. Regarding implications for policy, the results suggest a nuanced approach. I find positive impacts on wages as shocks to product-market power increase wages through rent sharing. In the model of competition illustrated in the paper, workers in the security industry benefit from increased prices. In other settings, different models of competition between firms may lead to different outcomes. For example, in a standard static monopsony model, an increase in product-market power will lead the firm to reduce employment, moving down the labor supply curve, decreasing earnings. These different predictions emphasize the importance of understanding the specific industry and the specific firms involved in evaluating the impacts of mergers on labor markets.

This paper contributes to a few distinct literatures. First, there is a literature that studies the impact of M&A on workers. This literature can be broken into two distinct strands. The first strand studies the impact on workers within M&A firms (Brown and Medoff, 1989; Siegel and Simons, 2010; He and le Maire, 2022; Lagaras, forthcoming; Arnold et al., 2023). The bulk of this prior work finds negative impacts of mergers on workers, primarily at target firm workers who face layoffs. The second strand of literature focuses on market-level impacts of mergers, finding evidence of decreased wages through increased monopsony power (Arnold, 2021; Prager and Schmitt, 2021; Guanziroli, 2022; Thoresson, 2024).[6] Unlike most prior work, Compton et al. (2023) also studies a single event, the acquisition of Target's pharmacy business by CVS, again finding decreases in earnings for workers in markets where CVS and Target overlapped. In my setting, I find increased wages and no impact on churn, in contrast to much of the prior literature. Second, I explore strategic interactions that depend on the identities of the competing firms.

Second, this paper relates to recent work that incorporates imperfect competition on both the product and labor-market side.[7] For example, Rubens (2023) studies impacts of Chinese Tobacco consolidation in a model which allows for both price markups and wage markdowns. Yeh et al.

[6] Guanziroli (2022) similarly uses a merger in the pharmacy industry in Brazil and finds places that experience higher changes in concentration experience wage decreases. Thoresson (2024) studies deregulation in the Swedish pharmacy market that led to large changes in concentration, again finding places that experienced large concentration increases experienced wage declines.

[7] Relatedly, there is also a large literature in industrial organization studying the price effects of mergers. For example, Borenstein (1990) studies price effects in airline mergers, Ashenfelter and Hosken (2010) studies price effects across five mergers in retail industries. See Whinston (2007) and Asker and Nocke (2021) for summaries of papers that perform retrospective merger analysis of price effects.

(2022) also uses insights from the industrial organization literature to simultaneously estimate wage markdowns and price markups in the US manufacturing sector. Conceptually, this paper is most similar to Kroft et al. (2021), who use information on procurement auctions in construction to structurally estimate a model with imperfect competition in both the product and labor market. I find similar channels useful for rationalizing the labor-market impacts of the AlliedBarton and Universal Protection Service merger, providing further evidence of the importance of jointly modelling imperfect competition.

Lastly, this paper relates to ongoing work to understand strategic interactions in labor markets. Staiger et al. (2010) uses an exogenous increase in wages at veterans affairs hospitals to understand how nearby hospitals respond, finding evidence of important strategic interactions. Additionally, there is now a large literature on concentration in the labor market, which can be interpreted as providing empirical evidence supporting the importance of strategic interactions (See Azar et al. (2022); Rinz (2020); Qiu and Sojourner (2023), among others). Although difficult to detect, there is also some evidence of illegal strategic interactions in the form of explicit collusion. For example, Ashenfelter and Gilgenbach (2023) discuss the case of no poaching agreements in the high-tech industry, in which firms in Silicon Valley agreed explicitly to not poach each other's workers. Recent theoretical work has also made progress on models in which there are granular firms and potential for strategic interactions (Berger et al., 2022; Jarosch et al., 2024). In this work I provide novel evidence of strategic interactions in non-wage aspects of job postings. In particular, competitors adopt similar transparency and benefits advertising strategies as the merging party following the merger.

The organization of the paper is as follows. Section 2 provides institutional details on the security industry and data sources. Section 3 provides descriptive statistics about the security guard market. Section 4 studies the impact of the merger on market-level outcomes using publicly available data sources the cover the universe of formal sector work. Section 5 breaks down impacts by specific firms using online job posting data. Section 6 explores mechanisms of the wage increase, first presenting a conceptual model and then disentangling mechanism by exploring additional outcomes. Section 7 concludes.

2 Institutional Details and Data

2.1 Institutional Details

2.1.1 Security Guard Industry

In 2023, there were roughly 1.2 million total security guards (Bureau of Labor Statistics), which is roughly similar to the total number of policeman and fireman combined. Security guards are often not directly hired by the company or government agency that they are providing security services for, instead being hired by a security service firm. These firms make up an important component of the labor market for security guards. According to BLS, about 60 percent of security guards

are employed in the Investigation and Security Services Industry (NAICS code 5616). The other 40 percent are employed in a wide range of industries. For example, the next largest employer of security guards are general merchandise retailers, who employ only about 4 percent of all security guards.

Security service firms provide a variety of services which may depend on the client. While most contracts are not publicly available, many local governments, airports, and hospitals outsource their security needs to a security service firm, and these are occasionally made easily accessible online. These contracts clarify the range of services provided. Additionally, these contracts include details on the types of guards that will be employed, how much they will work, and the billing rate per hour for the guard. In some rare instances, the contract additionally specifies the pay rate for each type of worker.

Appendix Table A1 presents a table of terms that appears in a contract between the city of San Diego and Allied Universal that was effective in 2021. In this contract, different types of workers are specified, including the account manager (AM), supervisors, grave shift security guards, and general security guards. Each is associated with a pay rate. For example, a standard security guard in this contract will receive an hourly wage of $16.54. Interestingly, this contract also specifies the markup that generates the bill rate. In this contract, the markup is the same across all worker types (1.51). Therefore, the bill rate for a standard security guard under this contract is $24.98.

While the difference between the pay and bill rate is described as a product markup, it can also be conceptualized as a wage markdown. A common goal in the monopsony literature is to identify the markdown of a worker, which is the gap between marginal revenue product and the wage. This generally involves estimating elasticities of labor supply and then using model assumptions to retrieve markdowns. Because of the specific structure of the security industries, the marginal revenue product and the wage are conceptually straightforward and directly observable in a subset of contracts. An analysis of the impact of the AlliedBarton and Universal Protection Service merger on wage markdowns is beyond the scope of this paper due to billing rates generally being private information between the clients and security firms. However, these contracts provide important context for the conceptual model in Section 6.1, which includes imperfect competition in both the product and labor market.

In terms of major competitors in the security service industry, in 2015, the four largest companies were AlliedBarton, Universal Protection Service, G4S, and Securitas. According to Security Guard Magazine (Zalud, 2015), all of these firms had over 60,000 employees in 2014 and annual revenues of over 2 billion dollars. The next largest firm, US Security Associates, had roughly 49,000 employees and annual revenues of 1.5 billion dollars. After US Security Associates, firms become much smaller. The bulk of the analysis will focus on G4S and Securitas as the two major competitors with AlliedBarton and Universal Protection Service, which is a common grouping of firms in this industry. However, given the size of US Security Associates, I will also consider results that include US Security Associates as a major competitor.

2.1.2 AlliedBarton and Universal Protection Service Merger

Prior to the merger AlliedBarton and Universal Protection service were two of the largest security services firms in the US, both of which had been operating for several decades. The merger between the two firms was initially announced on May 3, 2016, and completed August 1, 2016. Therefore, when turning to results, one should interpret 2016 as a partially treated year. For the first half of 2016, the two firms operated as separate entities, while in the second half of 2016 they operated as a single entity.

In a 2017 article (Jones and Tarallo, 2017), Steve Jones, CEO of Universal Protection Service provides an overview of the merging process for the two companies. The process began in May, with leadership at both firms meeting to discuss how to integrate the two companies. In terms of leadership going forward, Steve Jones became the CEO of the new company, while Bill Whitmore, the CEO of AlliedBarton, became the Chairman of the Board. The article focuses on the benefits of the merger in terms of productivity, but also describes how the two were competitors prior to the merger. For example, it states, "merging two separate corporate cultures can be quite thorny, especially when the two companies were former competitors for many years, and both are deeply invested in being the industry leader." The article later goes on to describe AlliedBarton and Universal Protection Service as "fierce competitors". These quotes suggest that the merger could lead to anticompetitive impacts, as at least from the CEO's perspective, the two competed with each other prior to the merger.

Steve Jones also details difficulties with integrating the two firms. For example, he describes a process of making employment decisions, both at the executive and non-executive level, as well as difficulty in merging corporate cultures. At the end of the merging process, Allied Universal was formed, a 5.1 billion dollar company and the largest provider of security guard services in the US. The company maintained two headquarters, one in Pennsylvania, the former headquarters of AlliedBarton, and another in Santa Ana, the former headquarters of Universal Protection Service.

The merger of AlliedBarton and Universal Protection Service is clearly a disruptive event, both for the firm itself and the broader industry. The discussion by Steve Jones touches on many aspects that are common in antitrust discussions, such as potential efficiencies and potential reductions in competition, both of which may impact workers in the labor market.

2.2 Data

This section describes the data sources used in the paper. The first source of data is job posting data from Lightcast, which is used to measure exposure to the merger and study outcomes at specific firms. The Quarterly Census of Employment and Wages (QCEW) and Quarterly Workforce Indicators (QWI) are used to study market-level outcomes such as wages, employment, and churn. Lastly, data from usaspending.gov is used to measure the amount spent on federal contracts in the security guard industry.

2.2.1 Lightcast Data

The data on job postings come from Lightcast, which scrapes data from over 45,000 internet sources, including job boards and company websites. Lightcast records whether the job posting data contains information on salary. In some postings hourly wages are reported, while in others, annual salaries are reported. In order to make these two types of reporting comparable, hourly wages are converted to annual salaries by multiplying by 2080 (52 weeks times 40 hours a week). Postings with salary information often include a lower and upper bound. I refer to a job's "posted salary" as the average between the minimum and maximum values posted. From the text of the posting one can also identify whether the posting reports certain benefits, such as medical, dental or retirement benefits.

Lightcast data is useful for two key purposes. First, it is a valuable source of data to understand the locations where AlliedBarton and Universal Protection Service overlap. This will allow for the construction of a labor-market level exposure to the merger. Second, the Lightcast data allows for measuring outcomes beyond wages, such as transparency and the presence of advertised benefits. Importantly for this project, it also allows to study the impacts at particular firms. For example, the analysis will study heterogeneity depending on whether a firm is a major competitor with Allied Universal or not.

Lightcast also one to study impacts on posted wages, conditional on a wage being present. Given transparency in pay may change after the merger, the point estimates should be interpreted with caution. In order to make definitive conclusions on posted wages, I implement bounding methods following Lee (2009).

2.2.2 Quarterly Census of Employment and Wages (QCEW)

The second source of data is the Quarterly Census of Employment and Wages (QCEW). The Census Bureau constructs the QCEW from administrative data that establishments report to State UI programs. The strength of the QCEW data is that it is representative, as the UI programs cover about 97 percent of the workforce in the country. Wages in the QCEW capture a variety of forms of compensation, including regular wages, bonuses, stock options, severance pay, the cash value of meals and lodging, tips and other gratuities, and, in some states' employer contributions to certain deferred compensation plans, such as 401(k) plans.

Importantly, the QCEW data is available at the county-industry level. I study the impacts of the merger on the security guards and patrol services industry (NAICS code 561612). This industry includes firms whose main business is to provide security services, which includes Allied Universal, G4S and Securitas, among others. Unlike the Lightcast data, there is no information on the occupation in the QCEW. Therefore, there are two important distinctions between this data and the Lightcast data. First, the market definition does not capture all security guards, it captures employees in the security guards and patrol services industry. Therefore, security guards employed at Hilton Hotels for example (a frequent employer of guards) will not be captured in this

data. According to the BLS, slightly more than 60 percent of all security guards are employed in the slightly broader investigation and security services industry (NAICS code 5616).

Similarly, there are also occupations in the security guards and patrol services industry that are not security guards, such as managers. In the slightly broader investigation and security services industry (NAICS code 5616), the fraction of workers that are security guards is 74 percent. Therefore, to summarize, using industry codes to define the market will not capture all security guards and will include occupations other than security guards. However, in both instances, a majority (60 percent) of security guards are employed in the investigation and security services industry and a majority of workers in this industry (74 percent) are security guards.

One last important point regarding the data is that while the QCEW generally contains data for many industries that go back further than 2014, the publicly available data for the security guard industry begins in 2014. Therefore, the analysis will focus on the period from 2014 to 2019. The analysis stops at 2020 to avoid the impacts of the COVID-19 pandemic.

2.3 Quarterly Workforce Indicators (QWI)

The Quarterly Workforce Indicators (QWI) is another industry-county level dataset that will complement the analysis that utilizes the QCEW. Like the QCEW, the QWI also includes measures of earnings and employment. In addition, the QWI is built from the Longitudinal Employer-Household Dynamics (LEHD) program, which is a job-level dataset. This allows for the construction of metrics on job creation and destruction. Therefore, in addition to earnings and employment, the QWI will be used to study the impacts on hiring and separations following the merger.

A key limitation for the QWI relative to the QCEW for this project is that it does not contain information for the security guards and patrol services industry (561612), instead reporting data for the more broadly defined investigation and security services sector (5616). This industry contains the security guards and patrol services industry, but also includes other industries such as armored cars, security systems, and even locksmiths. While I estimate earnings impacts in both datasets, the primary analysis will focus on the QCEW. However, I will use the QWI to study hiring and separations, which is not available in the QCEW. In particular, the measure of hires is equal to the total number of workers that were hired during the quarter and that remain employed at the firm during the entire quarter. Therefore, this is a measure of relatively stable hires. Separations are the total number of workers that separate during the quarter and remain separated by the end of the quarter. The turnover rate is given by:

$$\text{Turnover Rate} = 0.5 \cdot \frac{\text{Separations} + \text{Hires}}{\text{Employment}} \tag{1}$$

Which captures the fraction of workers currently in the market that are newly hired.

2.4 USA Spending Data

The last data source is usaspending.gov, which is a database of all federal contracts. This data includes information on the amount spent on a contract, the length of the contract, the location of the contract, the industry of the contract, and a description of the work to be performed under the contract. The analysis sample will include all federal contracts in the security guards and patrol services industry (NAICS 561612) from 2014-2019. There are a few key limitations to consider when using this data. First, this data is a small subset of the total number of contracts in the security guard industry. Second, while the ideal data on security guard prices would contain billing rates for different types of security guards, this data does not contain that level of granularity. Instead, it contains the total amount of an award, which combines quantities of security guards as well as the prices. As will be discussed further in Section 6, some contracts report either small or zero amounts, which are not the types of contracts that are relevant for the analysis. Contracts are associated with zero dollars if there is an agreement in place, but no work has been performed. Therefore, in the main results I restrict to contracts with a relatively long length (1 year) that are for at least $10,000, showing robustness in additional results to these choices.

3 Descriptive Statistics

3.1 Descriptive Statistics on Large Firms in the Security Industry

To understand the size of the main employers of security guards, Figure 1 plots the fraction of postings for a security guard that occur for the merging parties and the other two largest security guard firms over the study period: Securitas and G4S. Prior to the merger, AlliedBarton is the largest employer of security guards, with between 25 and 35 percent of all security guard postings for AlliedBarton. Universal Protection Service is also a large player, with roughly 9 percent of all postings. Securitas and G4S are both similar in size to Universal Protection service, with variation over time. In terms of absolute levels, Allied Universal is associated with roughly 200,000 job postings between 2016 and 2019.

Next, Table 1 explores variation across pay for firms in the security guard industry. To do so, I first restrict to the period before the merger (2014-2015). Then, using this sample, I estimate an ordinary least squares regressions of the following form:

$$log(w_i) = \alpha + \beta_1 \cdot AB_i + \beta_2 \cdot UPS_i + \beta_3 \cdot Securitas_i + \beta_4 \cdot G4S_i + \gamma_{j(i)} + \xi_{c(i)} + \varepsilon_{it} \qquad (2)$$

Where AB_i is equal to one if the posting is made by AlliedBarton, UPS_i is equal to one if the posting is made by Universal Protection Service, $Securitas_i$ is equal to one if the posting is made by Securitas, and $G4S_i$ is equal to one if the posting is made by G4S. Column (1) in Table 1 presents results without any additional controls, while Column (2) adds title of job fixed effects ($\gamma_{j(i)}$) and county fixed effects ($\xi_{c(i)}$).

As can be seen in Column 1 of Table 1, all the major employers for security guards post

significantly lower wages than other firms hiring for security guards. Differences range from about 20 percent lower for Allied Barton, to roughly 26 percent lower for Universal Protection Service. Part of this could be due to exact type of security guard that is being hired. For example, one could hire for an unarmed or armed guard, with armed guards generally receiving higher pay. Additionally, these large security firms may be hiring in locations that are different from the general population of postings.

To control for these factors, Column 2 adds job title fixed effects and county fixed effects. While this does lower the disparity across the board, large disparities remain. AlliedBarton posts wages that are 16 percent lower relative to other firms, while Universal Protection Service posts wages that are about 18 percent lower. Securitas and G4S post similar wages. Therefore, overall, the large security service firms tend to post much lower wages than other firms.

Appendix Figure A1 presents the correlation in posted wages across counties in the US. Panel (a) presents the correlation in posted wages between the merging parties (AlliedBarton and Universal Protection Service) on the vertical axis vs. its top competitors (G4S and Securitas) on the horizontal axis. Each marker in the figure is a different county, with the size of the marker proportional to the number of total postings made by all four firms in that county. As can be seen, there is a strong correlation across space, with a slope coefficient equal to 0.77.

Panel (b) instead plots wages between the merging parties on the vertical axis and all other firms on the horizontal axis. The correlation here is much lower, with a slope coefficient around 0.12. There could be multiple reasons for this difference. First, it could be that the merging parties and their top competitors are more likely to be hiring similar types of workers, making their posted wages more similar. Second, it could be that the merging parties and their top competitors are more responsive to each the others' posted wages. In either case, these descriptive statistics provide additional motivation to study heterogeneity in effects by the identity of the firm.

4 Market-Level Responses

4.1 County-Level Merger Exposure

The goal of this paper is to utilize variation in exposure to the AlliedBarton and Universal Protection Service merger across counties to estimate its labor market impacts. The first step is therefore to define exposure. Understanding which counties are exposed to a merger is an extremely relevant policy question. In many merger cases, antitrust authorities must identify the markets for which the merger may impact competition. Often, market remedies are proposed for these markets, such as divestiture of stores or assets.

One key issue in antitrust is that it is not always clear what defines a market. As a baseline, I assume security guards within a county is a relevant market. Prior work has found large flows across occupations (Schubert et al., 2024) and industries (Arnold, 2021), implying this definition may be too narrow. Similarly, a single county may be too narrow geographically. In Section 4, I will explicitly test whether there are impacts of the merger on markets connected to the security

guard market by worker flows. Additionally, I will test whether the results depend on the definition of geography. For now, I will assume that security guards within a county is a relevant market.

Most common approaches to predicting impacts of mergers depends directly on market shares of firms. For example, common concentration indices, such as the Herfindahl-Hirschman Index (HHI), depend only on market shares of companies. Structural methods, such as those in Nevo (2000), depend on market shares, as these are integral in estimating substitution patterns between firms. As my baseline measure of exposure I will utilize the predicted change in the HHI index. This has the strength of being easy to compute and interpret, is common in evaluation of mergers, and has been utilized as a measure of exposure in previous work studying national mergers (Dafny et al., 2012; Ashenfelter et al., 2015).

The HHI is equal to the sum of squared market shares. Computing the change in HHI is done by constructing pre-merger shares of the market, and computing the change in the HHI by combining the shares of the merging party. This isn't equal to the actual change in HHI since market shares may endogenously change in response to the merger. Therefore, throughout the paper I refer to this metric as the predicted change in HHI. It is straightforward to show that the predicted change in HHI can be written analytically as:

$$\Delta_m^{HHI} = 2 \cdot s_1 \cdot s_2 \tag{3}$$

Where s_1 and s_2 are the market shares of the merging parties. In Panel (a) of Figure 2, I plot the market shares of AlliedBarton (horizontal) axis vs. Universal Protection Service (vertical axis). These shares are computed by taking the fraction of security guards postings between 2014-2015 that are from the given firms.

As can be seen in this figure, many counties have very large shares of the merging parties. For example, it is not uncommon for 20-40 percent of the postings to be from AlliedBarton. While shares are lower for Universal Protection Service, they are substantial in many counties. Panel (b) of Figure 2 displays a histogram of the predicted change in HHI due to the merger, which will be the primary exposure measure used throughout the paper. Around 45 percent of counties have a change in concentration less than 0.01, but the distribution exhibits a long-right tail, with some counties experiencing very large increases in concentration. An increase in HHI of 0.01 is a rule-of-thumb that is referenced in the 2023 merger guidelines as large enough to indicate a potential for anticompetitive impacts.

4.2 Impact on Earnings

In this section, I estimate the impact of exposure to the AlliedBarton and Universal Protection Service merger on county-level outcomes using a dynamic difference-in-differences design of the following form:

$$Y_{mt} = \sum_{k=-2}^{3} \delta_k \cdot \Delta_m^{HHI} + \gamma_t + \xi_m + \varepsilon_{mt} \tag{4}$$

Where Y_{mt} is a market outcome for the security services industry in county m at time t. γ_t are calendar year-fixed effects and ξ_m are county fixed effects. Δ_m^{HHI} is the predicted change in market-level HHI. The regression is weighted by the average pre-merger employment in the county (i.e. average employment between 2014-2015). The weighting uses pre-merger employment to account for the possibility that the merger may have direct impacts on employment.

Figure 3 presents the results of the difference-in-differences analysis. As can be seen in the figure, there is no differential pre-trend in earnings between more and less exposed counties between 2014 and 2015 (i.e. years -2 and -1). In 2016, there is a small increase in wages for more exposed counties relative to less exposed counties. Recall, the merger was finalized in August 2016, so a portion of this period is before treatment. The impact continues to increase over time. The interpretation of vertical axis is the impact of a 1-unit change in HHI, which is measured from 0 to 1.

To make these estimates more interpretable, Table 2 reports the impact of a one-standard deviation increase in the exposure measure, assuming the impact is given by the average of the three post-merger coefficients ($\sum_{i=1}^{3} \frac{\hat{\delta}_k}{3}$). A one-standard deviation in exposure is equal to 0.036. As a reminder, the merger guidelines specify an HHI increase of 0.01 as potentially decreasing competition, so relative to this metric a 0.036 increase is substantial. Still, there are roughly 93 many counties that experience a predicted HHI increases larger 0.036. Column (1) of Table 2 finds that a one-standard deviation increase in the HHI change is associated with a 2.4 percent increase in average weekly wages, an effect statistically significant at the 1 percent level.

4.3 Employment and Churn

In this section, I explore the impact of the merger on additional labor market outcomes. Figure A2 displays the impact of exposure to the merger on market-level employment, finding no impact. Column 2 of Table 2 summarizes these results, finding a negligible 0.3 percent increase in employment in more exposed areas, which is not statistically significant. This is an informative result for two reasons. First, an increase in wages with no corresponding change in employment eliminates many models of wage determination. If a firm is paying wages along a firm-specific labor-supply curve, then higher wages will be accompanied by higher employment, assuming no contemporaneous shift in the labor supply of security guards. Therefore, a key aspect of the theoretical model will allow for employment to remain constant after a wage increase, indicating firms are not paying wages along their labor supply curve.

Second, this result is also informative of one potential channel through which market-level wages could increase – changes in worker composition. Prior work finds large displacement effects after mergers. If the type of workers in the security guard industry changes after the merger, then the increase in wages could be due to a higher share of more productive workers in the market. These employment results are suggestive that this is not the case in this particular merger. However, it is still possible that firms increased both separations and hires after the merger, implying no change in overall employment, but a change in worker composition.

To study this possibility, Figure A3 displays the impact of exposure to the merger on log hires

(Panel (a)), log separations (Panel (b)), and the overall turnover rate (Panel (c)), which captures the fraction of all workers that are newly hired. As can be seen in the figure, there is no impact of exposure to the merger on any of these additional outcomes.[8] Therefore, while mergers may cause large amounts of layoffs in some circumstances, it does not appear that the AlliedBarton and Universal Protection Service merger had this effect.

4.4 Robustness

In this section, I present a number of robustness checks. First, the exposure measure in the prior section entered the regression equation linearly. There is no a priori reason to believe that changes in wages are linear with respect to changes in concentration. Therefore, I next explore a more nonparametric approach to measuring exposure. Figure A4 presents results from a series of regressions that replace the continuous measure with a binary indicator variable that captures the degree of exposure. To create this figure, I estimate linear regressions of the form:

$$Y_{mt} = \sum_{k=-2}^{3} \delta_k \cdot \mathbf{1}(\Delta_m^{HHI} \geq \tau) + \gamma_t + \xi_m + \varepsilon_{mt} \tag{5}$$

Where $\mathbf{1}(\Delta_m^{HHI} \geq \tau)$ is a binary variable that equals one if the county has a predicted change in HHI greater than a threshold τ. Panel (a) displays the average effect ($\sum_{k=1}^{3} \frac{\hat{\delta}_k}{3}$) for different values of τ. I choose the thresholds to be the quintiles of the distribution of the predicted change in HHI. As can be seen in Panel (a) of Figure A4, when τ is equal to the 20th percentile, there is actually a negative coefficient that is marginally insignificant. As τ increases, the coefficient becomes positive and statistically significant, with a monotonic relationship between exposure and earnings. Overall, this relationship appears roughly linear.

Although the linearity assumption appears not to be a serious issue, recent work highlights an additional issue with continuous specifications of exposure. Utilizing continuous treatments in difference-in-differences settings requires a stronger parallel trends assumption than is generally assumed (Callaway et al., 2024). Therefore, I next split counties by the average level of exposure (0.027) and re-estimate the dynamic difference-in-differences design to understand the impact of exposure when exposure is measured by a binary indicator. Above 0.027, Figure A4 found positive impacts while below there were zero impact, making this a reasonable binary threshold to choose. By converting the continuous measure to a binary measure, the standard parallel trends assumption is assumed: that the trends in earnings in counties with above-average exposure would have followed the same trend as counties with below-average exposure in the absence of the merger.

Panel (b) of Figure 3 presents the results. Similar to the continuous exposure measure, I find no evidence of pre-trends in earnings among more exposed and less exposed counties. After the merger, the counties highly exposed experience wage gains. Column 1 of Table A2 reports the average effect, finding that more-exposed counties experience a 3.0 percent increase in wages

[8] Table 2 summarizes the results, confirming no impact of exposure on either hires or separations.

relative to less-exposed counties. Again, I find no evidence of an impact on employment (Columns 2 and 4), or measures of turnover (Column 5).

The results so far have measured exposure at the county level. It is possible this creates measurement issues if the labor market is more broad than a county. For example, if a low-exposure county is located near a highly-exposed county, then it is possible that workers in the low-exposure county are actually impacted by the merger if workers routinely commute between these two places. Therefore, the next set of results measures exposure at the Commuting Zone level, which clusters counties together based on commuting flows. Table A3 presents the results. The procedure to construct exposure is identical, except market shares are computed as the fraction of postings in a commuting zone, rather than a county. As can be seen in the table, the results are similar to the county-level results. In the QCEW, a one-standard deviation increase in the change in HHI is associated with a 2.4 percent increase in wages, an effect statistically significant at the 1 percent level. Turning to employment, hires, and separations, I again find no impact of the merger on any of these outcomes.

Next one possibility is that the estimates so far underestimate the impact of the merger on the labor market by not considering impacts on closely-related occupations and industries. Recent work has highlighted that there are large flows across occupations (Schubert et al., 2024) and industries (Arnold, 2021), implying there could be spillovers due to the merger. To understand the scope of this issue, I compute flows between the security services industry and all other industries using data from the Current Population Survey. I find that the two most common industries that individuals from the investigation and security services (CPS IND code 7680) move to (or move from) are the construction industry (0770) and restaurants and other food services (8680).

To understand the impacts on these connected industries, I again utilize the QCEW data for the construction and restaurant industries (NAICS codes 236220 and 722511, respectively). I then estimate the same dynamic difference-in-difference design as in Equation (4). Figure A5 plots the results in Panel (a) for the construction industry and Panel (b) for the restaurant industry. As can be seen in the figure, there is no impact of exposure to the merger on earnings in these industries. Theoretically, while impacts on these industries would not invalidate the design, these results provide additional support for the research design in two ways. First, it is not the case that the markets with high exposure to the merger happened to be on different trends than other markets. These are both industries that pay similar wages to the security services industry. If the results were driven by a local confounding factor, such as increases in the cost of living, then we would expect to see this manifest as earnings increases for these alternative industries. Second, it is possible that the exposure measure is mismeasured due to the fact it does not contain information about employment opportunities in closely-related industries. These results suggest that these substitutable industries are second-order in this setting.

Lastly, because the change in HHI only uses the market shares of the merging parties, it is possible that one could better predict the heterogeneity by incorporating initial market shares or market shares of different companies. For example, it is possible that the impact depends crucially

on the identity of other firms operating in the market. Appendix Section B details constructing two alternative measures of exposure that are more flexible in how they incorporate information on initial market shares. The first is a LASSO model that incorporates initial market shares of the merging parties as well as other major firms, allowing for interactions between all firms. The second is a Random Forest model that likewise allows for interactions between firms, while also allowing HHI changes to have nonlinear impacts. Figure A6 presents the results of using these alternative measures of exposure, finding overall similar results. In practice, these metrics are highly correlated with the change in concentration measure, and therefore lead to qualitatively similar results.

4.5 Summary of Market-Level Responses

In this section I found that places more heavily exposed to the merger of AlliedBarton and Universal Protection Service experienced greater wage growth following the merger. There are no impacts on employment or turnover, suggesting that the wage growth is not due to changes in worker composition. In the next section, I study the impacts of the merger using Lightcast data. Unlike the QCEW and QWI, Lightcast data allows for the identification of individual firms. One way to rationalize the prior results is that Allied Universal is such a large player that shifts at Allied Universal change the average level in the entire market. The Lightcast data will allow me to test for this possibility. Further, Lightcast allows for studying additional outcomes, such as pay transparency and benefits.

5 Firm-Level Responses

5.1 Direct Impact at Allied Universal

In this section I study outcomes at the firm level using data from Lightcast. While job-posting data has certain limitations, the ability to identify individual firms is a unique strength for this particular project. Additionally, it allows one to study impacts beyond wages. For the first part of the analysis I study the direct impact on Allied Universal. Then, in the next section, I study whether direct impacts spill over to other firms in the market.

For the first part of the analysis, I study the impact of the merger on Allied Universal postings by estimating the following difference-in-differences specification:

$$Y_{it} = \sum_{k=-2}^{3} \delta_k \cdot Allied_i + \gamma_{c(i),t} + \zeta_{j(i)} + \varepsilon_{it} \tag{6}$$

Where Y_{it} is an outcome for posting i at time t. $Allied_i$ is an indicator variable that is equal to one if the posting is from Allied Universal. $\gamma_{c(i),t}$ are year fixed effects that are allowed to vary by job title, where the function $c(i)$ captures the job title of posting i. Given the inclusion of these fixed effects, the identifying variation stems from within job title differences. Therefore, if Allied Universal changes the types of jobs it posts, but does not change the features of those jobs, this

specification will find null effects of the merger. This provides another way to verify that the results are not driven by changes in worker composition. $\zeta_{j(i)}$ are job fixed effects, where a job is defined as a title, county, and firm interaction.

While the posted wage is an obvious outcome of interest, one issue is that many job postings do not include a wage (Batra et al., 2023). Panel (a) of Figure A7 plots the trends in transparency for Allied Universal, Securitas, G4S, and all other security guard postings. The vertical axis plots the fraction of postings that contain salary information. In the period before the merger, postings from AlliedBarton and Universal Protection Service are grouped together.

As can be seen in the figure, the presence of posted wages varies dramatically across firms and time. In particular, just after the merger, transparency drops dramatically in Allied Universal postings. Panel (a) of Figure A8 plots the trends in transparency for AlliedBarton and Universal Protection Service separately. While Universal Protection Service has initial transparency levels higher than AlliedBarton, it appears that the decline in transparency is not solely driven by Universal Protection Service adopting AlliedBarton's practices. The transparency of postings for Allied Universal in 2017 (8 percent) is much lower than AlliedBarton's transparency in 2015 (29 percent).

These impacts will clearly complicate any analysis of the impact of the merger on Allied Universal posted wages. The censoring is so severe that any results could be potentially rationalized by the selective observability of wages.[9] However, the main goal of this section is not necessarily to study the impact of the merger on Allied Universal wages, but rather to study strategic actions between firms, including wage and non-wage interactions. Additionally, pay transparency is an important outcome in its own right, with many states increasingly passing legislation aimed at increasing pay transparency in online postings.

Given the clear impact on transparency in the raw trends, I next estimate the impact on transparency by estimating Equation (6). Panel (a) of Figure 4 plots the dynamic difference-in-differences estimates of the impact of the merger on Allied Universal transparency, confirming what is clear in the raw trends. Column 1 of Table 3 summarizes the result, finding that Allied Universal ads decreased transparency by 27.7 percentage points following the merger, an effect statistically significant at the 1 percent level.

Next, I explore the impact of the merger on whether the job posting mentions benefits. If the merger increased wages, but lowered benefits, then it is possible total compensation did not change. In Panel (b) of Figure A7, I plot the trends in the fraction of postings that mention either medical or dental benefits.[10] As can be seen in the figure, the fraction of postings that include a benefit jumps significantly in Allied Universal after the merger. Before the merger, roughly 10-30 percent of postings included a benefit, while after the merger, around 90 percent of postings included a benefit. Panel (b) of Figure 4 plots the dynamic difference-in-differences estimates, again confirming

[9] Panel (c) of Figure A7 displays trends in posted wages for Allied Universal and other firms. Figure A9 plots estimates of the wage effect. Conditional on posting a wage, wages do grow significantly after the merger, though selection makes these estimates difficult to interpret.

[10] This is done by performing a key word search on the raw text data, searching for the words "medical" and "dental".

the raw trends. Allied Universal increased the fraction of postings that include a benefit by 71.2 percentage points following the merger (see Column 2 of Table 3).[11]

These results should again be interpreted with caution. It is not possible to conclude that Allied Universal greatly expanded benefits after the merger. It could be that they were already offering benefits, but did not explicitly advertise them in their job postings. Still, this is certainly compelling evidence that benefits did not decline after the merger, as they are being advertised in the majority of postings. Given these large changes at Allied Universal, the next section studies whether competing firms respond by changing their transparency and benefits.

5.2 Spillover Effects

Next, I study whether these direct changes at Allied Universal spill over to other firms in the market. To do so, I estimate the following difference-in-differences specification:

$$Y_{it} = \sum_{k=-2}^{3} \delta_k \cdot \Delta_{m(i)}^{HHI} + \gamma_{c(i),t} + \zeta_{j(i)} + \varepsilon_{it} \tag{7}$$

Where $\Delta_{m(i)}^{HHI}$ is the predicted change in HHI for the market of posting i at time t. All other variables are as defined previously.

Panel (a) of Figure 5 plots the estimates for a sample that restricts to postings from either G4S or Securitas, Allied Universal's largest competitors. As can be seen in the figure, in areas that are more exposed to the merger, there is a decrease in transparency in postings for these firms. Table 4 reports the average effect, finding a one-standard deviation increase in exposure is associated with a 2.8 percentage point decrease in the probability a posting from G4S or Securitas includes a wage, an effect statistically significant at the 5 percent level.

Turning to all other firms posting for security guards in Panel (b), I find no evidence that transparency decreased in exposed markets after the merger. In contrast to Allied Universal's close competitors, other firms are actually increasingly transparent in their job postings after the merger. Table 4 reports the average effect, finding a one-standard deviation increase in exposure is associated with a 2.6 percentage point increase in the probability a posting includes a wage, an effect that is statistically significant at the 1 percent level. This finding shows that areas more exposed are not simply arears that are experiencing decreases in transparency over time. Whether a firm increases or decreases transparency depends crucially on whether the firm is a major competitor with Allied Universal or not.

Next, I consider spillovers impacts on the presence of benefits mentioned in the job posting. As can be seen in Panel (c) of Figure 5, G4S and Securitas increasingly mention benefits in areas that are more exposed the merger, while there is no impact for other firms. In Table 4, I find a one-standard deviation in exposure is associated with a 3 percentage point increase in the probability

[11] Column 3 of Table 3 reports the impact of the merger on the posted wage at Allied Universal, finding an increase of 8.1 percent. Given the selection issues due to decreased transparency, these results should be interpreted with caution.

the job advertisement mentions medical or dental benefits. In contrast, other firms hiring security jobs do not change their behavior. Therefore, again, the response of firms depends on whether the firm is a close competitor to Allied Universal.

Lastly, I turn to impacts of exposure on posted wages. This analysis most closely relates to the prior section that studied market-level impacts. The goal here is to both study heterogeneity by type of competitor and confirm that the market-level effects are not solely driven by Allied Universal. Additionally, one advantage of the job-posting data is the availability of job titles. This allows for granular information on the exact job that an individual worker will be performing. These results can therefore help confirm that changes in market-level wages are not driven by changes in the type of jobs workers are performing. For example, if the merger led to more employment of armed guards vs. unarmed guards, then compositional impacts could explain the market-level results. While the null impacts on churn and employment are suggestive that this is not the case, these posted wage results can provide further evidence by estimating within-job title impacts. One large complication, however, is that this outcome is only observable conditional on a firm posting wages, and given the previous results, there is differential selection into wage posting after the merger. Therefore, after estimating the initial point estimates, I will next consider an alternative estimation strategy that bounds the impacts of exposure to the merger on posted wages.

Panel (e) of Figure 5 plots the estimates for G4S and Securitas, finding an increase in wages in more exposed areas after merger, with effects that grow in the following three years. A one-standard deviation in exposure is associated with a 2.6 percent increase in posted wages, similar to the increase in wages at the market level. Similarly, Panel (f) of Figure 5 plots the results for all other firms hiring security guards. Unlike the transparency and benefits results, the wage results are quite similar across firms. A one-standard deviation is associated with a 1.7 percent increase in posted wages at other firms hiring for security guards. All wage impacts are statistically significant at the 1 percent level.

Given selection issues, Table A4 presents bounds on the impacts following Lee (2009). As a first step in estimating bounds, I define exposure using a binary measure that is equal to one if the change in HHI is above the average. This allows one to directly apply the methodology of Lee (2009), which assumes a binary treatment. For this alternative outcome, I find that exposure increases the posted wage of G4S and Securitas by 2.6 percent. The bounds are relatively tight, with the lower bound being 1.6 percent and the upper bound being 3.6 percent. In particular, even the lower bound, which assumes the worst case scenario in terms of selection, is significantly different from zero. However, turning to outcomes for other firms, the bounds are much wider and do contain zero. Therefore, while the overall estimate is positive, there is more uncertainty regarding the impact on other firms, which under worst case scenarios of selection could be zero. For further description of the bounding methodology see Appendix C.

Overall, the results in this section show that the impacts of the merger are not only driven by changes at Allied Universal. All firms increase posted wages following the merger. This shows that strategic interactions between firms are an important component in understanding the overall

impacts of the merger on the labor market for security guards.[12] Further, strategic interactions go beyond wage setting. For closer competitors, the firms responded to the non-wage changes at Allied Universal. This resulted in lower transparency in pay but more advertising of job benefits.

6 Mechanisms

The goal of this section is to explore the mechanism through which the merger increased market-level wages. To do so, I first illustrate a simple conceptual model. This model can rationalize the results so far through two separate mechanisms: increased efficiency or increased product-market power. I then turn to empirical results to distinguish between these two mechanisms.

6.1 Conceptual Model

The model has three stakeholders: security firms, purchasing firms, and workers. Purchasing firms can be either private-sector firms, but also federal, state or local governments, all of which utilize security firms' services. The model is similar conceptually to work that studies the impact of mergers on hospital prices (Gowrisankaran et al., 2015) in a setting in which prices are determined by bargaining between managed care organizations and hospitals. In my setting, the first stage of bargaining is between security firms and purchasing firms. The model is also closely related to Miller (2014) who studies the impact of mergers on prices in procurement auctions and shows that such a model is equivalent to a model of bargaining between firms and buyers. Unlike both of these papers, the goal of my model is not to structurally estimate and simulate the impacts of a merger, but instead highlight channels through which the merger may impact wages and discuss how to empirically distinguish between them.

I assume purchasing firms have idiosyncratic preferences over security guard firms. The utility of a purchasing firm i from hiring security guard firm j is given by $U_{ij} = v_{ij} - b_{ij} \cdot L$, where v_{ij} is the idiosyncratic preference of purchasing firm i for security firm j, b_{ij} is the billing rate charged to firm i by firm j, and L is the number of security guards required for the given contract. Let $z_{i,-j}$ be the maximum value of v_{ij} across all other security guard firms. This is the value the buying firm i associates with the second-best option. I assume the billing rate is determined by a Nash-in-Nash bargaining solution given by:

$$b_{ij} = \arg\max_b \left(b \cdot L - w(b) \cdot L - c_R(L)\right)^{\alpha} \left(v_{ij} - b \cdot L - z_{i,-j}\right)^{1-\alpha} \tag{8}$$

Where $w(b)$ is the wage paid to security guards, $c_R(L)$ is the cost of recruiting L security guards for the contract, and α is the bargaining power of the security firm. The wage explicitly depends on the billing rate, as higher billing rates generate higher profits, leading to higher overall wages. This will be evident when turning to the worker side of the model. On the worker side, I assume

[12] Table A5 reports results that include US Security Associates as a major competitor, along with G4S and Securitas. The results are qualitatively similar, though some impacts are attenuated slightly, implying US Security Associates was not as responsive to changes at Allied Universal.

the wage is determined by a Nash-in-Nash bargaining solution between the security firm and the workers:

$$w = \arg\max_w \left(b(w) \cdot L - w \cdot L - c_R(L)\right)^{\gamma} \left((w - o) \cdot L\right)^{1-\gamma} \tag{9}$$

Where o is the outside option of the worker, and γ is the bargaining power of the security firm in labor negotiations. In Appendix D, I solve for equilibrium wages and billing rates by setting both first-order conditions of the bargaining problems to zero. In this section, I focus on the comparative statics of mergers.

First, as firms often argue, M&A can improve efficiency. In the model, this can be captured by a decrease in recruiting costs. For example, in an interview with Steve Jones, CEO of Allied Universal and CEO of Universal Protection Service prior to the merger, the potential synergies of the merger is the core focus of the discussion.[13] He states, "We had to work through two different corporate cultures and approaches to the business to determine where the specific functions would best be situated for efficiency and success...the industrial synergies were pretty black and white." In the context of the model, one can conceptualize synergies as decreasing the cost of supplying a contract. This will be captured by a decrease in the recruiting cost $c_R(L)$.

Second, the merger could lead to a reduction in competition. Steve Jones describes his relationship with the CEO of AlliedBarton, Bill Whitmore as: "I like to call it a "fierce and friendly" relationship – we were fierce competitors in the marketplace."[14] If these two firms are no longer competing in the product market, this could increase billing rates for purchasing firms. In the context of the model, this can be conceptualized as a decrease in the outside option of purchasing firms $z_{i,-j}$.

Regarding wages, the comparative statics of changes in recruiting costs and changes in outside options of purchasing firms are identical in this model:

$$\frac{\partial w}{\partial \frac{c_r(L)}{L}} = \frac{\partial w}{\partial z_{i,-j}} = \frac{-(1-\gamma)\cdot\alpha}{\alpha + \gamma - \alpha\cdot\gamma} < 0 \tag{10}$$

This equation shows that the two channels have the same predictions with respect to the wage. It also helps clarify what parameters generate the largest impacts. In the model, the wage impact is maximized if the security firm has all the bargaining power in the product market ($\alpha = 1$) and no bargaining power in the labor market ($\gamma = 0$). Intuitively, in this scenario, the security firm captures all the gains from any increase in surplus on the product side that stems from either decreases in recruiting costs or decreases in outside options of purchasing firms. All this surplus is then passed on to workers in the form of higher wages. This discussion also makes it clear that impacts on wages will not allow one to distinguish these two channels.

Therefore, I next turn to the comparative statics on billing rates. First, the change in the billing

[13] See here for the full interview: https://www.ceocfointerviews.com/interviews/AlliedUniversal17.htm

[14] For the full article, see here: https://www.asisonline.org/security-management-magazine/articles/2017/07/the-meaning-of-a-merger/

rate with respect to the average recruiting cost is given by:

$$\frac{\partial b}{\partial \frac{c_r(L)}{L}} = \frac{(1-\alpha)\cdot\gamma}{\alpha+\gamma-\alpha\cdot\gamma} > 0 \tag{11}$$

In contrast, the change in the billing rate with respect to a change in the outside option of purchasing firms is given by:

$$\frac{\partial b}{\partial z_{i,-j}} = \frac{-\alpha}{\alpha+\gamma-\alpha\cdot\gamma} < 0 \tag{12}$$

Therefore, if the main channel is through a decrease in the average recruiting cost, then the billing rate will decrease after the merger. The cost to the security firm of providing the service has decreased, leading to increased surplus for the security firm of providing services for the job, some of which are shared with the purchasing firm. Profits of the security firm will still increase despite the lower billing rates as overall costs have declined. In contrast, if the main channel is through a decrease in the outside option of the purchasing firm, then the billing rate will increase after the merger. This is because the next-best option for the firm has decreased, giving the firm less leverage in the bargaining problem.[15] In the next section, I aim to empirically distinguish between these two mechanisms.[16]

Note that the impact on billing rates has another implication. If a firm is able to lower billing rates, then it will be able to win more contracts. In the context of the bargaining model, I have assumed that the purchasing firm is matched to the security firm that yields the highest value. However, if the merging party is able to take advantage of cost savings and lower billing rates, then there will be a set of contracts that the security firm now becomes the top choice. This will lead to an increase in the number of contracts won by the merging party. Therefore, in the next section I study whether Allied Universal grows in size relative to other firms after the merger before turning to evidence on billing rates.

6.2 Impacts on Posting Shares

In this section, I study the impact of the merger on the share of job postings from Allied Universal. To do so, I estimate the following difference-in-differences specification:

$$Y_{mt} = \sum_{k=-2}^{3} \delta_k \cdot \Delta_m^{HHI} + \gamma_t + \xi_m + \varepsilon_{mt} \tag{13}$$

Where Y_{mt} is the county-level measure of the share of postings for a particular firm, and all other variables are as defined previously in Section 4 Equation (4).

In Panel (a) of Figure A10 I plot the estimates, with the share of postings from Allied Universal as the outcome. As can be seen in this figure, the share of postings from Allied Universal drops in

[15] The term leverage is often used synonymously with outside options in bargaining problems.

[16] It is certainly possible that multiple channels are at play simultaneously. In Appendix Section D, I discuss other potential channels through which mergers may impact worker outcomes.

the more exposed markets.[17] Table A7 summarizes these results, finding a one-standard deviation in exposure is associated with a 5.9 percentage point decreases in the fraction of postings attributed to Allied Universal and a 1.8 percentage point increases in the fraction of jobs associated with Securitas and G4S. These findings are inconsistent with the idea that the merger is lowering costs for Allied Universal. If the merger lowered recruiting costs, then Allied Universal should increase their market share in exposed counties.

However, there are two potentially large caveats to this finding. First, in reality, it is somewhat difficult to predict where the cost savings would occur. Using exposure assumes that the recruiting costs for labor accrue in areas in which the two firms overlap. While this a priori seems reasonable, there could be cost savings in other locations as well. Second, the exposure measure is defined as an interaction between AlliedBarton and Universal Protection Service market shares. Therefore, counties without these firms will have low exposure. By construction these counties can only see an increase in the share of postings for Allied Universal following the merger, as they had zero previously. This mean reversion could bias the results towards finding a negative impact.

To address these concerns, Figure A11 plots trends in the share of postings for Allied Universal by above-average exposure vs. below-average exposure markets. First, below-average exposure counties do not necessarily have zero shares of Allied Universal. The average share of Allied Universal is between 20-30 percent in the pre period. In the pre period a job is defined as belonging to Allied Universal if it is in either AlliedBarton or Universal Protection Service. So the reason these places are not exposed is not because the firms are not present at all, but rather only one of the two companies has a significant share of postings.

Second, as can be seen in the graph, the fraction of postings for Allied Universal declines in both above-average exposure and below-average exposure markets. If the results were due to mean reversion, we would expect to see decrease in above-average markets and increases in below-average markets. However, we see declines in both, with larger declines in above-average exposure markets. This also suggest that the effects here are not driven by Allied Universal taking advantage of decreases in recruiting costs. Not only do the share of postings decline in more exposed counties, but the aggregate share of postings for Allied Universal declines as well.

6.3 Impacts on Spending

In this section, I explore the impact of the merger on billing rates. To do so I use data on the amount spent on federal contracts for security guard services. The sample includes all contracts from usaspending.gov from the years 2014-2019 for the security guard industry (NAICS code 561612). Panel (a) of Table A6 presents summary statistics for all security guard contracts. The average award amount for a contract is roughly 1.1 million dollars. However, the distribution of contract sizes is highly skewed. The median contract award is $10,570. The award amount is the total amount of money the government has either paid or agreed to pay. In some cases, a contract has

[17] Panel (b) presents results for the share of postings for G4S and Securitas, finding an increase in the presence of these companies.

been awarded, but no money has been paid out on the contract, and the government is not required to pay out any money. These will appear as zero dollar contracts in the data.

Next, turning to contract length, the average contract is 343 days, while the median contract is for 364 days. As with award amounts, there are some contracts for very short durations, for example, a single day. Given the conceptual model in Section 6, the goal is to focus on economically meaningful contracts that are likely to be negotiated over, rather than small, short duration contracts. Therefore, for the main sample I restrict to relatively large contracts that have a contract duration of at least 1 year and an award amount of at least $10,000. These restrictions reduce the number of contracts from 14,525 to 5,201.[18] Panel (b) presents summary statistics of this analysis sample. The average award is 2.8 million dollars, though again the distribution is highly skewed, with the median award being $75,000. The average contract length is 487 days with the median still being 364 days.

By far the most common agency that hires security guard services is the Department of Justice, which accounts for 69 percent of all contracts and 57 percent in the main analysis sample. The next most common is Homeland Security (16 percent in total sample and 24 percent in analysis sample) followed by the Department of Defense (3 percent in total sample and 4 percent in analysis sample). For the Department of Justice, although the headquarters is located in Washington D.C., there are many field offices. While Washington D.C. is certainly overrepresented relative to its population (the location of work for 8.6 percent of contracts is Washington D.C.), there is still considerable variation across space. This variation will be crucial to understand the impacts of the AlliedBarton and Universal Protection Service merger.

The empirical strategy to estimate spending effects closely follows the prior sections. In particular, to estimate the impact of the merger on contract spending I estimate the following difference-in-differences specification:

$$log(spending_{it}) = \sum_{k=-2}^{3} \delta_k \cdot \Delta_{m(i)}^{HHI} + \gamma_t + \chi_{c(i)} + \varepsilon_{it} \tag{14}$$

Where $log(spending_{it})$ is the log award amount of contract i at time t. $\Delta_{m(i)}^{HHI}$ is the predicted change in HHI for the market of contract i at time t. γ_t are year fixed effects that capture the year that the contract work begins. It is not possible to directly measure how much is spent on an award over time. For example, for a two-year contract, it is not possible to tell when the money is actually paid to the security firm. Therefore, the interpretation of this outcome variable is the total amount of money spent on awards that began in a given year.

Each contract in the sample comes with a very short description of the type of work. For example, a contract may be for security services at a particular federal building. $\chi_{c(i)}$ are county-by-description fixed effects, where the county is location of the work for county i. The goal in including county-by-description fixed effects is to focus on similar types of jobs over time.

[18] There are 7,119 contracts with award amounts less than 7,119 and 3,734 contracts with durations less than 1 year.

Panel (a) of Figure 6 presents the results from estimating Equation (14). As can be seen in the figure, there is no differential pre-trend in spending between more and less exposed counties. After the merger, there is an increase in spending in more exposed counties. Panel (b) drops the restrictions on contract length and size, finding qualitatively similar results. Both specifications in Panel (a) and Panel (b) include county-by-description fixed effects. While this ensures that the comparison is made between similar jobs over time, it also reduces the sample further. In many cases, there is not the same job description both before and after the merger within a county.

Therefore, in Panel (c) I instead include county-by-award type fixed effects. There are eight different award types in the data, with the most common being a purchasing order (59%) or a delivery order (26%). A purchasing order is a standalone contract while a delivery order is an order that utilizes an existing contract. The goal in allowing for county-by-award type fixed effects is again to focus on identifying impacts from similar types of jobs, but in a less granular way than including the entire description of the job. Again I find qualitatively similar results.

To put these various estimates into perspective, Table 5 reports the effect of a one-standard deviation in exposure across different specifications. For the main specification that restricts to economically meaningful contracts and includes county-by-description fixed effects, a one-standard deviation increase in exposure is associated with a massive 36% increase in spending (Column 1), an effect that is statistically significant at the 5 percent level. One potential issue with the outcome measure is that it is extremely skewed, implying outliers could drive the results. Therefore, in Column 2 I winsorize the outcome at the 99th percentiles, finding nearly identical results.

In Column (3), I present results from the specification that includes fixed effects for county-by-award type. As can be seen in the table, this more than doubles the sample size, from 2,106 contracts to 4,958. The magnitude of the impact is smaller now, but still economically large, at 13 percent. However, given the relatively large standard errors, the impact is just marginally insignificant under this specification. Columns (4) and (5) again includes county-by-description effects and explores how the results vary by the sample included. Column (4) removes the restriction that the award must be at least $10,000. Column (5) further removes the restriction that the contract must be at least one year in length. Qualitatively, both results find large and statistically significant impacts of the merger on contract spending, though the exact magnitudes differ.

Overall, I find consistent evidence that the merger led to an increase in contract spending. However, as mentioned previously, there are a few caveats to these results. First, the sample contains only federal contracts, which is a small subset of the overall market for security services. This makes it difficult to extrapolate the effects here to the wider market and also leads to issues with precision. The magnitudes of the impacts are extremely large, but imprecisely estimated. While all specifications find large and positive impacts, the magnitudes range from 13 to 36 percent. Second, the outcome is the total amount spent on security guard services, but it is not possible to observe a billing rate. Future work with more detailed data on billing rates could help verify the price impacts of the merger, even allowing one to study wage markdowns and effects by specific types of guards.

7 Conclusion

In this paper, I study the impacts of the AlliedBarton and Universal Protection Service merger on workers in the broader security guard labor market. While I allow for measures of exposure that incorporate more flexibility in how competition operates between firms, I find a simple change in concentration measure is highly correlated with these flexible approaches and predicts meaningful heterogeneity in wage impacts. However, the results go in the opposite direction of increased monopsony power in the labor market, finding higher wages in markets that are more exposed to the merger.

Turning to job-posting data, I explore outcomes other than wages. I find that Allied Universal becomes less transparent in their posted wages, but begins to aggressively advertise job benefits. Large competitors respond strategically, reducing transparency and increasing benefit advertisement in locations heavily exposed to the merger. There is no such response from other firms in the market. This provides evidence of strategic interactions between large firms that go beyond wages. These results also confirm that the wage impacts are not due to solely changes at Allied Universal. Competitors increase posted wages in response to the merger.

Lastly, I explore further outcomes to understand the mechanism behind the increase in market wages. I find evidence consistent with increased product-market power increasing billing rates, leading to higher wages through rent sharing. I find areas more exposed to the merger see a decline in the share of postings for Allied Universal, a finding consistent with higher billing rates. Additionally, using contract spending data from the federal government, I find that the merger led to a large increase in contract spending, conditional on a location and specific type of work. While a small portion of the overall industry, this provides consistent evidence of increased billing rates due to the merger.

This merger is one example that may not necessarily extrapolate to other settings. However, the basic approach used here is relatively straightforward to apply to other large merger events, or to a broader set of mergers in the industry. The combination of Lightcast job-posting data and Census data on earnings could be a powerful setup for providing analysis on proposed mergers by studying similar mergers in the past. The job-posting data is essential to understand the geographic distribution of the firm and to isolate specific competitors, while the Census data allows for an accurate measure of labor-market outcomes that is free from selection into the sample.

Additionally, while the results here apply to a specific merger, there is considerable to learn from this case-study approach. This approach is of course not new, with extensive examples present in the Industrial Organization literature. However, it is relatively novel in the labor-market setting. The case-study approach allows one to understand the specific structure of how wages are set within a given industry. For example, publicly available contracts explicitly state how billing rates are set as a markup of wages. It additionally allows one to explore more complex competition behaviors by identifying individuals firms that the merging party consistently competes with across many regions. While these results are specific to the security guard industry, they are reflective of

broader questions. How does labor-market competition between firms work in practice? How do the product market and labor market interact to determine worker outcomes? Making progress on these questions may necessitate taking a more case-study approach before finding broad generalizations.

The ability to focus on the specific setting also lead to a number of interesting areas for future research. For example, while I model competition as occurring on a specific contract, the actual setting is more complex, with companies competing across many contracts over time. Multimarket contact is pervasive for many of the largest employers, such as major retailers or major grocers. How multimarket contact in the product market impacts labor market outcomes could be an interesting area for future research.[19] Focusing on the specific nature of competition within a given setting is a promising direction to answer these big questions.

[19] Bernheim and Whinston (1990) for example studies theoretically how multimarket contact can in some situations help sustain high prices.

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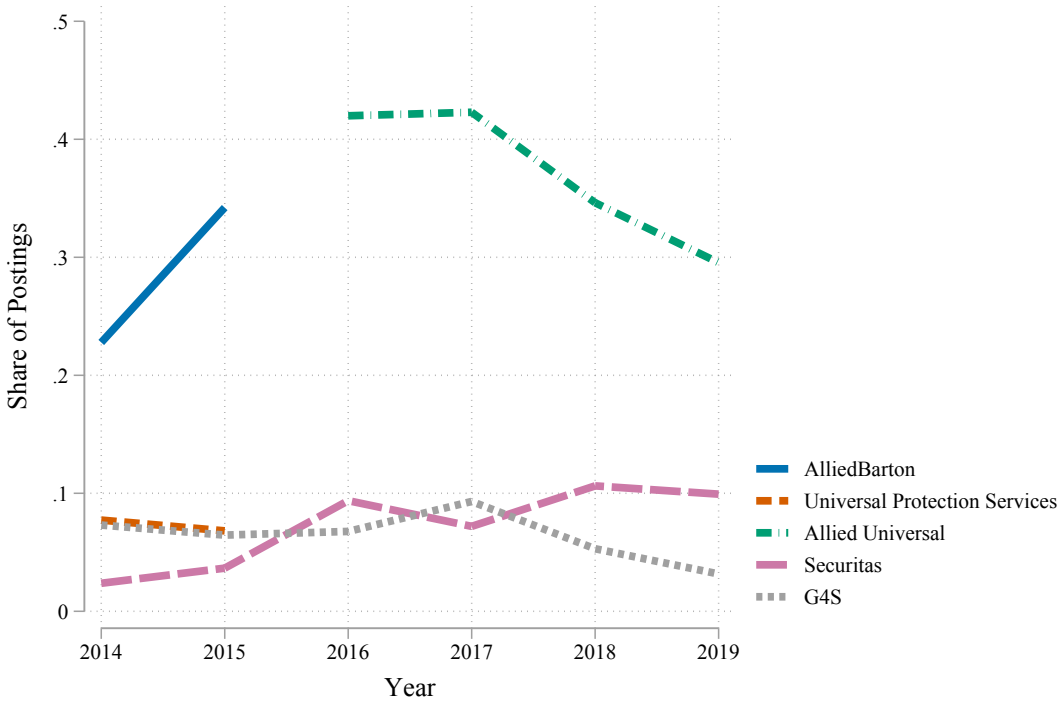
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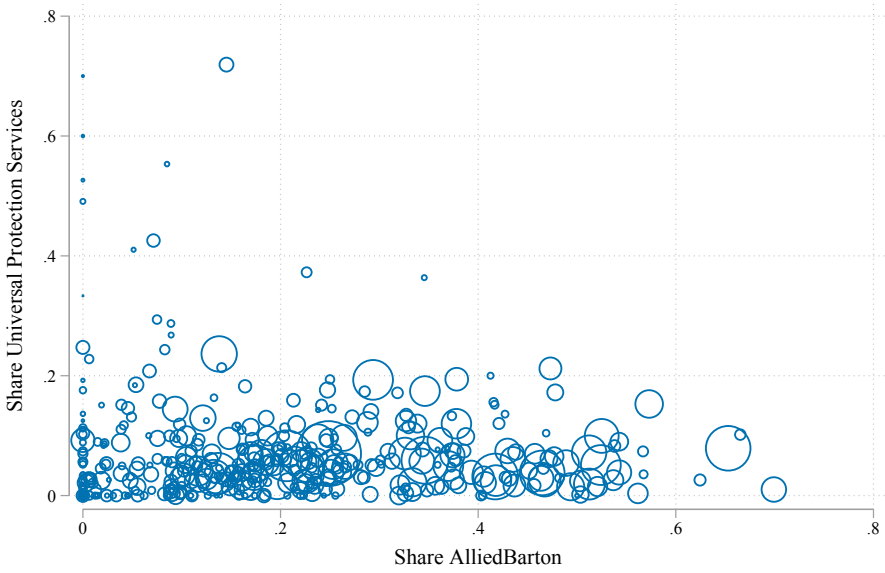
Figures

Figure 1: Trends in Share of Postings For Security Guards by Firm

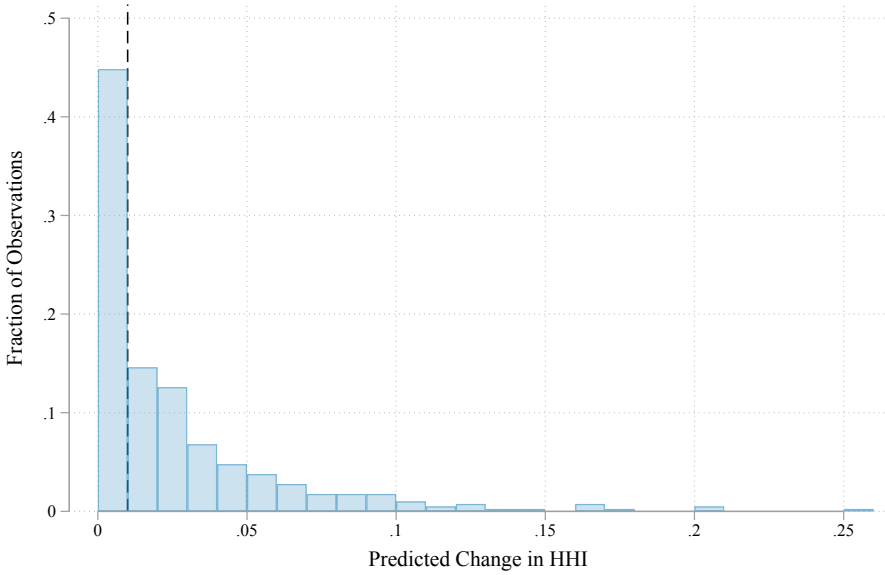


Note: This figure plots the share of job postings over time for AlliedBarton, Universal Protection Service, Allied Universal, Securitas, and G4S. Allied Universal formed in 2016 from the merger of AlliedBarton and Universal Protection Service.

Figure 2: County-Level Exposure to AlliedBarton and Universal Protection Service Merger



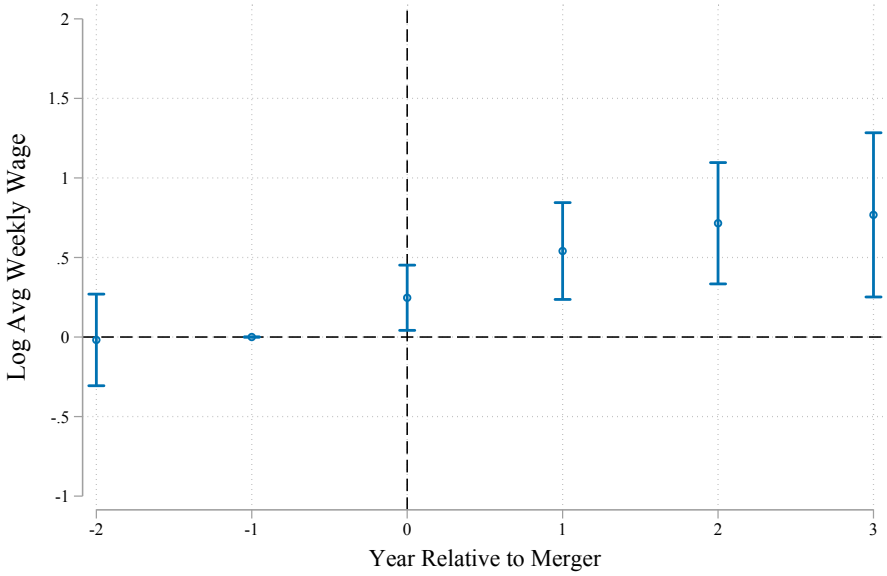
(a) Shares of Security Guard Postings for AlliedBarton and Universal Protection Service



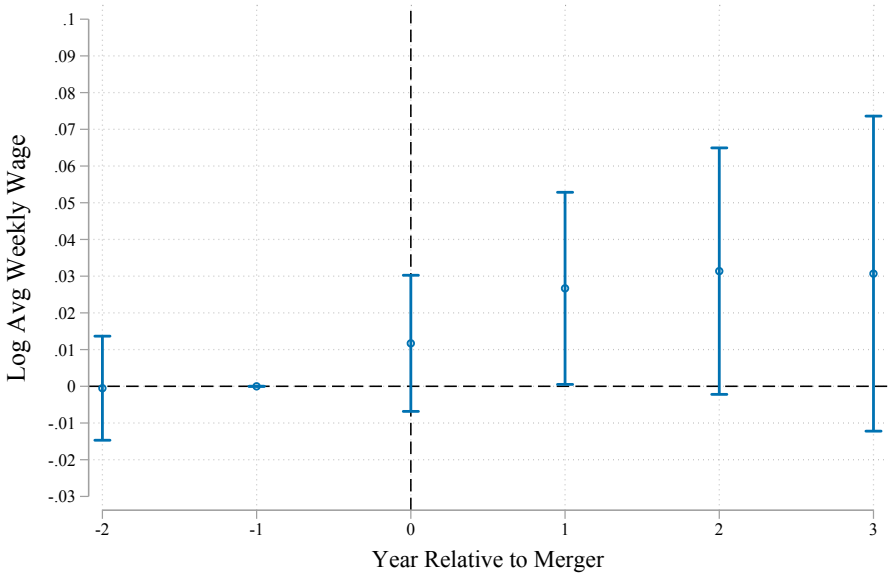
(b) Histogram of Predicted County-Level Change in HHI

Note: Panel (a) plots the shares of security guard postings that are for AlliedBarton (horizontal axis) vs. Universal Protection Service (vertical axis). Panel (b) plots a histogram of predicted changes in HHI at the county level due to the merger.

Figure 3: Difference-in-Differences: Impact of Merger on County-Level Earnings



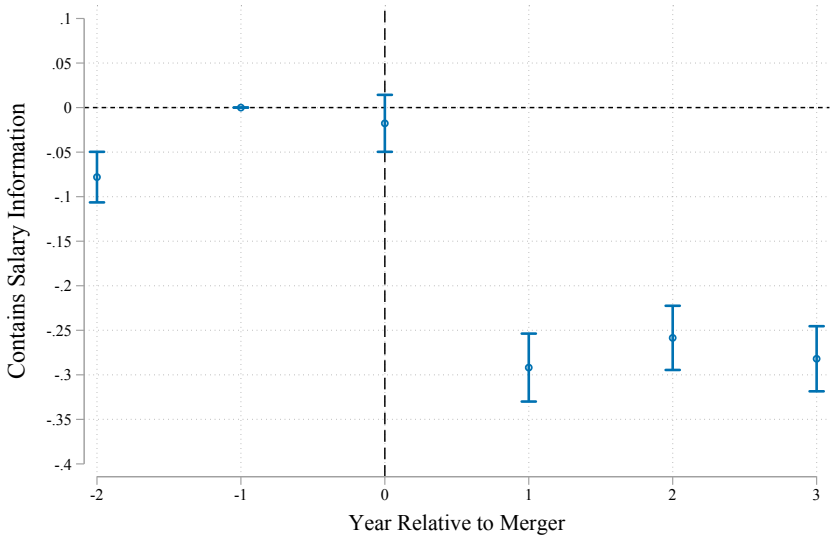
(a) Exposure Measure: Predicted Change in Concentration



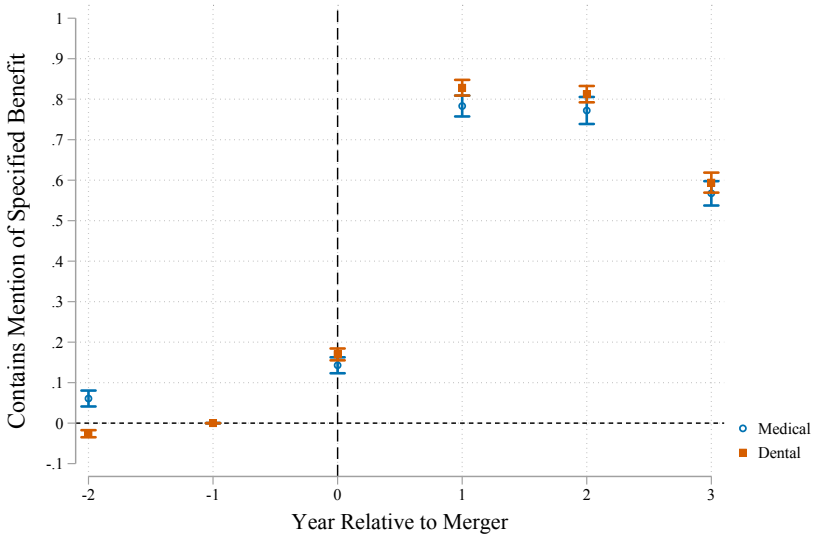
(b) Exposure Measure: Above-Average Predicted Change in Concentration

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on county-level earnings. In Panel (a) the exposure measure is the predicted county-level change in concentration while in Panel (b) the exposure variable is a binary indicator equal to one if the county experienced an above-average increase in predicted concentration, where concentration is estimated using Lightcast job posting data. Earnings are measured using the log average weekly wage in the Quarterly Census of Employment and Wages. Standard errors are clustered at the county level. 95 percent confidence intervals are displayed in the figure.

Figure 4: Impact of Merger Allied Universal Job Posting Outcomes



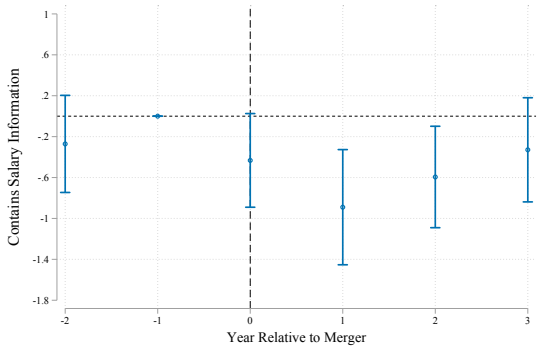
(a) Fraction of Postings with Salary Information



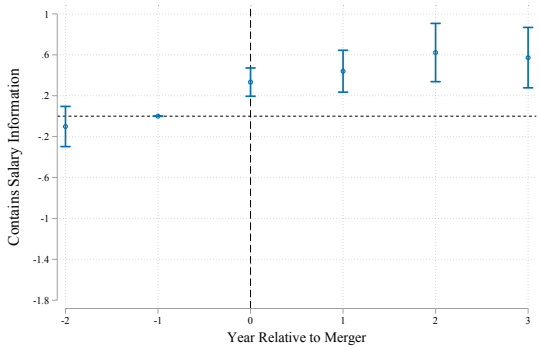
(b) Benefits Mentioned in Job Posting

Note: This figure estimates the direct impact of the AlliedBarton and Universal Protection Service merger on outcomes at the merging firms. In the pre-merger period, outcomes at AlliedBarton and Universal Protection Service are grouped together to reflect that post-merger the firms are a single entity: Allied Universal. Panel (a) plots the impact of the merger on the probability a job posting from Allied Universal contains salary information. Panel (b) plots the impact of the merger on the probability a job posting mentions medical or dental benefits. Each specification includes firm-by-title-by-county fixed effects and job title-by-year fixed effects. Standard errors are clustered at the county level. 95 percent confidence intervals are displayed in the figure.

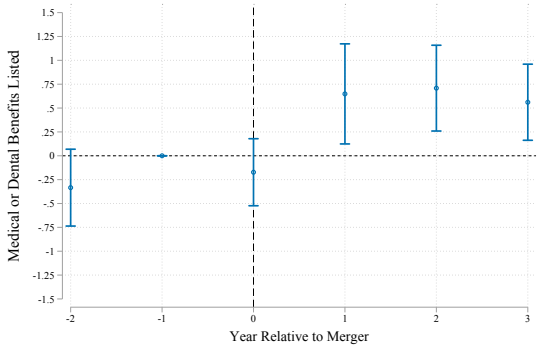
Figure 5: Impact of Exposure to Merger on Outcomes at Competing Firms



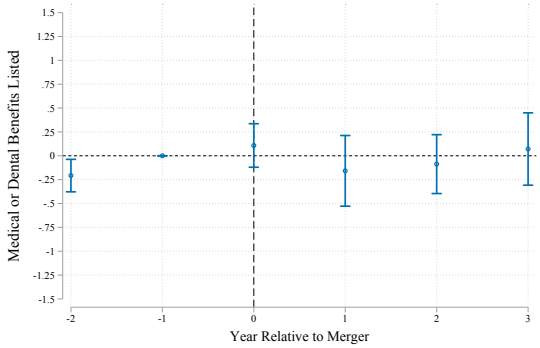
(a) Transparency at G4S/Securitas



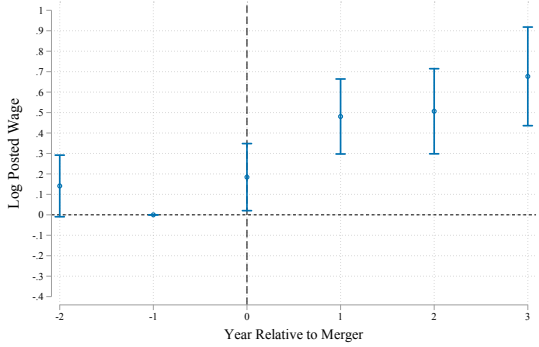
(b) Transparency at Other Firms



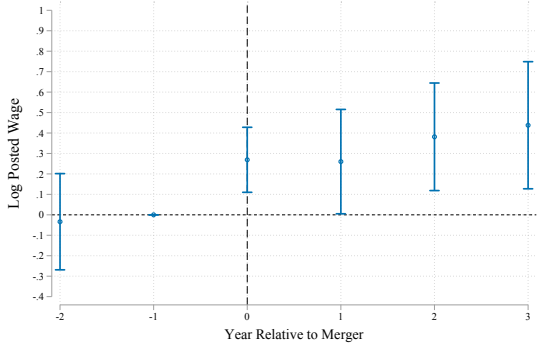
(c) Benefits at G4S/Securitas



(d) Benefits at Other Firms



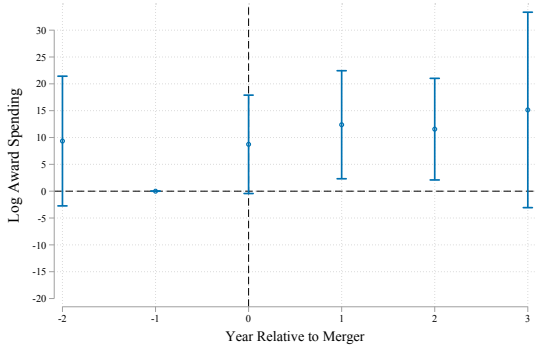
(e) Log Posted Wage at G4S/Securitas



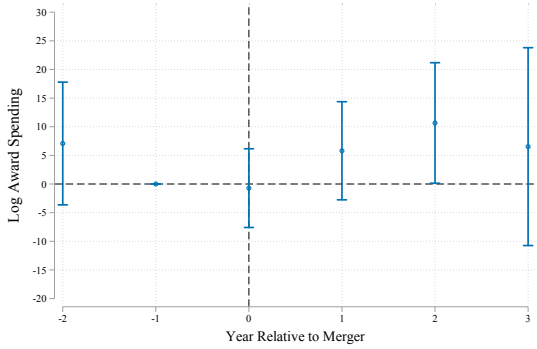
(f) Log Posted Wage at Other Firms

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on pay transparency, whether a posting mentions benefits, and the log posted wage separately for G4S/Securitas vs. all firms posting for security guard jobs, excluding Allied Universal, G4S and Securitas. Exposure is measured as the predicted change in county-level concentration, estimated using Lightcast job posting data. All specifications include firm-by-title-by-county fixed effects and job title-by-year fixed effects. Standard errors are clustered at the county level. 95 percent confidence intervals are displayed in the figure.

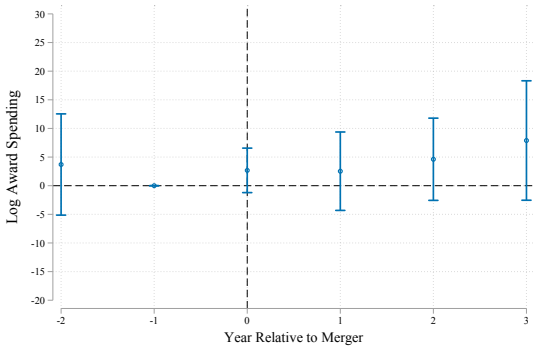
Figure 6: Impact of Exposure to Merger on Federal Contract Spending in Security Industry



(a) Main Sample



(b) All Awards



(c) Different Fixed Effects

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on the log spending for federal contract awards in the security guard industry (NAICS code 561612). Data come from usaspending.gov for the years 2014-2019. Exposure is measured as the predicted change in county-level concentration, estimated using Lightcast job posting data. Panel (a) presents the main results which restrict to contracts of meaningful size, defined as contracts that last at least 1 year and award at least $10,000. Panel (b) drops these restrictions, allowing for contracts of any length or monetary amount. In both Panel (a) and Panel (b) the specifications include county-by-description fixed effects, which reduces the total number of observations available to identify impacts. Panel (c) instead includes county-by-award type fixed effects, which are less restrictive and include more overall observations. See Table 5 for information on observation counts across various specifications. Standard errors are clustered at the county level. 95 percent confidence intervals are displayed in the figure.

Tables

Table 1: Log Posted Pay Premia at Large Security Firms

	(1)	(2)
Allied Barton	-0.226	-0.171
	(0.028)	(0.015)
Universal Protection Service	-0.298	-0.199
	(0.014)	(0.013)
G4S	-0.239	-0.153
	(0.011)	(0.014)
Securitas	-0.279	-0.174
	(0.016)	(0.014)
Observations	65159	64250
Job Title FE	No	Yes
County FE	No	Yes

Note: This table reports OLS estimates of the log posted wage premium of various security guard firms. The regressions are estimated on the Lightcast job posting data, restricted to postings for security guards in the years 2014-2015, before the merger between AlliedBarton and Universal Protection Service. Column 1 includes no control variables, while column 2 includes county and job title fixed effects. The premium is relative to the average log wage at all other firms hiring for security guards. Standard errors are clustered at the county level.

Table 2: Impact of Exposure to Merger on Market-Level Outcomes

	QCEW		QWI		
	(1)	(2)	(3)	(4)	(5)
	Log Wage	Log Emp	Log Hires	Log Seps	Turnover
1 SD Δ_m^{HHI}	0.024	0.003	-0.006	0.002	0.001
	(0.007)	(0.017)	(0.010)	(0.012)	(0.001)
Observations	2098	2098	2093	2086	2053
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Services merger on county-level outcomes. In Columns 1-2, the outcomes are measured in the Quarterly Census of Employment and Wages. In Columns 3-5, the outcomes are measured in the Quarterly Workforce Indicators. The coefficient displayed is the impact of a 1 standard deviation increase in the exposure measure, where Δ_m^{HHI} is the predicted change in HHI. Standard errors are clustered at the county level.

Table 3: Impact of Merger on Allied Universal Job Posting Characteristics

	(1) Transparency	(2) Benefits	(3) Log Wage
Allied	-0.277	0.712	0.078
	(0.017)	(0.013)	(0.011)
Observations	822130	822130	204929
Firm-County-Title FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table estimates the direct impact of the AlliedBarton and Universal Protection Services merger on the characteristics of Allied Universal postings. Column 1 estimates the impact on the probability a job posting contains salary information, column 2 estimates the impact on the probability a job posting contains a mention of medical or dental benefits, column 3 estimates the impact on the log posted wage. Standard errors are clustered at the county level.

Table 4: Impact of Exposure to Merger on Job Posting Characteristics

	G4S/Securitas			Other Firms		
	(1)	(2)	(3)	(4)	(5)	(6)
	Transparency	Benefits	Log Wage	Transparency	Benefits	Log Wage
1 SD Δ_m^{HHI}	-0.028	0.030	0.026	0.026	-0.003	0.017
	(0.012)	(0.010)	(0.004)	(0.006)	(0.008)	(0.006)
Observations	120519	120519	50421	378326	378326	91084
Firm-County-Title FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Services merger on the probability of a job posting containing salary information (columns 1 and 4), the probability of a job posting containing a mention of medical or dental benefits (columns 2 and 5) and the log posted wage (columns 3 and 6). In columns 1-3, the sample is restricted to the firms G4S and Securitas. In columns 4-6, the sample contains all firms posting for security guards, excluding Allied Universal, G4S and Securitas. The coefficient displayed is the impact of a 1 standard deviation increase in the exposure measure, where Δ_m^{HHI} is the predicted change in HHI. Standard errors are clustered at the county level.

Table 5: Impact of Exposure to Merger on Log Award Spending

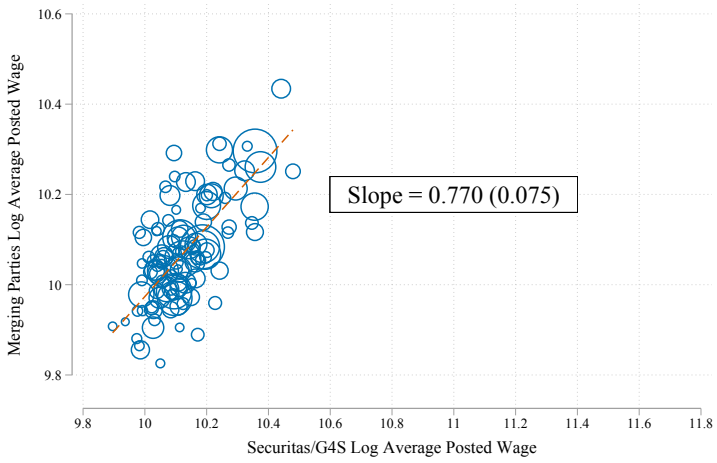
	Log Award Amount				
	Main	Winsorized	Different FE	Small Awards	All Awards
	(1)	(2)	(3)	(4)	(5)
1 SD Δ_m^{HHI}	0.310	0.305	0.119	0.495	0.183
	(0.128)	(0.129)	(0.084)	(0.219)	(0.103)
Observations	2016	2016	4958	3689	5058
County-by-Description FE	Yes	Yes	Yes	Yes	Yes
County-by-Award Type FE	No	No	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Services merger on the log spending for federal contract awards in the security guard industry (NAICS code 561612). Data come from usaspending.gov for the years 2014-2019. The main sample in column 1 only contains awards that specify a contract length of at least a year and are for at least $10,000. Colum 2 winsorizes award amounts at the 99th percentile. Column 3 includes a fixed effect for the county-by-award type rather than the county-by-description, as in Column 1. Column 4 adds in awards that are less than $10,000. Finally, Column 5 adds in awards of any length above 1 day. The coefficient displayed is the impact of a 1 standard deviation increase in the exposure measure, where Δ_m^{HHI} is the predicted change in HHI. Standard errors are clustered at the county level.

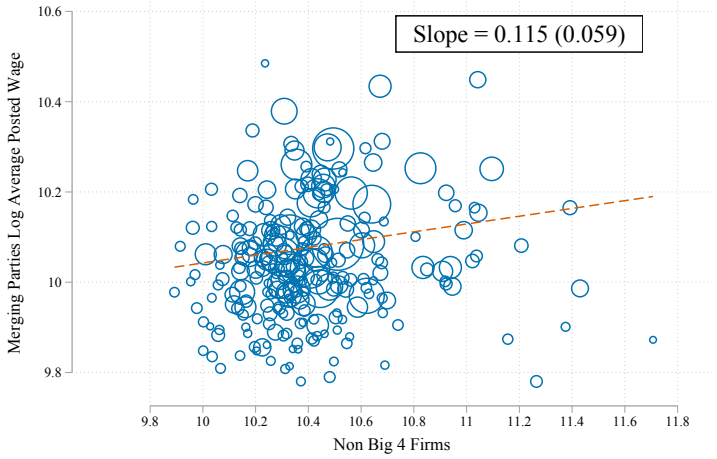
Appendix: For Online Publication

Appendix A. Additional figures and tables

Appendix Figure A1: Correlation in Log Average Posted Wages Between Merging Parties and Other Firms: County-Level Analysis



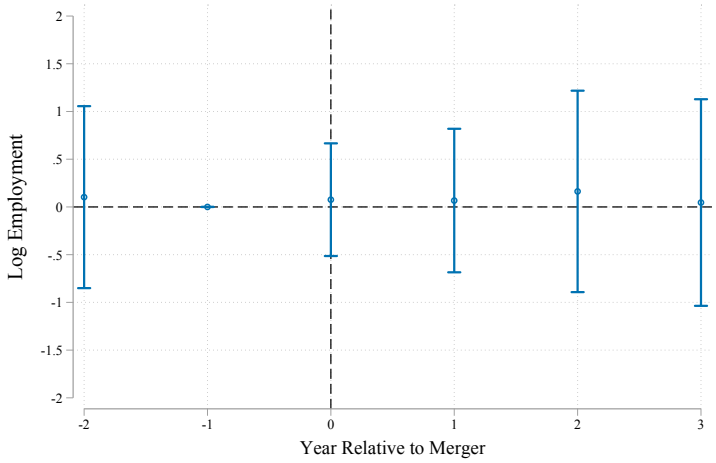
(a) Correlation with Securitas and G4S



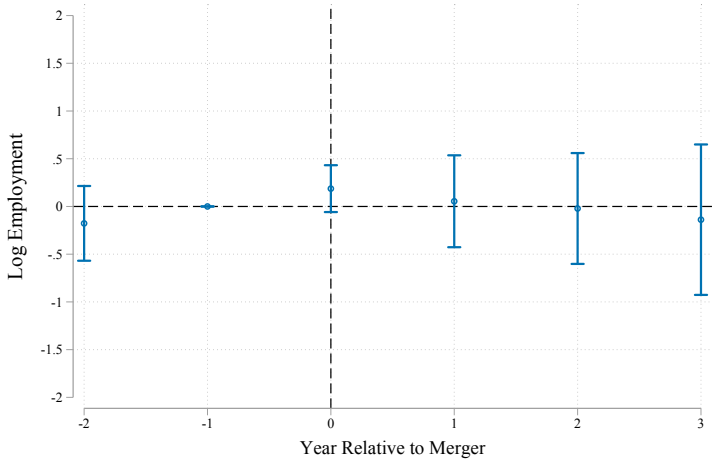
(b) Correlation with all Other Firms

Note: The figure correlates the average log posted wage in a county in 2014-2015 for AlliedBarton and Universal Protection Service against other firms average log posted wages in the county. Panel (a) plots average county-level log posted wages for AlliedBarton and Universal Protection Service against Securitas and G4S, the second and third-largest security guard firms following the merger of AlliedBarton and Universal Protection Service to form Allied Universal. Panel (b) plots average county-level log posted wages for AlliedBarton and Universal Protection Service against all other firms, excluding Securitas and G4S. Markers are proportional to the total number of postings.

Appendix Figure A2: Impact of Merger on Market-Level Employment



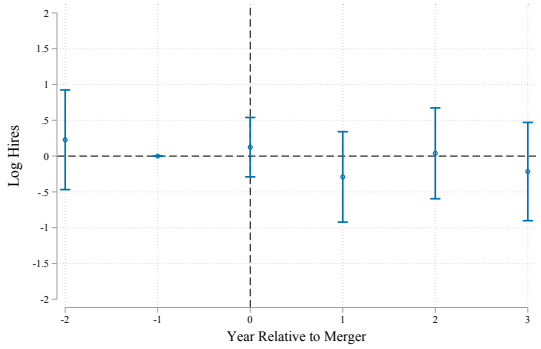
(a) Change in Employment in QCEW



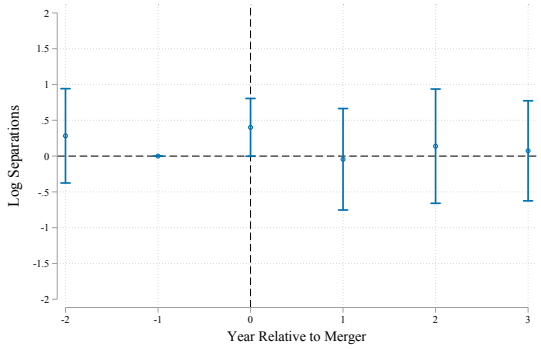
(b) Change in Employment in QWI

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on county-level log employment. Exposure is measured as the predicted change in county-level concentration, estimated using Lightcast job posting data. Panel (a) measures employment using the Quarterly Census of Employment and Wages, while Panel (b) measures employment using the Quarterly Workforce Indicators. Standard errors are clustered at the county level with 95% confidence intervals displayed in the figure.

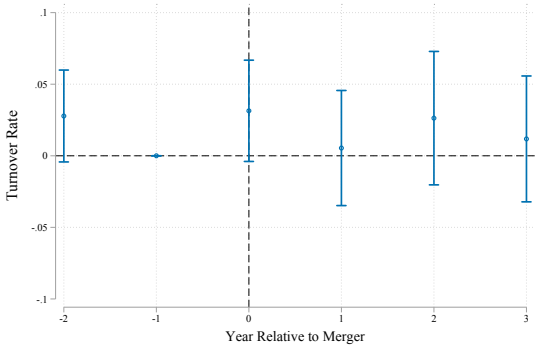
Appendix Figure A3: Impact of Merger on Market Outcomes in the QWI



(a) Impact on Log Hires



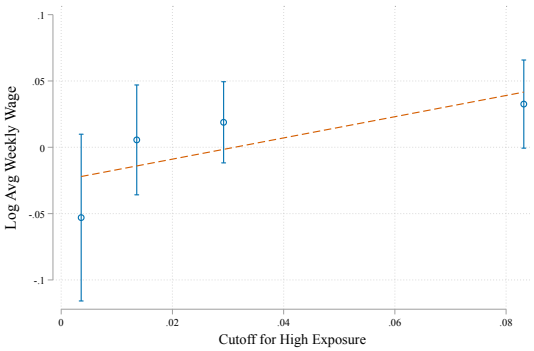
(b) Impact on Log Separations



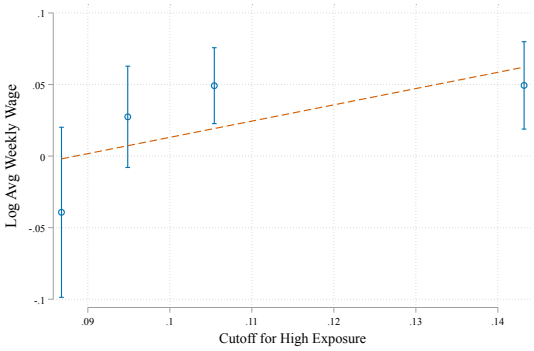
(c) Impact on Turnover Rate

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on various county-level outcomes. Exposure is measured as the predicted change in county-level concentration, estimated using Lightcast job posting data. In Panel (a) the outcome is the total number of stable hires in the county. In Panel (b) the outcome is the total number of stable separations in the county. A stable hire is a hire that begins in the county and continues throughout the quarter, while a stable separation is a separation that occurs during the quarter and the worker is not re-employed at the same firm by the end of the quarter. In Panel (c) the outcome is the turnover rate, which is computed in the QWI by adding the number of stable hires in the reference quarter and stable separations in the next quarter, and dividing by the average full-quarter employment. Standard errors are clustered at the county level with 95% confidence intervals displayed in the figure.

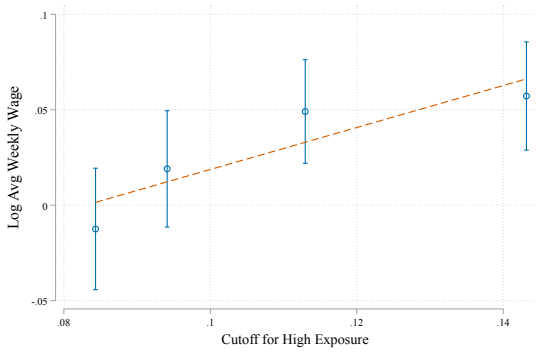
Appendix Figure A4: Impact of Merger on County-Level Earnings by Exposure Level



(a) Exposure Definition: Change in HHI



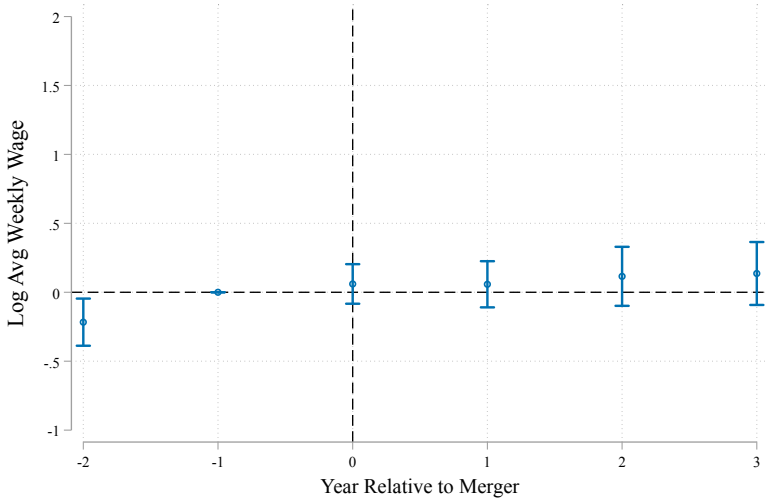
(b) Exposure Definition: Predicted Heterogeneity by LASSO



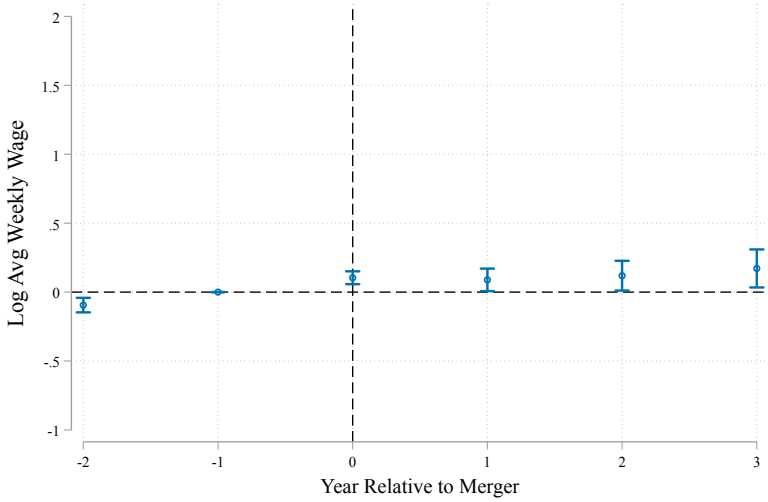
(c) Exposure Definition: Predicted Heterogeneity by Random Forest Using Honest Splitting

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on county-level earnings for highly exposed markets. For each marker, a labor market is defined as highly exposed if the county-level measure of exposure is larger than or equal to the value in the horizontal axis. In Panel (a) exposure is defined by the change in HHI, Panel (b) defines it as the change in wages predicted by a LASSO that uses market shares of the merging firms and competitors as the features, while Panel (c) defines it as the change in wages predicted by a Random Forest model with honest splitting. For details on the construction of the alternative exposure measures see Appendix B. Standard errors are clustered at the county level with 95% confidence intervals displayed in the figure.

Appendix Figure A5: Difference-in-Differences: Impact of Merger on County-Level Earnings in Control Industries



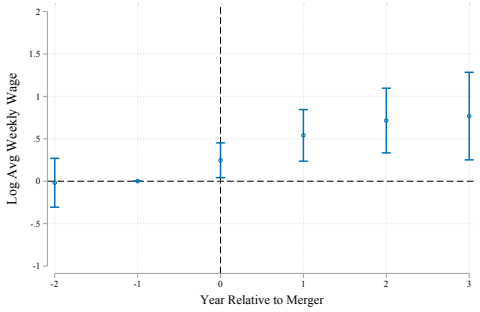
(a) Impact of Merge on County-Level Average Weekly Wage: Construction Industry



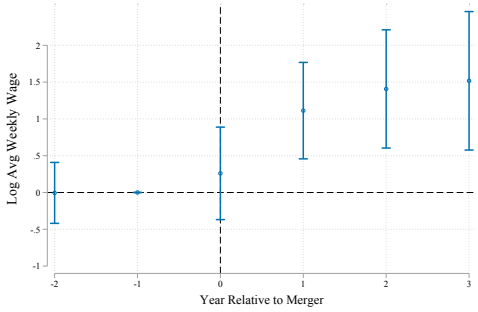
(b) Impact of Merge on County-Level Average Weekly Wage: Restaurants and Food Services Industry

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on county-level earnings. Exposure is measured as the predicted change in county-level concentration, estimated using Lightcast job posting data. In Panel (a) the outcome is the log average weekly wage in the construction industry, while in Panel (b) the outcome is the log average weekly wage in the restaurant and food services industry. The vertical scaling was chosen to match the scaling for the main results that presented impacts on the security guard industry. 95 percent confidence intervals clustered at the county level are displayed in the figure.

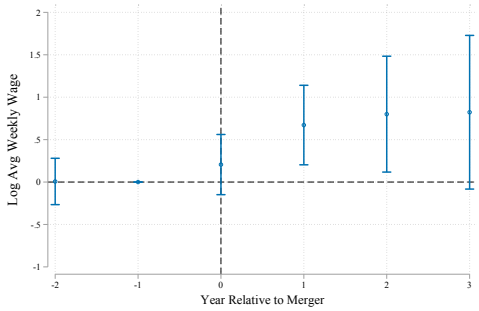
Appendix Figure A6: Impact of Merger on Market-Level Earnings for Different Exposure Measures



(a) Earnings Impact for Concentration Exposure



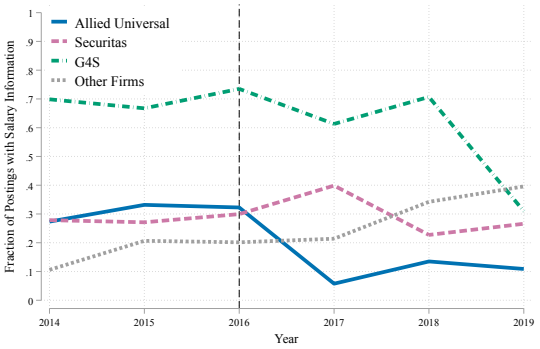
(b) Earnings Impact for LASSO Exposure



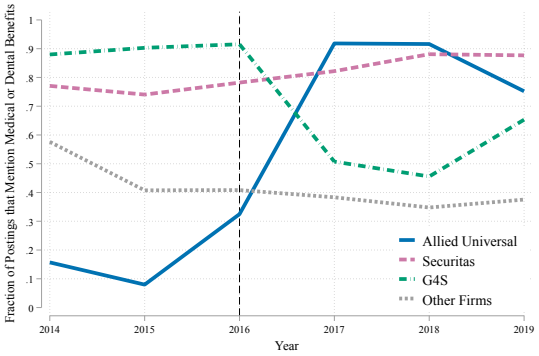
(c) Earnings Impact for Random Forest Exposure

Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on county-level earnings. In all panels, the explanatory variables of interest are time indicators interacted with the predicted county-level exposure. In Panel (a), exposure is measured using the predicted change in concentration due to the merger. In Panel (b), exposure is measured using the predicted county-level changes in wages estimated via LASSO. In Panel (c) exposure is measured using the predicted county-level changes in wages estimated via a Random Forest algorithm with honest splitting. For details on how these alternative exposure metrics are constructed see Appendix B. Standard errors are clustered at the county level. 95 percent confidence intervals are displayed in the figure.

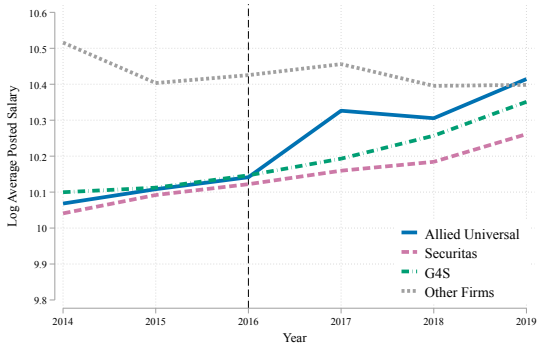
Appendix Figure A7: Trends in Outcomes Across Security Guard Firms



(a) Trends in Pay Transparency



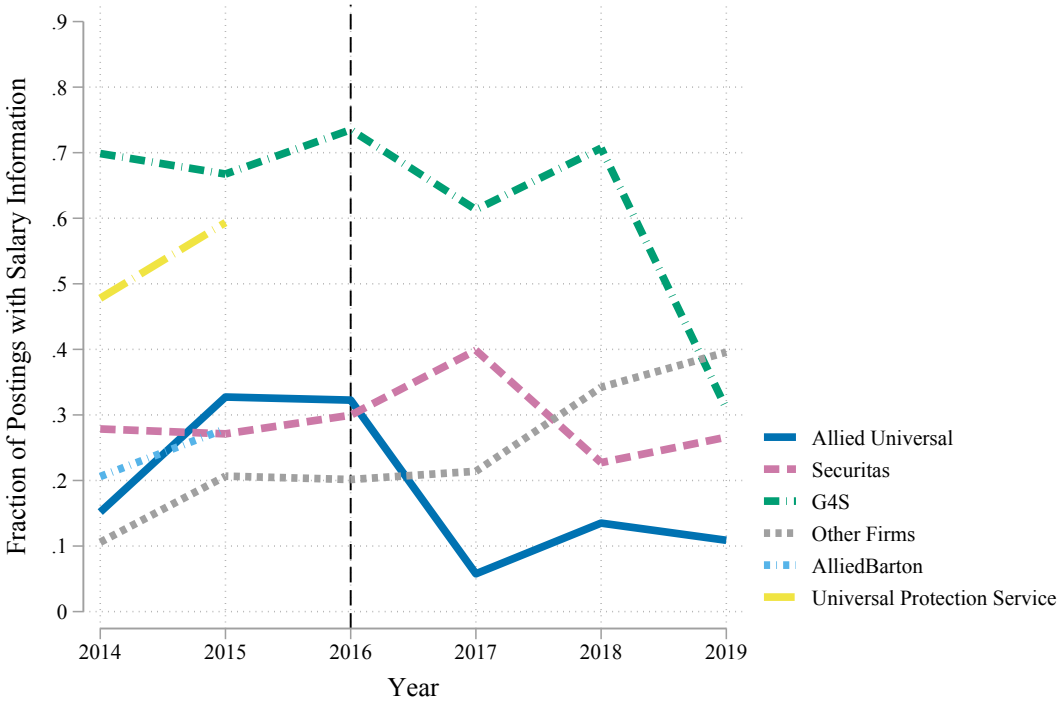
(b) Trends in Medical/Dental Benefits Mentioned in Job Posting



(c) Trends in Posted Wages

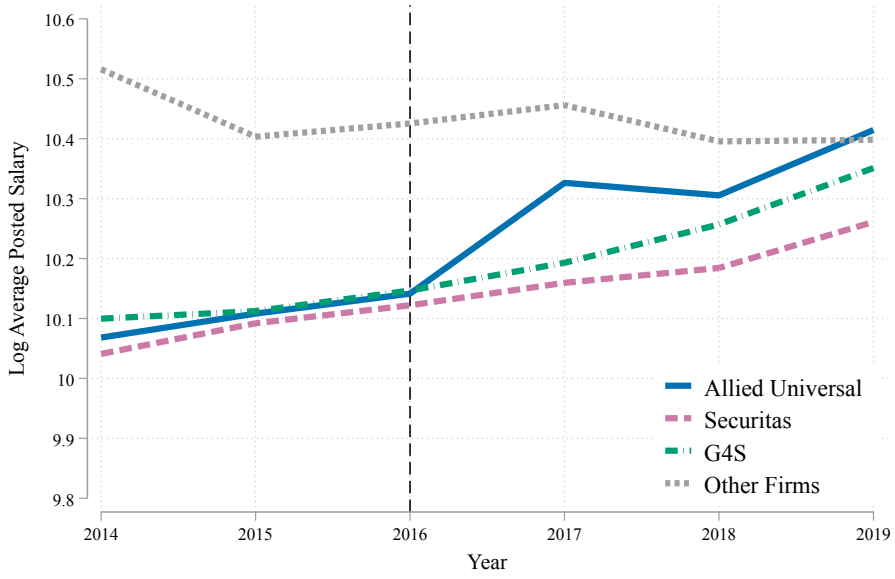
Note: Panel (a) plots the fraction of job postings that contain salary information. Panel (b) plots the fraction of postings that mention either medical or dental benefits for various security guard firms. Panel (c) plots the log average posted wage. In the period before the merger, AlliedBarton and Universal Protection Service posts are aggregated to form the Allied Universal averages.

Appendix Figure A8: Trends in Transparency For Security Guard Postings by Firm

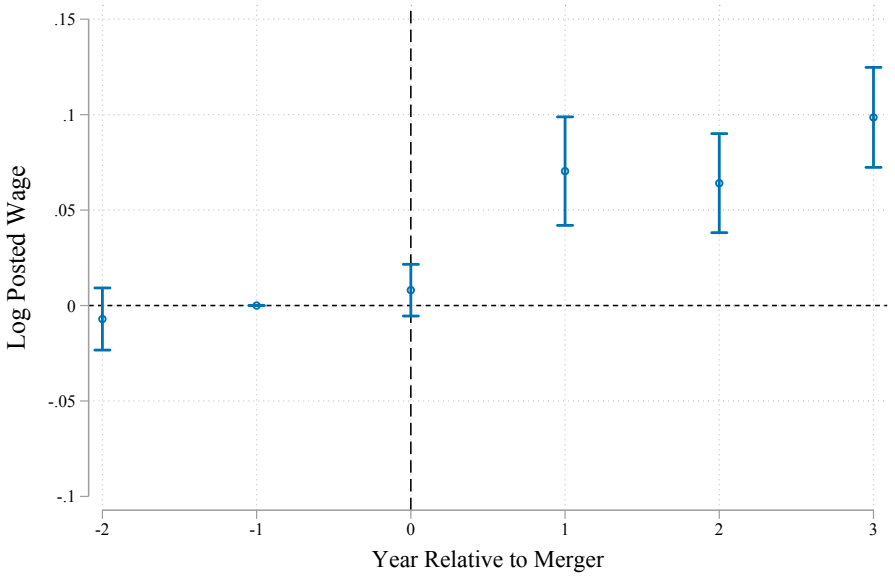


Note: This figure plots the fraction of job postings that contain salary information over time for AlliedBarton, Universal Protection Service, Allied Universal, Securitas, and G4S.

Appendix Figure A9: Impact of Merger on Allied Universal Posted Wage



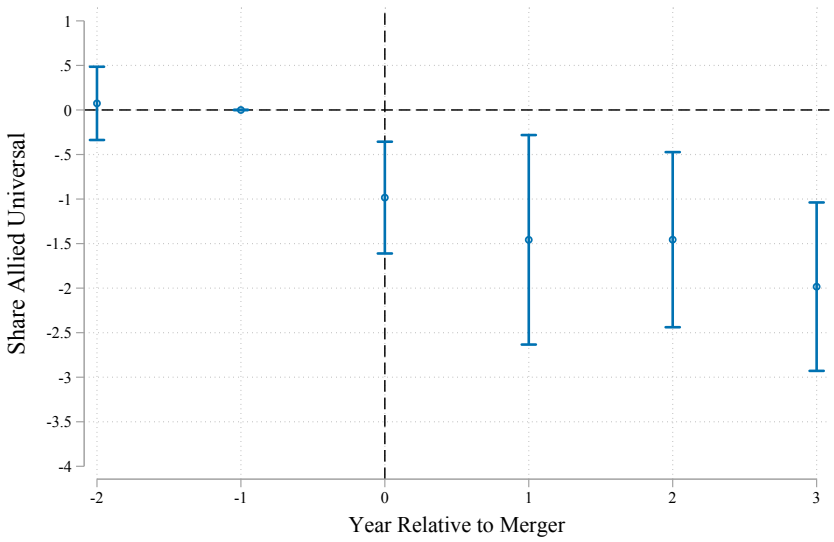
(a) Trends in Log Average Posted Wage Across Firms



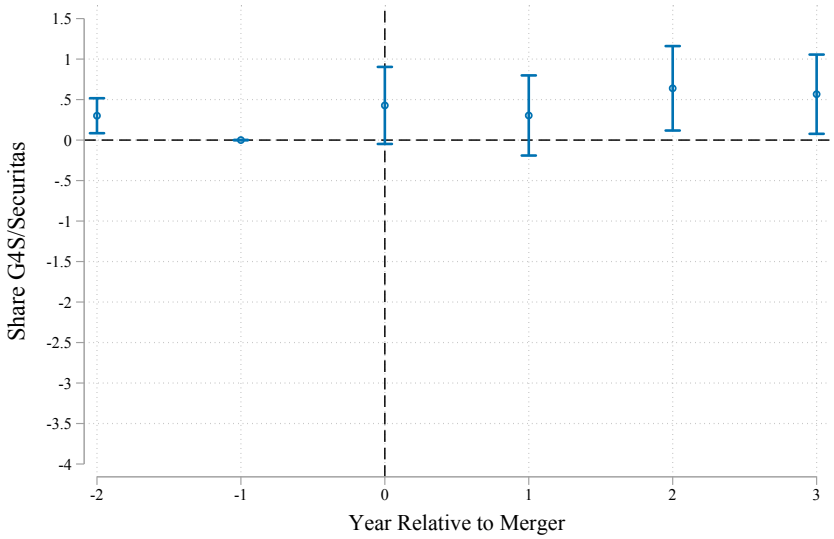
(b) Change in Log Average Posted Wage for Allied Universal

Note: Panel (a) plots the log average posted salary across different firms. In the period before the merger, AlliedBarton and Universal Protection Service posts are aggregated to form the Allied Universal averages. Panel (b) plots the impact of the merger on the log average posted salary at Allied Universal. These regressions condition on a salary being present in the job posting. The specification includes firm-by-title-by-county fixed effects and job title-by-year fixed effects. Standard errors are clustered at the county level. 95 percent confidence intervals are displayed in the figure.

Appendix Figure A10: Impact of Exposure to Merger on Posting Shares at the County Level



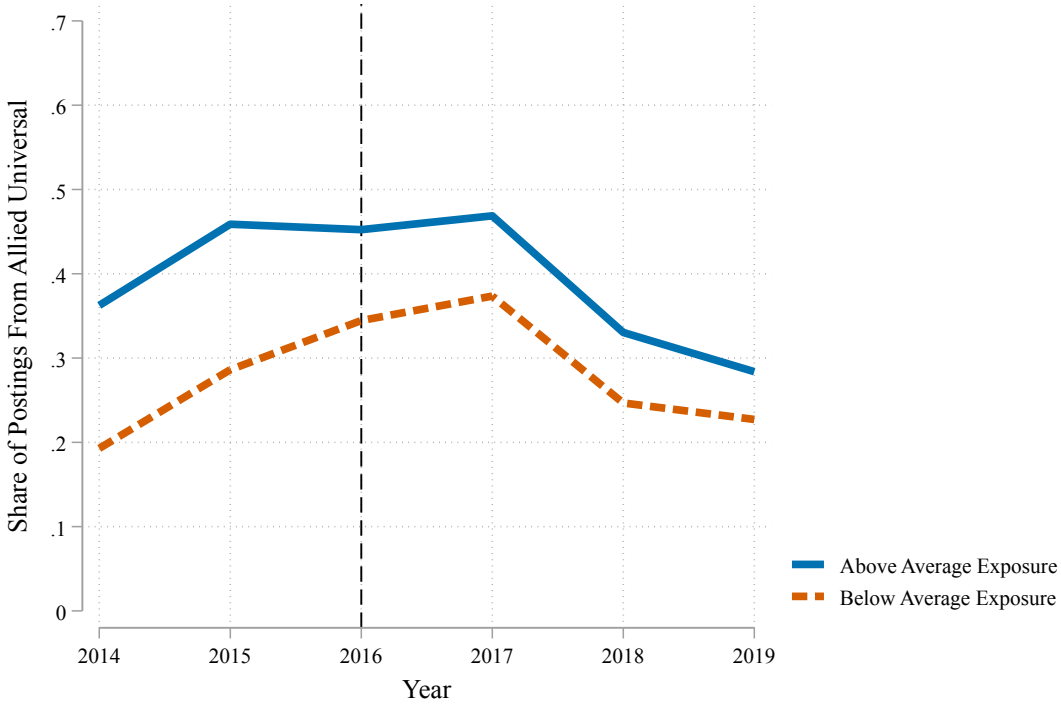
(a) Allied Universal Share



(b) G4S/Securitas Share

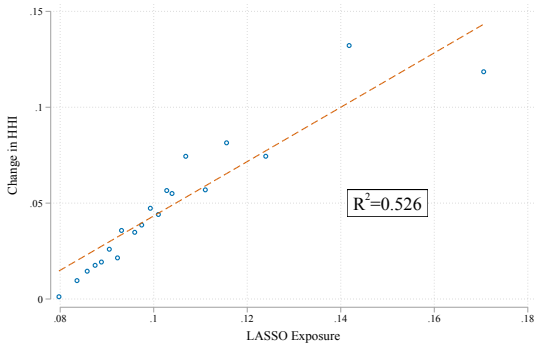
Note: This figure estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on the share of postings in a county using a dynamic difference-in-differences design. Exposure is measured as the predicted change in county-level concentration, estimated using Lightcast job posting data. Panel (a) plots the impact on the fraction of postings in the county that are for Allied Universal. In the pre-period, AlliedBarton and Universal Protection Service job postings are combined to form Allied Universal. Panel (b) plots the impact on the fraction of postings in the county that are for either G4S or Securitas. The unit-of-observation in these specifications is the county and all specifications include county and year fixed effects. Standard errors are clustered at the county level. 95 percent confidence intervals are displayed in the figure.

Appendix Figure A11: Trends in Share of Postings for Allied Universal by County-Level Exposure

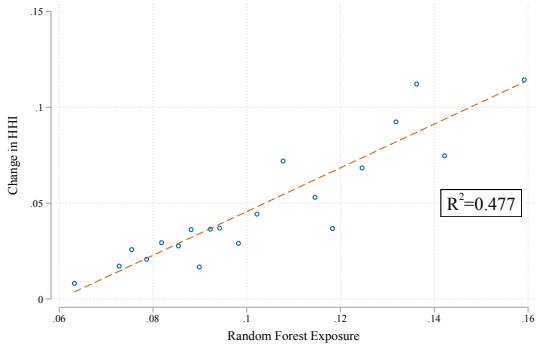


Note: This figure plots the average fraction of postings for Allied Universal separately for counties with above the average level of exposure and below the average level of exposure, where exposure is measured as the predicted change in county-level concentration, estimated using Lightcast job posting data.

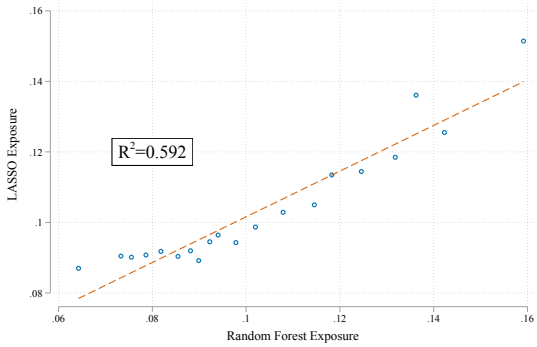
Appendix Figure A12: Correlation Between Different Exposure Metrics



(a) Correlation between HHI Change and LASSO Exposure



(b) Correlation between HHI Change and Random Forest Exposure



(c) Correlation between LASSO Exposure and Random Forest Exposure

Each figure presents a binned scatter plot of different exposure measures and presents the corresponding R-squared. Panel (a) presents changes in HHI vs. LASSO exposure, Panel (b) presents changes in HHI vs. Random Forest exposure, while Panel (c) presents LASSO exposure vs. Random Forest Exposure.

Appendix Table A1: Contract Between San Diego and Allied Universal Effective 07/01/2021

Staff	**Weekly Hours**	**Pay Rate**	**Markup**	**Bill Rate**	**Overtime**
AM	40	$30.00	1.51	$45.30	NA
Supervisor	112	$19.24	1.51	$29.05	$43.58
Grave Shift Rover	112	$16.54	1.51	$24.98	$37.47
Core	320	$16.54	1.51	$24.98	$37.47
Columbia	40	$16.54	1.51	$24.98	$37.47
Gaslamp	240	$16.54	1.51	$24.98	$37.47
East Village	720	$16.54	1.51	$24.98	$37.47
Marina	80	$16.54	1.51	$24.98	$37.47
Cortez	40	$16.54	1.51	$24.98	$37.47

Note: This table presents the terms on a contract between Allied Universal and the city of San Diego that was effective 07/01/2021. This table is an exact replica of a portion of a table that appears in the publicly available contract, with no additional columns added by the researcher. AM stands for Account Manager. A Grave Shift Rover is the term used for security guards who work night shifts. Core, Columbia, Gaslamp, East Village, Marina, and Cortez are areas within San Diego.

Appendix Table A2: Impact of Exposure to Merger on Market-Level Earnings: Binary Treatment Equal to Above Average Exposure

	QCEW		QWI		
	(1)	(2)	(3)	(4)	(5)
	Log Wage	Log Emp	Log Wage	Log Emp	Turnover
Above Average HHI	0.030	0.001	0.023	-0.018	0.001
	(0.017)	(0.024)	(0.012)	(0.018)	(0.002)
Observations	2098	2098	2097	2098	2053
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Services merger on county-level earnings. Rather than continuous exposure measures, this table defines a market as exposed if the market has a predicted concentration increase that is above average. Columns 1-2 study outcomes in the Quarterly Census of Employment and Wages while Columns 3-5 study outcomes in the Quarterly Workforce Indicator. Standard errors are clustered at the county level.

Appendix Table A3: Impact of Exposure to Merger on Market-Level Earnings: Measuring Exposure at the Commuting Zone Level

	QCEW		QWI		
	(1)	(2)	(3)	(4)	(5)
	Log Wage	Log Emp	Log Wage	Log Emp	Turnover
1 SD Δ_m^{HHI}	0.024	0.016	0.018	0.002	0.002
	(0.009)	(0.010)	(0.005)	(0.008)	(0.001)
Observations	2092	2092	2091	2092	2047
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Services merger on county-level earnings. Rather than measuring exposure at the county level, this specification measures exposure at the commuting zone level (i.e. to construct the change in concentration, I compute the shares of postings in a commuting zone, rather than a county). Columns 1-2 study outcomes in the Quarterly Census of Employment and Wages while Columns 3-5 study outcomes in the Quarterly Workforce Indicator. The coefficient displayed is the impact of a 1 standard deviation increase in the exposure measure, where Δ_m^{HHI} is the predicted change in HHI. Standard errors are clustered at the commuting zone level.

Appendix Table A4: Impact of Merger on Log Posted Wages of Other Firms: Lee Bounds

	G4S/Securitas Log Wage			Other Firms' Log Wage		
	(1)	(2)	(3)	(4)	(5)	(6)
	Effect	Lower Bound	Upper Bound	Effect	Lower Bound	Upper Bound
Above Avg Exposure	0.027	0.016	0.035	0.016	-0.050	0.071
	(0.007)	(0.003)	(0.003)	(0.020)	(0.007)	(0.006)
Observations	68270	68270	68270	113035	113035	113035

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Service merger on log posted wages for G4S/Securitas (Columns 1-3) and all other firms hiring for security guards (Columns 4-6). The explanatory variable in the regression is whether the job posting is located in a county with above or below average exposure. The main effect is the point estimate, while columns 2,3 and 5,6 present Lee bounds on the estimated effect. The reason there is selection in this setting is because only a subset of postings have salary information available, and there is an impact of the exposure to the merger on the presence of salary information. For more details on the bounding procedure see Appendix C.

Appendix Table A5: Impact of Exposure to Merger on Job Posting Characteristics of Large Firms

	(1) Transparency	(2) Benefits	(3) Log Wage
1 SD Δ_m^{HHI}	-0.016	0.027	0.027
	(0.009)	(0.010)	(0.004)
Observations	136126	136126	54938
Job FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Services merger on the probability of a job posting containing salary information, the probability of a job posting containing a mention of medical or dental benefits, and the log posted wage. The sample is restricted to the G4S, Securitas, and U.S. Security Associates. The coefficient displayed is the impact of a 1 standard deviation increase in the exposure measure, where Δ_m^{HHI} is the predicted change in HHI. Standard errors are clustered at the county level.

Appendix Table A6: Summary Statistics for Spending Awards from usaspending.gov

	Mean	Median
Panel (a): All Security Contracts	(1)	(2)
Award Amount	1,125,028	10,570
Contract Length (Days)	343	364
Department of Justice	0.69	
Department of Defense	0.03	
Department of Homeland Security	0.16	
Observations	14525	14525
Panel (b): Main Analysis Sample		
Award Amount	2,793,968	75,000
Contract Length (Days)	487	364
Department of Justice	0.57	
Department of Defense	0.04	
Department of Homeland Security	0.24	
Observations	5201	5201

Note: This table presents summary statistics on the sample of awards used to estimate the impact of exposure on the amount spent on security guard contracts by the federal government. The data comes from usaspending.gov. Panel (a) presents summary statistics for all security guard contracts while Panel (b) presents summary statistics for the main analysis sample which includes contracts that are at least one year long and for at least $10,000.

Appendix Table A7: Impact of Exposure to Merger on Job Posting Shares

	Share Allied	Share Securitas/G4S
	(1)	(2)
1 SD Δ_m^{HHI}	-0.059	0.018
	(0.017)	(0.009)
Observations	2098	2098
County FE	Yes	Yes
Year FE	Yes	Yes

Note: This table estimates the impact of exposure to the AlliedBarton and Universal Protection Services merger on the share of postings in the county for Allied Universal (Column 1) and share of postings in the county for either Securitas or G4S (Column 2). The coefficient displayed is the impact of a 1 standard deviation increase in the exposure measure, where Δ_m^{HHI} is the predicted change in HHI. Standard errors are clustered at the county level.

Appendix Table A8: Predicting Wage Changes Via LASSO

Variable	Coefficient
Constant	0.08
UPS Share	0.32
UPS Share X AlliedBarton Share	0.09

Note: This table presents the results of the LASSO model which predicts county-level changes in wages using shares of major firms (AlliedBarton, Universal Protection Service, Securitas, G4S, and all other firms), squared terms of all shares, and interactions of all shares. The non-zero coefficients are displayed in the table above. The optimal λ was chosen by cross-validation with 10 folds.

Appendix B. Alternative Exposure Metrics

In this section, I test whether more flexible functional forms of market shares better predicts heterogeneity in wage impacts of the merger. To operationalize flexible formulations of exposure, I will utilize simple machine learning methods to predict wage changes across markets. Instead of including market shares only of the merging parties, as the change in HHI metric does, I also include market shares of the major competitors: G4S and Securitas, the remaining market share of all other firms, as well as interactions between all of these shares. If the impact of the merger depends crucially on whether the other firm in the market is G4S, then the machine-learning methods will choose interactions between the merging parties and G4S as important features in the model. A weakness of this approach of course is that is not feasible in a prospective merger analysis, where the two parties have not yet merged. It relies on predicting wage outcomes after the merger has been finalized. However, the goal here is to show robustness to the primary exposure metric used in the paper, not to produce a measure that can necessarily be used in prospective merger analysis.

To begin I compute the percent change in the average weekly wage in QCEW between a post-period (2018-2019) and pre-period (2014-2015). Let ΔW_m be the percent change average weekly wages in market m between the post and pre period. The first prediction will use a Least-Absolute Shrinkage Operator (LASSO). This prediction will take the form of:

$$\Delta W_m^{LASSO} = \underbrace{\sum_{i=1}^{2} \hat{\beta}_i^{LASSO} \cdot s_i + \sum_{i=1}^{2}\sum_{k=1}^{J} \hat{\beta}_{i,k}^{LASSO} \cdot s_i \cdot s_k}_{\text{Merging Party Shares/Interactions}} + \underbrace{\sum_{i=3}^{J} \hat{\beta}_i^{LASSO} \cdot s_i + \sum_{i=3}^{J}\sum_{k=3}^{J} \hat{\beta}_{i,k}^{LASSO} \cdot s_i \cdot s_k}_{\text{Other Party Shares/Interactions}} \tag{15}$$

In words, the change in market-level wages is predicted from initial market shares s_i, squared market shares $(s_i \cdot s_i)$ as well as interactions $(s_i \cdot s_k)$. In practice, when estimating the LASSO model I weight each market by the total employment in the security guard industry. The first bracketed terms all contain a market share of the merging parties. Therefore, these terms conceivably will capture the impact of the merger.

The second bracketed term includes market shares of other companies, but no market shares of the merging parties. If G4S, for example, saw substantial wage growth in this period, then it is possible markets with a higher share of G4S jobs will see higher wage growth. This is clearly not due to the merger, however, so it would not be appropriate to use the resulting ΔW_m^{LASSO} as a measure of exposure to the merger. To isolate terms that are relevant for defining exposure, there are two possible approaches. One could only include shares of merging parties and interactions with other firms in the prediction problem. Second, one could estimate the full model, but when making predictions, restrict to only features that include a share of at least one of the two merging parties. As I will discuss when turning to results, in my setting, only features that include a share of the merging parties are selected by the LASSO model, making this a straightforward approach to defining exposure.

A nice aspect of this LASSO model is that it includes the feature $(s_1 \cdot s_2)$ that appears in the simpler Δ_m^{HHI}. It is possible that the change in concentration is the key factor in predicting heterogeneity. If so, the coefficients on other shares and interactions may be set to zero by the LASSO model. A weakness of the LASSO model is that it again makes assumptions on how market shares and interactions between firms enter into an exposure measure by assuming they all enter linearly. One approach would be to generate further features that are nonlinear and add them to the LASSO prediction. However, a more straightforward approach is to use a prediction algorithm in which nonlinearity is central in the algorithm itself. Therefore, the final algorithm considered for predicting heterogeneity is a Random Forest model with Honest splitting (Wager and Athey, 2018), which I will denote ΔW_m^{RF}. Again, the features available to the algorithm will be the market shares. However, unlike the LASSO model, the market shares will be able to enter in highly nonlinear ways. If these nonlinearities are important, then the Random Forest will be able to better predict the heterogeneity in outcomes across markets. The weakness of this algorithm is that it is difficult visualize which features and interactions are most important in predicting heterogeneity.

B.1. Predicting Wage Impacts

Table A8 presents all the non-zero coefficients from the LASSO model predicting county-level changes in wages. Although there were 21 variables included in the model, only three have non-zero coefficients when the LASSO model is estimated at the optimal value of the model's tuning parameter.[20] These three coefficients are the constant, the Universal Protection Service share in the county, and the interaction between AlliedBarton and Universal Protection Service share.

There are a few takeaways from this exercise. First, if the merger did not have any impact on labor-market outcomes, it would be surprising that the only terms that are selected are terms associated with the merging parties. Second, the coefficients are in the opposite sign than would be predicted if the only impact of the merger was to increase monopsony power in the labor market. This is most starkly seen perhaps in the coefficient for the term that interacts UPS Share and AlliedBarton Share. This term is directly proportional to the change in HHI caused by the merger. However, the coefficient is positive, indicating that areas with larger predicted changes in concentration experience greater wage growth than other areas.

Given one of the two inputs in the LASSO measure is proportional to the HHI change, it is not surprising that the two are correlated in practice. Panel (a) of Figure A12 presents a binned scatter plot with the LASSO predicted change in wages on the horizontal axis and the change in HHI on the vertical axis. The two are highly correlated, with an R-squared of about 0.53. Panel (b) of Figure A12 replaces the LASSO predicted change in wages with the Random Forest predicted change in wages. Again, the Random Forest and change in HHI are highly correlated, with an

[20] The optimal penalty term λ is chosen by choosing the value of λ that minimizes the cross-validation mean-squared error with 10 folds. The 21 variables are the 5 main shares, 15 interactions, which include the squared terms, and the constant.

R-squared of about 0.48. Lastly, Panel (c) plots the binned scatter plot with the Random Forest predicted wage change on the horizontal axis and the LASSO predicted wage change on the vertical axis. The LASSO only depends on two linear terms, while the Random Forest will allow for much greater flexibility. Both, however, are correlated in practice. The R-squared from regressing the LASSO measure on the Random Forest measure is about 0.60.

While adding interactions and allow for nonlinearities may be crucial in other settings, I find that for the AlliedBarton and Universal Protection Service merger the various exposure measures are highly correlated in practice. Given the results for the LASSO model, it is clear that areas with a larger presence of the companies are places that experience higher-than-average wage growth. Figure A6 confirms that the results are similar across different exposure metrics.

Appendix C. Bounding Procedure

Figure 5 estimates the impact of exposure to the Allied Universal merger on the log average posted wage in job postings by estimating the following dynamic difference-in-differences specification:

$$Y_{it} = \sum_{k=-2}^{3} \delta_k \cdot \Delta_{m(i)}^{HHI} + \gamma_t + \zeta_{j(i)} + \varepsilon_{it} \tag{16}$$

Where Y_{it} is the log posted wage, $\Delta_{m(i)}^{HHI}$ is the predicted change in HHI for the market of posting i at time t. γ_t are year fixed effects that are allowed to vary by job title and $\zeta_{j(i)}$ are job fixed effects. In the main specification, a job is defined as a title, location, and firm interaction.

In this setting not all postings contain salary information, and in particular, there is a treatment effect of merger exposure on the likelihood that a posting contains salary information. The goal here is to estimate the treatment effect of exposure conditional on the posting containing salary information. To estimate bounds on this parameter I follow the procedure outlined in Lee (2009).

The methodology assumes a binary treatment. For the bounding procedure, I define exposure as equal to one if the change in concentration is greater than the average level of concentration across all counties. While Equation 16 is the main specification, it contains a variety of time effects that makes it less straightforward to apply the bounding procedure. Therefore, as an initial step, I create a residualized salary measure by first estimating:

$$sal_{it} = \gamma_t + \varepsilon_{it} \tag{17}$$

And collecting the residuals as $\tilde{sal}_{it}$. For each unit (i.e. a job title by a specific firm in a given county), I construct the average value of $\tilde{sal}_{it}$ for the pre-treatment period and post-treatment period. Let $\Delta_i(sal) = log(\tilde{sal}_i^{post}) - log(\tilde{sal}_i^{pre})$ be the change in log average salary for unit i.

Using this measure of outcomes, we can estimate an equation that is analogous to 16, but at the unit level instead of at the unit-by-time level. In simple terms, the procedure is constructing a change in wages for each unit and then regressing this change in wages on the exposure measure:

$$\Delta_i(sal) = \delta \cdot \Delta_{m(i)}^{HHI} + \varepsilon_i \tag{18}$$

Table A4 presents the results of estimating Equation 18. The coefficient δ is the treatment effect of exposure on the change in log average salary. Columns 1-3 correspond to a sample that restricts to G4S and Securitas, which are Allied Universal's largest competitors. I find that areas with high exposure experience a 2.6 percent increase in log average salary. Columns 2 and 3 present worst-case bounds on selection, constructing these following Lee (2009). In the sample, the treatment group (i.e. exposed to merger) has more selection than the control group (i.e. not exposed to merger). To form bounds, Lee (2009) proposes trimming the outliers of the distribution. In my setting, the trimming will drop the highest values of $\Delta_i(sal)$ in the control group until the selected fraction is equal to the selected fraction in the treatment group. This will form the upper bound

on the treatment effect as it will lower the average earnings in the treatment group. To form the lower bound, the lowest values of $\Delta_i(sal)$ for the control group are dropped.

As can be seen in Columns 2 and 3, the bounds are quite tight, with the lower bound still finding a 1.6 percent increase in wages for the treatment group. This implies the main results are robust to assuming the worst-case scenario for selection. Applying this procedure to other firms, the bounds are wider. While the point estimate is still positive, the bounds now contain zero.

Appendix D. Additional Details on Conceptual Model

In the model, there are three different stakeholders: purchasing firms (or government departments), security guard firms, and workers. The first part of the model illustrates a model of price negotiation between purchasing firms and security guard firms.

I assume purchasing firms have idiosyncratic preferences over security guard firms. The utility of a purchasing firm i from hiring security guard firm j is given by $U_{ij} = v_{ij} - b_{ij} \cdot L$, where v_{ij} is the idiosyncratic preference of purchasing firm i for security firm j, b_{ij} is the billing rate charged to firm i by firm j, and L is the number of security guards required for the given contract. Let $z_{i,-j}$ be the maximum value of v_{ij} across all other security guard firms. This is the value the buying firm i associates with the second-best option. I assume the billing rate is determined by a Nash-in-Nash bargaining solution given by:

$$b_{ij} = \arg\max_b \left(b \cdot L - w \cdot L - c_R(L)\right)^{\alpha} \left(v_{ij} - b \cdot L - z_{i,-j}\right)^{1-\alpha} \tag{19}$$

One nice feature of this setup is that Miller (2014) shows that the solution to this Nash bargaining problem is equivalent to a second-score auction model. In practice, how contracts for security guards are determined does depend on the context. Any results here do not depend necessarily on the process being a bilateral negotiation, but also applies in auction settings.

Taking the first order condition with respect to b yields the optimal billing rate:

$$b_{ij} = \alpha \cdot (v_{ij} - z_{i,-j}) + (1-\alpha) \cdot \left(\frac{w \cdot L + c_R(L)}{L}\right) \tag{20}$$

The billing rate charged for contract i is a weighted average of the surplus the purchasing firm receives $(v_{ij} - z_{i,-j})$ and the average cost of labor for the job $(\frac{w \cdot L + c_R(L)}{L})$. If the security firm has all the bargaining power ($\alpha = 1$), then the billing rate chosen extracts all the surplus from the purchasing firm. If the purchasing firm has all the bargaining power ($\alpha = 0$), then the billing rate is equal to the average cost of labor.

So far, the model has taken w as given. Next, I add a labor-side of the model to make the wage endogenous. To do so, I set up a similar bargaining model between the workers and the firm.

$$w = \arg\max_w \left(b \cdot L - w \cdot L - c_R(L)\right)^{\gamma} \left((w - o) \cdot L\right)^{1-\gamma} \tag{21}$$

Where o is the outside option for the worker. γ is the bargaining power of the firm when it negotiates with labor. The structure of this problem is identical to the structure of the bargaining problem between the security firm and the purchasing firm. The first order condition with respect to w allows one to solve for the equilibrium wage:

$$w = \gamma \cdot o + (1-\gamma) \cdot \left(b - \frac{c_r(L)}{L}\right) \tag{22}$$

Again, if the security firm has all the bargaining power ($\gamma = 1$), then the wage is equal to the

outside option for the worker. If the worker has all the bargaining power ($\gamma = 0$), then the wage is equal to the billing rate minus the average recruiting cost. This value of the wage implies that the firm makes zero profits in equilibrium.

Next, I plug the billing rate into the wage equation to solve for the equilibrium wage in terms of the model primitives.

$$w = \frac{1}{\alpha + \gamma - \alpha \cdot \gamma} \left(\alpha \cdot o + (1 - \gamma) \cdot \alpha \cdot \left(v_{ij} - z_{i,-j} - \frac{c_r(L)}{L} \right) \right) \tag{23}$$

Next, I consider two channels through which wages may increase due to a merger. The first is that competition in the product market decreases. This can be conceptualized in a fall in the value of $z_{i,-j}$. In a second price auction, for example, the value of $z_{i,-j}$ is the value associated with the second-best option. If the merger eliminates this option from the choice set by combining two firms, then the next best option will be worse. The impact of a change in the outside option on wages is given by:

$$\frac{\partial w}{\partial z_{i,-j}} = \frac{-(1 - \gamma) \cdot \alpha}{\alpha + \gamma - \alpha \cdot \gamma} < 0 \tag{24}$$

Therefore, since $z_{i,-j}$ declines after a merger, the wages will increase. The scope of the increase depends on the bargaining power of the security firm on both sides of the market. The size of the impact is maximized when the security firm has no bargaining power on the labor-market side ($\gamma = 0$) and all the bargaining power on the product market side ($\alpha = 1$). In this case, $\frac{\partial w}{\partial z_{i,-j}} = -1$. Intuitively, if the security firm has all the bargaining power in the product market, then it can extract all the surplus in the relationship. A 1-unit change in $z_{i,-j}$ will correspond to a 1-unit change in the billing rate. Since the workers have all the power in the labor-side of the model, this 1-unit change in billing rate is fully passed through to wages.

The second channel through which wages may increase is through a change in the average recruiting cost. The impact of a change in the average recruiting cost on wages is given by:

$$\frac{\partial w}{\partial \frac{c_r(L)}{L}} = \frac{-(1 - \gamma) \cdot \alpha}{\alpha + \gamma - \alpha \cdot \gamma} < 0 \tag{25}$$

This is identical to the impact due to a change in the outside option, as the two enter the wage equation identically. Again, if the firm has all the bargaining power in the product market, but no bargaining power in the labor market, then any change in recruiting costs is fully passed through to wages. In this case, the security firm extracts all the surplus from the purchasing firm and the workers extract all the surplus from the security firm.

Given the empirical results on wages, both of these channels may rationalize the result. One important note, however, is that it is certainly possible that the outside option of workers is also changing in response to the merger. The impact of a change in the outside option on wages is given by:

$$\frac{\partial w}{\partial o} = \frac{\alpha}{\alpha + \gamma - \alpha \cdot \gamma} > 0 \tag{26}$$

Therefore, it is certainly possible that the outside option of the workers shift down as there are fewer firms in the market. The empirical results, however, show that any wage decrease is swamped by the changes in either the average recruiting cost or the outside option of the purchasing firm.

Next, I consider how to distinguish between changes in average costs and changes in outside option for purchasing firms. The key will be to consider the impact on the billing rate. Now that the optimal wage has been solved for, we can plug in the optimal wage into the billing rate equation to solve for the equilibrium billing rate, which is given by:

$$b = \frac{1}{\alpha + \gamma - \alpha \cdot \gamma} \left(\alpha \cdot (v_{ij} - z_{i,-j}) + (1 - \alpha) \cdot \gamma \cdot \left(o + \frac{c_r(L)}{L} \right) \right) \tag{27}$$

The impact of a change in the outside option of the purchasing firm on the billing rate is given by:

$$\frac{\partial b}{\partial z_{i,-j}} = \frac{-\alpha}{\alpha + \gamma - \alpha \cdot \gamma} < 0 \tag{28}$$

In contrast, an impact of a change in the average recruiting cost on the billing rate is given by:

$$\frac{\partial b}{\partial \frac{c_r(L)}{L}} = \frac{(1 - \alpha) \cdot \gamma}{\alpha + \gamma - \alpha \cdot \gamma} > 0 \tag{29}$$

Therefore, if the main channel is through a decrease in the outside option of the purchasing firm, then the billing rate will increase after the merger. This is because the next-best option for the firm has decreased, giving it less leverage in the bargaining problem.

In contrast, if the main channel is through a decrease in the average recruiting cost, then the billing rate will decrease after the merger. The cost to the security firm of providing the service has decreased, leading to increased surplus for the security firm of providing services for the job, some of which are shared with the purchasing firm. Profits of the security firm will still increase despite the lower billing rates as overall costs have declined.