Appendix for CEA Issue Brief:
The Cost of Anticompetitive Pricing Algorithms in Rental Housing

We estimate the costs of anticompetitive rental pricing among RealPage software users as the difference between the prices that reflect collective profit maximization among landlords using the same software and the prices predicted by a model of independent profit maximization. We estimate the cost for each metro area included in the RealPage usage data for 2023. We derive the estimates in five steps.

First, we approximate the elasticity of demand faced by the group of rental units using each pricing software (AIRM/YieldStar and LRO). The elasticity of demand faced by the group of units using a given software ($\varepsilon_{software}$) is approximated by the linear interpolation between the residual elasticity of demand for an individual building and the aggregate elasticity of demand for rental apartments, evaluated at the share of rental apartments using the software (see Equation 1). For instance, the residual elasticity for the group of units using AIRM software in the San Francisco metro area is the linear interpolation evaluated at the AIRM software usage share, where the software share is calculated as a share of all rental apartments in the San Francisco metro area. In an extreme scenario where all rental apartments in San Francisco use AIRM software, our formula for the demand elasticity faced by the group of units using AIRM amounts to the aggregate demand elasticity—precisely the demand elasticity faced by a hypothetical monopolist.

$$\varepsilon_{software} := \varepsilon_{building} \times (1 - software\ share) + \varepsilon_{aggregate} \times (software\ share) \quad (1)$$

We form the software group elasticities using publicly available data. The values for the two endpoints of the linear interpolation are the median residual demand elasticity for an individual building (-4.79) and the median aggregate demand elasticity (-1.93) estimated in *Calder-Wang and Kim, 2024*. To calculate the software usage share of rental apartments, we use the RealPage data on AIRM/YieldStar and LRO software usage rates. We consider rental apartments to be all rental units in buildings with 10 or more units, rather than all multifamily buildings (5 or more units), because they more closely align with both the type of units that use RealPage software and the units analyzed in *Calder-Wang and Kim, 2024*, which form the basis of the demand elasticities. One limitation of our approach is that the demand elasticities here do not vary with price levels, nor with the elasticity of supply among landlords who are not coordinated, as predicted by economic theory.

For the second step, we combine the elasticity estimates with observed rental prices to estimate landlords' marginal costs. We use the first-order condition of the profit maximization problem (Equation 2) given the observed price (p^*) and the elasticity of demand faced by software using-units collectively (ε) to infer marginal costs (*mc)*. The profit maximization condition follows the conventional assumption of Nash-Bertrand price competition.

$$p^* = mc \times (1 + \varepsilon^{-1})^{-1} \quad (2)$$

Prices are measured by the Zillow Observed Rent Index for multifamily housing. We observe one multifamily rental price per metro area from the Zillow Index, and yet the prices for units using the AIRM/YieldStar algorithm may be systematically different from the prices for units using the LRO algorithm. The difference arises, in part, because the two groups differ in size, and therefore face

different residual demand elasticities (so long as they are not all coordinating together). For this reason, the value of the demand elasticity that we use to back-out marginal costs in Equation 2 is defined as the average of the AIRM/YieldStar group elasticity and the LRO group elasticity, weighted by the number of units in each group. We use this average demand elasticity because we believe it is more plausible that the group of units using AIRM/YieldStar and the group using LRO have the same average marginal cost than the same average price within each metro area.

In the third step, we calculate the profit-maximizing price mark-ups when prices are coordinated, for both the AIRM/YieldStar and LRO unit groups. The mark-ups—defined as the difference between price and marginal cost—are inferred from the estimates of the demand elasticities for the two software groups (step 1), the marginal costs (step 2), and the profit maximization condition in Equation 2.

In the fourth step, we calculate the price that would occur if prices were set independently across competing buildings that use the same software, given our marginal cost estimate from the previous step. Again, we use the same profit maximization condition, but the relevant elasticity of demand is now the average building-level elasticity of demand.

In the fifth step, we take the difference between the coordinated price mark-up and the independent price mark-up to obtain the coordination cost. For each metro, we calculate the average of the cost across all buildings using AIRM/YieldStar or LRO, which is reported in Figure 2.

To get the total cost estimate for 2023, we add up the estimates for every metropolitan statistical area in the U.S. This amounts to combining the monthly costs for the individual metro areas in our sample, along with the "Other MSAs" category, and multiplying by 12. The differences in costs across metros are mostly driven by differences in software usage rates, but also driven by differences in price levels, which affects the marginal cost of supplying a unit.

Once again, our estimates are an approximation based on several simplifying assumptions. Our approach reflects the limited nature of the data, which provides a rent level for each metro area but does not capture differences in rents across units within a metro area. We also note that our analysis rests on the assumption that without pricing software, landlords would be competing. If landlords coordinate prices even without algorithmic recommendations, then the costs of price coordination should not be attributed to algorithmic pricing.