Appendix E: Matching Estimators for our Merger Analysis

In order to demonstrate the robustness of our result to choices of control hospitals, we implement several matching procedures. First, we follow Dranove and Lindrooth (2003) in generating propensity score matches using a probit regression including controls for the share of hospital admissions covered by Medicare and Medicaid, whether the hospital was located in an urban area, HMO penetration, number of hospitals in the market, miles to the closest hospital, teaching status, ownership type, and the number of beds in the hospital.

We perform K-Nearest Neighbor (KNN) matching to select the 20 closest matches for each hospital using the propensity score generated from a probit regression. Specifically, we predict the probability of merger using lagged controls for monopoly, duopoly, and triopoly indicators, combined county market share of HCCI insurers, county level insurer HHI, technologies, whether the hospital was ranked by US News and World Reports, number of beds, teaching status, ownership type, median income and un-insurance rate of the county, Medicare base payment rate, and share of hospital admissions paid by Medicare or Medicaid. We then use the predicted values from the probit to select the 20 closest matches for each hospital as control observations.

We also match based on Mahalanobis distance nationally and within state using the same controls used in the KNN matching (which rely on the hospital controls we use in our main analysis □i.e. in Table V Panel B).

APPENDIX F: Robustness of Key Results in Markets Where Blue Cross and Blue Shield Insurance Plans Have High and Low Market Share

Although we provide the most comprehensive picture of privately insured spending and prices to date, we do not have claims from every insurer and, in particular, from the Blue Cross Blue Shield (BCBS) insurers. In this Appendix, we analyze the robustness of our results to focusing on segments of the data with high and low BCBS market share. The areas where the BCBS plans have high market share correspond to areas where we have low HCCI insurer market share.

We use data from HealthLeaders Interstudy to compute the BCBS market share by county (see Appendix Figure XV). The map in this figure shows the national distribution of BCBS market share. We estimate that BCBS plans account for approximately 41 percent of the privately insured market. The median county has BCBS market share of 51 percent. We use this measure directly in our hospital-level regression analyses, restricting attention to hospitals located in counties above and below the median.

In order to analyze the impact BCBS has on our spending results, we need a measure of BCBS market share by HRR. While there is not a one-to-one mapping between counties and HRRs (or even counties and zip codes), we estimate HRR level market share in the following way:

(1) We generate an estimate of zip code level market share using the counties which overlap it, weighting them by the share of residents in the zip code who live in each county;

(2) We then aggregate these zip code level market shares to the HRR level using the Dartmouth Atlas zip code to HRR crosswalk, again weighting by the fraction of the HRR who live in each zip code. We estimate the median HRR to have a BCBS market share of 47 percent, and present our spending results separately for HRRs above and below the median.

Appendix F1: Correlation of Private Health Spending Per Beneficiary and Medicare Spending Per Beneficiary

BCBS market share is not strongly correlated with private health spending per beneficiary on the HCCI beneficiaries. There is a -0.064 correlation between total private spending per beneficiary in our HCCI data and BCBS county-level market share. There is a -0.026 correlation between private inpatient spending per beneficiary in our HCCI data and BCBS county-level market share. In Section III.A, we show that there is a 0.044 correlation across all HRRs in total spending per Medicare beneficiary per HRR and total spending per privately insured beneficiary per HRR. We also find a 0.172 correlation across all HRRs in inpatient spending per Medicare beneficiary per HRR and inpatient spending per privately insured beneficiary per HRR. In Appendix Table XXV, we segment our sample into HRRs in which we estimate BCBS to have market share above and below 47 percent. As can be seen, the correlations differ little between high and low BCBS areas.

Appendix F2: Decomposing the Drivers of Spending Per Beneficiary into the Contributions of Price and Quantity

In Section III.B, we decompose the drivers of inpatient spending variation on the privately insured into the relative contributions of price variation and quantity variation across HRRs in the US. We find that across the nation, variation in hospital prices drives 49.6 percent of the

variation in inpatient spending and variation in the quantity of each DRG provided across HRRs accounts for 49.5 percent of the variation (the remainder is captured by a covariance term). In Appendix Table XXVI we redo this analysis on the 153 HRRs with BCBS market share above 47 percent and the half of HRRs with BCBS below 47 percent.

As these results demonstrate, we see a similar role for prices and quantities to drive spending variation in HRRs where BCBS plans have above and below median market shares.

Appendix F3: Variation in Hospital Prices

We find significant variation in hospital prices across HRRs, within HRRs, and within hospitals. In Table III, we identify the share of the variation explained by a combination of HRR fixed effects, hospital fixed effects, and controls for plan characteristics. We found that including HRR fixed effects capture 33.5 percent of the national variation in hospitals MRI prices and introducing hospital fixed effects captures 78.0 percent of price variation, which implies that roughly 22 percent of the variation in MRI prices across the nation occurs within hospitals. In Appendix Table XXVII we recreate Table III for the half of counties with BCBS market share below 51 percent and the half of counties with BCBS market share above 51 percent.

These results are nearly identical to our main results and the key findings do not differ as a function of the BCBS market share.

In addition, we report the national coefficient of variation across our main procedures across HRRs, within HRRs, and within hospitals by month. For lower limb MRIs, the coefficient of variation across hospitals in the US is 0.40, the average within HRR coefficient of variation across hospitals is 0.31, and the average within hospital, within month coefficient of variation for lower-limb MRIs is 0.17. In Appendix Table XXVIII, we replicate those numbers for all our procedures using hospitals in counties where BCBS market share is above 51 percent and in counties where BCBS market share is below 51 percent.

These results illustrate that we observe similar variation in procedure-level prices in counties with above and below average BCBS plan market share.

Appendix F4: Cross-Sectional Analysis of Hospital Prices

In our cross-sectional results in Section VI (Column (3) in Table IV), we show that monopoly hospitals have prices that are 12.5 percent higher than hospitals in markets with four or more competitors, have 10.5 percentage points more of their cases paid as a share of charges and have 11.3 percent less of their prospectively set payment rates pegged to Medicare payment rates. In Appendix Table XXIX Panels A and B, we replicate these results for hospitals in counties where BCBS has market share above and below 51 percent. These specifications include HRR, year fixed effects, and the same controls we use in the above mentioned analysis.

Our cross-sectional pricing results are similar in areas with high and low BCBS coverage when we do not include HRR fixed effects. When we include HRR fixed effects, we lose precision on our hospital market structure point estimates in HRRs with high BCBS market share. This is because while there are 70 low BCBS-share HRRs with both a monopoly hospital and a hospital facing three or more competitors, there are only 42 high BCBS-share HRRs with both a

monopoly hospital and a hospital facing three or more competitors. As a result, we lose the variation we need to estimate these cross-sectional results with precision.

Another approach to testing the sensitivity of our results to insurer composition is to control for BCBS market share directly as a covariate in the regressions. We have also run specifications using a high order polynomial on HCCI insurers, as well as versions where we control for the top 10 insurers in each market, allowing their effects to differ based on whether they are HCCI insurers or not. In all of these exercises, the results are qualitatively unchanged. Likewise, as we illustrate in Appendix Table XXIX, introducing the county-level BCBS insurer share as a control variable does not change our main monopoly/duopoly/triopoly point estimates (see Column (2) of Appendix Table XXIX).

Appendix Table XXIX Panel C examines whether hospital market structure is associated with the share of cases at a hospital paid as a share of hospital charges is robust in areas with high and low BCBS coverage with and without the inclusion of hospital fixed effects. Panel D shows that in markets where BCBS insurers have high and low market share, hospitals in markets with fewer other hospitals have a lower share of prospective payments that are linked to the Medicare fee schedule.

Appendix F5: Merger Analysis

In our merger analysis in Section VII, we show that mergers of two hospitals that are located less than 5 miles apart raise prices by over 6 percent. In Appendix Table XXX we analyze mergers that occurred in counties with BCBS market shares above and below the median BCBS market share. As these results illustrate, while we observe that mergers raise prices in areas where the BCBS plans have low market share, we do not observe a price effect in areas where the BCBS plans have high market share. In part, this reflects that we observe considerably more mergers in areas where BCBS have low market share. For instance, we have 188 hospitals that are exposed to mergers where the merging parties are less than 15 miles apart. However, only 56 of them are in markets where BCBS payers have high market share. Likewise, for mergers involving hospitals located less than 5-miles apart, we have 34 hospitals within the support of our treatment effect estimation. However, only 6 of these are in high BCBS HRRs.