Concurrences

REVUE DES DROITS DE LA CONCURRENCE | COMPETITION LAW JOURNAL

# Average overcharge models and determining individual harm in collective actions

Law & Economics | Concurrences N° 2-2015 | pp. 38-44

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**ABSTRACT**

Nous considérons ce qui peut être inféré à partir d'une surcharge moyenne au sujet du dommage individuel dans le contexte d'une action collective. Nous montrons que le pourcentage de membres d'une action collective pour lequel une inférence peut être faite dépend du pouvoir explicatif du modèle de calcul de la surcharge moyenne pour un individu donné et de la taille de cette surcharge. Une inférence est possible pour un plus grand pourcentage des requérants lorsque le pouvoir explicatif du modèle de calcul de la surcharge moyenne est plus élevé et quand la surcharge moyenne, elle-même l'est aussi, toutes choses égales par ailleurs. Nos résultats ont des conséquences importantes pour les juridictions qui permettent à des individus d'intenter une poursuite sous la forme d'actions collectives. Tout d'abord, notre analyse montre qu'une estimation correcte de la surcharge moyenne est un déterminant extrêmement important de ce qui peut être inféré au sujet du dommage individuel. Si le modèle d'estimation de la surcharge moyenne la surestime, la capacité à utiliser la surcharge moyenne pour inférer un dommage individuel sera surestimé aussi. Par ailleurs, bien que la précision statistique de la surcharge moyenne soit souvent considérée comme indicateur de l'existence de dommage pour les membres du recours, notre analyse montre que le pouvoir explicative global du modèle est un déterminant plus important de la pertinence de la surcharge moyenne pour un individu donné.

*We consider what can be inferred from an average overcharge model about individual harm in collective actions. We show that the percentage of claimants for which such inference is possible depends on the average overcharge model's explanatory power at the claimant level and the size of the average overcharge. Inference is possible for a larger percentage of claimants when the average overcharge model has more explanatory power, and when the average overcharge is larger, all else equal. Our findings have important takeaways for jurisdictions that allow individuals to pursue claims for harm as part of collective actions. One, our analysis shows that accurate estimation of the average overcharge is highly relevant to what can be inferred about individual harm. If the average overcharge model overestimates the average overcharge, the ability to make inferences about individual harm based on the average overcharge model will be overstated. Two, while the statistical significance of the average overcharge estimate is often considered a proxy for the fact of harm to individual members of the class, our analysis shows that the model's overall explanatory power is a more important determinant of the relevance of an average overcharge to any given individual claimants.*

## I. Introduction

**1.** Article 2 of the 26 November 2014 European Directive defines an "*action for damages*" as including "*an action* (…) *by someone acting on behalf of one or more alleged injured parties where Union or national law provides for that possibility* (…)"[1] This together with various national laws allowing collective actions akin to class actions in the United States means that claimants and defendants may pursue claims for harm as part of a collective redress matter.[2] This, in turn, will require identifying the harmed claimants and quantifying their harm. Over the last few decades, claimants in the United States have often proposed a single regression equation to estimate the average overcharge paid by claimants. In some cases, the parties agree that an average overcharge can be estimated, while in others they do not. However, in most cases, they disagree about what can be inferred about individual harm from an average overcharge approach.[3]

1 Directive 2014/104/EU of the European Parliament and of the Council of 26 November 2014 on certain rules governing actions for damages under national law for infringements of the competition law provisions of the Member States and of the European Union.

2 For example, the *Loi Hamon*, enacted in France in 2014, allows for consumer associations to bring claims for material damages on behalf of individual consumers. Similarly, in 2014 Belgium introduced a law allowing for limited claims for collective redress for groups of consumers.

3 Our analysis is similar in certain respects to the more theoretical discussion of the "inference gap" in Peterson and Lemon (2011). We differ from Peterson and Lemon (2011) in what follows below largely in terms of how we conceptualize the inference gap and how the magnitude of the inference gap itself depends on analysis of actual data. Peterson and Lemon (2011) conceptualize the inference gap from a theoretical perspective. We conceptualize the inference gap from a statistical, probabilistic perspective.

**2.** Estimating an average overcharge and testing whether an individual claimant paid an overcharge are different empirical challenges: to estimate an average overcharge, an accurate estimate of the average counterfactual price is required; to test whether an individual claimant was injured, an estimate of what that individual would have paid but for the alleged conduct is required. The former involves predicting an average price; the latter, an individual price. The key difference is that unmodeled differences across individuals affect prediction of individual prices more than prediction of average prices.[4] An approach that cannot explain why different individuals paid different prices cannot predict individual prices accurately. If individual prices cannot be predicted accurately, inference about whether individual claimants paid overcharges may be impossible.

**3.** In what follows we assume that an average overcharge can be estimated accurately. While this may or may not be the case, we make this assumption to focus our analysis not on whether such an average overcharge can be estimated, but rather on what can be inferred from an average overcharge model about individual harm even when an average overcharge has been estimated accurately. This means, for example, that we assume that data for a set of non-claimants are available, and that the prices that these non-claimants paid are a valid counterfactual for the prices that claimants would have paid but for the alleged misconduct. An implication is that our analysis likely overstates what can in many cases be inferred from an average overcharge model about individual harm.

**4.** We use a simple framework to show that the standard average overcharge model does not (and cannot) provide an estimate of a claimant's overcharge absent assumptions that are unlikely to hold; instead, it estimates the amount by which a claimant's price is higher than expected on average. We then show that this amount is the sum of (1) the average overcharge, (2) the unobserved difference between the claimant's overcharge and the average overcharge, and (3) unmodeled non-conspiratorial factors that affected the claimant's price. This implies that the amount that the claimant's price is higher than expected is the sum of three effects, one that is known (the average overcharge), and two that are not separately observed (the unobserved difference between the claimant's overcharge and the average overcharge, and unmodeled non-conspiratorial factors that affected the claimant's price).

**5.** An immediate implication is that a higher than expected price is not proof that a claimant actually paid an overcharge. Determining whether it paid an overcharge requires ruling out that the claimant's higher than expected price was caused by unmodeled non-conspiratorial factors. We show that a correctly specified average overcharge model's ability to do so depends on its explanatory power at the individual level;[5] if the model explains differences in prices across individuals, then an individual claimant's higher than expected price is less likely to reflect unmodeled non-conspiratorial factors (and more likely to reflect the overcharge to the individual claimant); if the model does not explain much of the differences in prices across individuals, then an individual claimant's higher than expected price is more likely to reflect unmodeled non-conspiratorial factors (and less likely to reflect any individual overcharge).[6]

**6.** Our findings have important implications for jurisdictions that allow individuals to pursue claims for harm as part of a collective action. In the United States, the importance of accurately estimating the average overcharge to determining whether harm can be inferred for all claimants using an average overcharge approach is a recurring point of contention. In the European Union, the language from Article 17 of the 26 November Directive states that "*Member States shall ensure that the national courts are empowered, in accordance with national procedures, to estimate the amount of harm if it is established that a claimant suffered harm but it is practically impossible or excessively difficult precisely to quantify the harm suffered on the basis of the evidence available.*" This means that identifying circumstances under which any estimation of damages becomes truly speculative is highly relevant. Our analysis examines conditions under which damages to any individual claimant can be inferred from an average overcharge calculation and shows that accurate estimation of the average overcharge is highly relevant to what can be inferred about individual harm using an average overcharge approach. If the average overcharge model does not yield an accurate average overcharge, the extent to which individual inference is possible even when an average overcharge calculation is possible will be misstated.

**7.** In the United States, claimants' experts also often emphasize that their estimates of average overcharges are statistically significantly different from zero. While this may be relevant if the goal is to estimate the average overcharge (and again assuming that the average estimate is accurate), the statistical significance of the average estimate does not determine whether individual inference is possible. A regression model may suggest that claimants paid higher prices on average, but if the model cannot explain the variation in prices paid across individuals, it may be impossible to infer that a claimant paid an overcharge simply because of a higher than expected price. This is because the higher than expected price could have resulted from unmodeled non-conspiratorial factors.

4 This is an example of the well-understood difference in statistics between predicting or forecasting an average data point and an individual data point. *See*, for example, discussion in Jeffrey Wooldridge, *Introductory Econometrics: A Modern Approach*, Fourth Edition, 2009, pp. 206-209.

5 By correctly specified, we mean that the average overcharge model provides an accurate estimate of the average overcharge.

6 Note that it is never possible in a statistical sense to rule out definitively that a claimant's higher than expected price was caused by unmodeled non-conspiratorial factors.

# II. Conceptual background

## 1. Drawing an inference for an individual claimant

**8.** Claimant $i$ paid price $P_i$ for a given product in the actual world. This price can be decomposed as follows:

$$P_i = \mathbf{X_i B} + d_i + e_i, \quad (1)$$

where $\mathbf{X_i B}$ is the portion explained by modeled non-conspiratorial factors, $d_i$ is $i$'s overcharge, and $e_i$ is the portion of $i$'s price attributable to unmodeled non-conspiratorial factors.[7]

**9.** Because $d_i$ usually cannot be estimated for each claimant, a model that estimates the average of the claimants' overcharges is typically specified as follows:

$$P_i = \mathbf{X_i B} + \bar{d} + v_i, \quad (2)$$

where $\bar{d} = \frac{1}{n} \sum d_i$. To be consistent with equation (1), $v_i = (d_i - \bar{d}) + e_i$.

**10.** Estimation of equation (2) requires data for sales alleged and not alleged to have been affected by the anticompetitive conduct. For example, such data could include sales to claimants and sales to non-claimants.[8] While the identification of reliable "benchmark" pricing data can introduce a host of reliability issues, we assume for present purposes that such data are available.[9]

**11.** Estimation of equation (2) using data on prices $P_i$ and modeled non-conspiratorial factors $\mathbf{X_i}$ yields estimates of the parameters $\hat{\mathbf{B}}$, $\hat{d}$ and $\hat{v}_i$ where $P_i = \mathbf{X_i}\hat{\mathbf{B}} + \hat{d} + \hat{v}_i$. The predicted value according to the model for claimant $i$ is $\hat{P}_i = \mathbf{X_i}\hat{\mathbf{B}} + \hat{d} + \hat{v}_i$ and $\hat{d} + \hat{v}_i$ is the amount by which claimant $i$'s price is higher than expected. Because $v_i = (d_i - \bar{d}) + e_i$, the amount by which $i$'s price is higher than expected can be interpreted as $i$'s unobserved overcharge $d_i$ plus the effects of unmodeled non-conspiratorial factors on $i$'s price $e_i$:

$$\hat{d} + \hat{v}_i = \hat{d} + (d_i - \hat{d}) + e_i = d_i + e_i \quad (3)$$

**12.** Thus, the amount by which $i$'s price is higher than expected ($\hat{d} + \hat{v}_i$) is the combination of $i$'s unobserved overcharge ($d_i$) and the effects of unmodeled non-conspiratorial factors ($e_i$) on $i$'s price.

**13.** An immediate implication of equation (3) is that the amount by which claimant $i$'s price is higher than expected is not an estimate of $i$'s overcharge unless $i$'s price is not affected by unmodeled non-conspiratorial factors (i.e., $e_i = 0$).[10] More generally, while the left-hand side of equation (3) ($\hat{d} + \hat{v}_i$) is observed, the individual components of the right-hand side ($d_i$ and $e_i$) are not separately observed. Thus, observing that claimant $i$ paid a price that was higher than expected ($\hat{d} + \hat{v}_i > 0$) does not reveal why the price was higher than expected and so cannot imply that $i$ paid an overcharge ($d_i > 0$); in other words, $d_i$ can equal zero even if $d_i + e_i$ is greater than zero. Depending on the unmodeled non-conspiratorial price effects, which are not observed for claimants, a claimant can pay a higher than expected price without having paid an overcharge.

**14.** Consider the following example. Assume that the average overcharge is \$10 ($\hat{d}$ = \$10) and claimant $i$ paid a price that was \$15 higher than expected ($\hat{d} + \hat{v}_i$ = \$15). From equation (3), $d_i + e_i$ = \$15. This is consistent with any number of values of $d_i$, including $d_i \leq 0$.

**15.** While equation (3) shows that an average overcharge model cannot yield an individual claimant's overcharge ($d_i$), the question of individual harm can be expressed statistically as whether the hypothesis that $i$ did not pay an overcharge can be rejected. This, in turn, depends on the significance of unmodeled non-conspiratorial factors and the relationship between the claimant's overcharge and unmodeled non-conspiratorial factors. Consider, for example, a claimant who paid \$75, \$15 more than his predicted price of \$60 ($\hat{d} + \hat{v}_i$ = \$15). From equation (3), $d_i + e_i$ = \$15. If it were shown that $e_i$ could be no larger than \$12, one could infer that $d_i > 0$. This is the scenario shown in Scenario A of Figure 1. Alternatively, if $e_i$ could have been greater than \$15, for example, as shown in Scenario B, it is possible that $d_i \leq 0$. In this case, whether one can statistically infer that $d_i > 0$ depends on the likelihood that $e_i$ was greater than \$15.

7 In principle, the effects of the $\mathbf{X_i}$ on price could be allowed to vary across claimants. We abstract away from this issue by constraining the effects to be common across claimants.

8 Such data could also include sales to claimants outside of the alleged conspiracy period.

9 That is, we assume that conditional on the $\mathbf{X_i}$, the average price paid by non-claimants is an unbiased estimate of the average price that claimants would have paid but for the alleged anticompetitive conduct.

10 Again, this is the case even if the average overcharge is estimated accurately.

**Figure 1. Relationship between estimated overcharge and unmodeled factors**

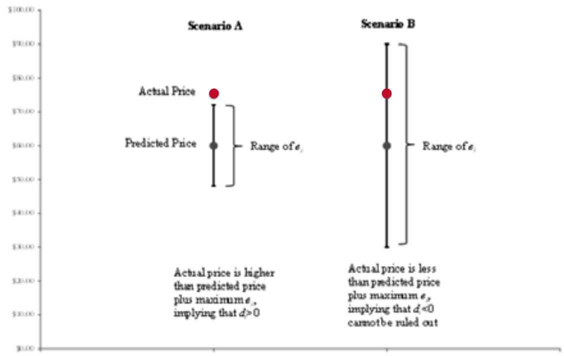
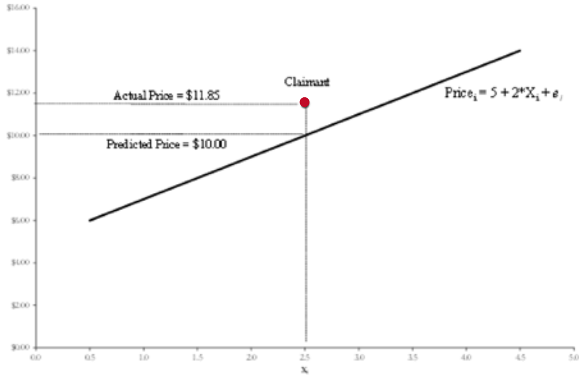



**Figure 2. Claimant that paid a higher than predicted price**

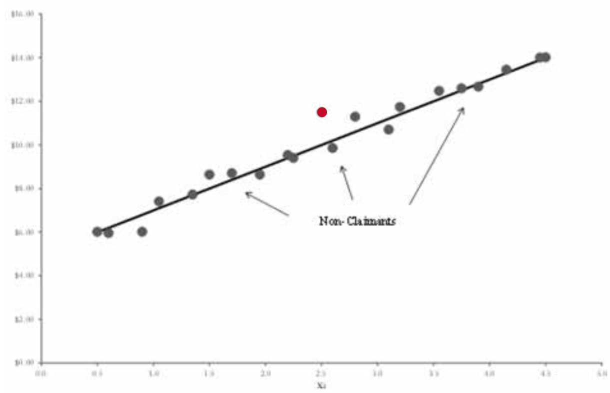



**16.** While the unmodeled non-conspiratorial price effects are not observed for claimants, they are observed for non-claimants if the average overcharge model is correctly specified.[11] This means that if the average overcharge model is correctly specified, for a given claimant it may be possible to rule out that an estimate of $\hat{d} + \hat{v}_i$ was caused by unmodeled non-conspiratorial price effects; under the null hypothesis that *i* did not pay an overcharge (i.e., that $d_i = 0$), the likelihood of observing that *i* paid a price that was $\hat{d} + \hat{v}_i$ higher than expected is given by the distribution of $\hat{e}_i$ for non-claimants.[12] If, for example, the probability of observing $\hat{d} + \hat{v}_i$ is less than 5 percent under the null hypothesis that $d_i = 0$, the null hypothesis can be rejected at the 5% level of significance. In this case, if the average overcharge model is correctly specified, inference about harm for claimant *i* may be possible based on estimates of equation (2). Alternatively, if the probability of observing $\hat{d} + \hat{v}_i$ is greater than 5 percent under the null hypothesis that $\hat{d} = 0$, the null hypothesis cannot be rejected. In this case, inference about harm for claimant *i* is not possible based on the estimates of equation (2), even if the average overcharge model is correctly specified.

**17.** Consider Figure 2. The black line is the price predicted by the modeled non-conspiratorial factors $\mathbf{X_i}$. The red dot is the price that claimant *i* paid. In this hypothetical example, *i* paid a price that was $1.85 higher than expected. Assuming that the average overcharge estimate is accurate, can the hypothesis that *i* did not pay an overcharge be rejected? It depends on whether unmodeled non-conspiratorial factors can be ruled out as the cause of *i*'s higher than expected price.

**18.** Figure 3a shows a scenario in which the modeled non-conspiratorial factors $\mathbf{X_i}$ explain individual variation well. Specifically, the grey dots are the prices paid by non-claimants. Some are higher and some are lower than the predicted price curve, but importantly, they are tightly distributed around the curve. In other words, the variance of $\hat{e}_i$ is small.

**Figure 3a. Scenario A – Regression analysis explains individual variation well**

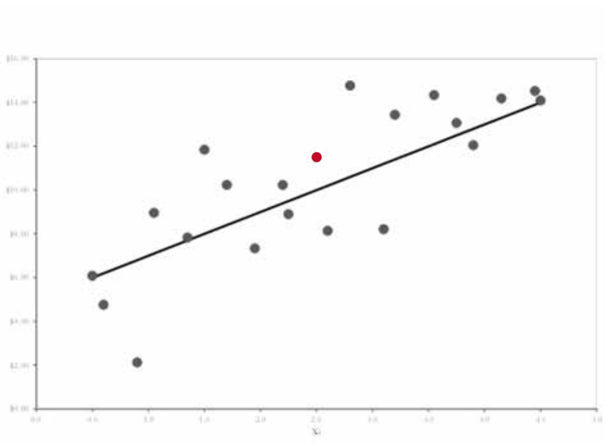



**19.** Figure 3b shows a scenario in which the modeled non-conspiratorial factors $\mathbf{X_i}$ provide little help in explaining individual variation. The individual prices paid by non-claimants (the grey dots) are not tightly distributed around the predicted price curve (the variance of $\hat{e}_i$ is large).

11 This is because $\hat{v}_i$ is observed and $\hat{v}_i = e_i$ for non-claimants if $d_i = \bar{d} = 0$ for non-claimants.

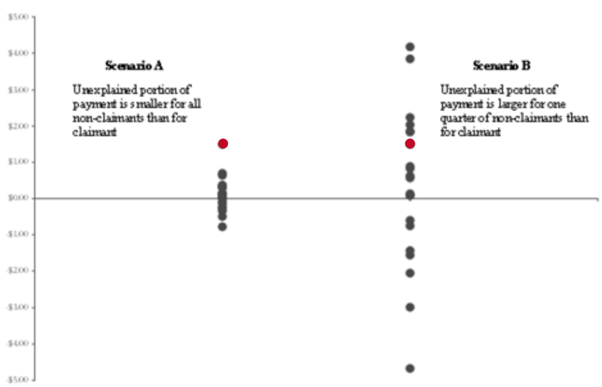
12 Note that this assumes that the error terms of the claimants and non-claimants are drawn from the same distribution.

**Figure 3b. Scenario B – Regression analysis explains individual variation poorly**



**20.** Figure 4 illustrates why the explanatory power of the modeled non-conspiratorial factors $\mathbf{X_i}$ matters. Scenario A corresponds to Figure 3a where the $\mathbf{X_i}$ help explain individual variation. Claimant *i* paid a price that was \$1.85 higher than expected, whereas none of the non-claimants paid a price that was more than \$1.00 higher than expected. Consequently, assuming that the average overcharge is estimated accurately, the null hypothesis that *i* did not pay an overcharge can be rejected; one can rule out statistically that the entire \$1.85 was an unmodeled non-conspiratorial price effect. Scenario B corresponds to Figure 3b where the $\mathbf{X_i}$ provide little help in explaining individual variation. Again, claimant *i* paid a price that was \$1.85 higher than expected. However, because the $\mathbf{X_i}$ provide little help in explaining individual variation, 25% of the non-claimants paid prices that were at least \$1.85 higher than expected. Here, the null hypothesis that *i* did not pay an overcharge cannot be rejected at standard levels of significance. Even assuming that the average overcharge is estimated accurately, *i*'s higher than expected price may be the result of unmodeled non-conspiratorial price effects.

**Figure 4. Distribution of Unexplained Payments in Scenarios A and B**




**21.** The reasoning above shows that individual inference depends on the extent to which differences in prices paid by non-claimants are explained by observable factors. If the observables do not explain much of the variation in prices paid by non-claimants, the variance of the $\hat{e}_i$'s among non-claimants will be high and inference about the sign of $d_i$ will be limited. This is intuitively appealing. If the observables only explain a limited amount of the variation in prices paid by non-claimants, it is more difficult to rule out that an individual claimant paid a higher than expected price because of some unmodeled non-conspiratorial factor.

# 2. Determining the percentage of claimants for which individual inference is possible

**22.** In the previous section, we discussed inference from the perspective of a single claimant. We now extend this discussion to consider the percentage of claimants for which the null hypothesis of no harm can be rejected, assuming that the average overcharge is estimated accurately.

**23.** Across all claimants, the amount by which price was higher than expected is on average equal to the average overcharge and is distributed across claimants with variance $\sigma^2_{d_i+e_i}$:

$$\hat{d} + \hat{v}_i \sim F(\hat{d}, \sigma^2_{d_i+e_i}) \quad (4)$$

**24.** It follows that if the average overcharge is estimated accurately, the percentage of claimants for which the null hypothesis of no overcharge can be rejected is given by:

$$\int_{\alpha\sigma_{e_i}}^{\max(\hat{d}+\hat{v}_i)} f(\hat{d} + \hat{v}_i)\, d(\hat{d} + \hat{v}_i), \quad (5)$$

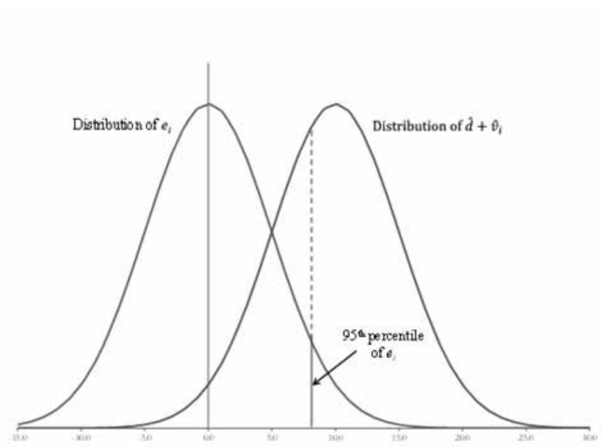
where $\alpha$ is the critical value of the student-t distribution. Intuitively, assuming that the average overcharge is estimated accurately, the null hypothesis of no overcharge can be rejected for claimants for which $\hat{d} + \hat{v}_i > \alpha\sigma_{e_i}$, which means that the percentage of claimants for which the null hypothesis of no overcharge can be rejected is the percentage of claimants for which $\hat{d} + \hat{v}_i$ is greater than $\alpha\sigma_{e_i}$.[13]

**25.** Figure 5 illustrates this point. The curve on the right is the distribution of $\hat{d} + \hat{v}_i$ across individual claimants, centered around a value of \$10.00, which is assumed to be the average overcharge ($\hat{d}$). Given the average overcharge ($\hat{d}$)and the variance of $\hat{d} + \hat{v}_i$ (the spread of the distribution of $\hat{d} + \hat{v}_i$), 95% of the claimants paid a price that was higher than expected (95% of the claimants paid a price for which $\hat{d} + \hat{v}_i > 0$). The curve on the left is the distribution of $\hat{e}_i$, centered around \$0.00. Given the size of the average overcharge ($\hat{d}$) and the variance of $\hat{e}_i$

13 For non-claimants, $e_i \sim G(0, \sigma^2 e_i)$. Thus, the upper limit of the 95% confidence interval for $e_i$ is approximately equal to $\sigma e_i$.

(the spread of the distribution of $\hat{e}_i$), and assuming that the average overcharge is estimated accurately, the null hypothesis of no overcharge can be rejected for 64% of the claimants (those for which $\hat{d} + \hat{v}_i$ is greater than the 95th percentile of the distribution of $\hat{e}_i$).

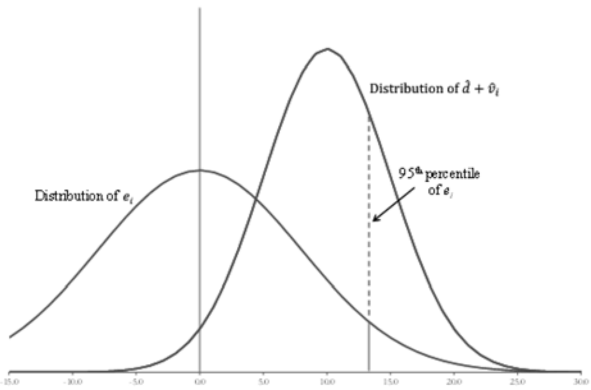
**Figure 5. Distribution of unexplained portion of prices**




**26.** Equation (5) has two important implications. One, assuming that the average overcharge is estimated accurately, the percentage of claimants for which the null hypothesis of no overcharge can be rejected depends on the extent to which the observables explain the variation in prices paid by non-claimants. If the observables explain much of the variation in prices paid by non-claimants, the variance of $\hat{e}_i$ among non-claimants will be low (the spread of the distribution of $\hat{e}_i$ will be narrow) and the percentage of claimants for which $\hat{d} + \hat{v}_i$ is greater than $\alpha\sigma_{e_i}$ will be higher, all else equal. This is intuitive. When the observables explain much of the variation in prices paid by non-claimants, there will be more claimants for which unmodeled non-conspiratorial factors can be ruled out as the possible cause of a higher than expected price.

**27.** Figure 6 shows a different scenario. The distribution of $\hat{d} + \hat{v}_i$ is centered around an average overcharge of $10.00, but the variance of $\hat{e}_i$ is larger than in Figure 5. Again, given the average overcharge and the variance of $\hat{d} + \hat{v}_i$, 95% of the claimants paid a price that was higher than expected. However, because the variance of $\hat{e}_i$ is larger, the null hypothesis of no overcharge can be rejected for only 26% of the claimants.

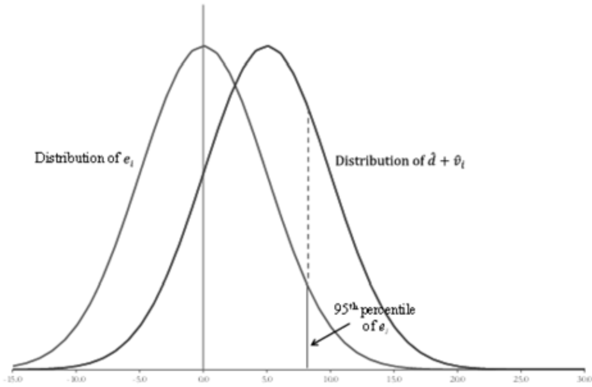
**Figure 6. Higher variance of unexplained portion of price for non-claimants**




**28.** Another implication of equation (5) is that the percentage of claimants for which the null hypothesis of no overcharge can be rejected depends on the average overcharge estimate $\hat{d}$. The distribution of $\hat{d} + \hat{v}_i$ is centered around $\hat{d}$. As $\hat{d}$ increases (i.e., as the curve shifts to the right), the percentage of claimants for which $\hat{d} + \hat{v}_i$ is greater than $\alpha\sigma_{e_i}$ increases, all else equal. This too is intuitive. When the average overcharge is larger, more claimants will pay prices that are high enough relative to expectations that unmodeled non-conspiratorial price factors may be ruled out as the sole source of the difference; relatedly, when the average overcharge is smaller, individual inference is possible for a smaller percentage of claimants.

29. Figure 7 illustrates this point. The variance of $\hat{e}_i$ is the same as in Figure 5, but the distribution of $\hat{d} + \hat{v}_i$ is centered around an average overcharge of $5.00 (rather than $10.00). Because of the decrease in the average overcharge (the shift in the distribution of $\hat{d} + \hat{v}_i$ to the left), the null hypothesis of no overcharge can be rejected for only 26% of the claimants (compared to 64% when the average overcharge is $10.00).

**Figure 7. Lower mean unexplained portion of price for claimants**




# III. Conclusions

**30.** Assuming a correctly specified average overcharge model, the percentage of claimants for which the null hypothesis of no harm can be rejected depends on the average overcharge model's explanatory power at the individual level and the size of the average overcharge. Assuming that the average overcharge is estimated accurately, individual inference will be possible for a larger percentage of claimants when the model has more explanatory power at the individual level and when the average overcharge is larger. Consequently, two questions, among others, are particularly relevant to whether individual harm can be determined for all claimants using an average overcharge approach.

**31.** First, what is the size of the average overcharge? If the extent to which individual inference is possible depends on the size of the average overcharge, then the size of the average overcharge is relevant to whether harm can be determined for all claimants using an average overcharge approach. Thus, our analysis shows that accurate estimation of the average overcharge is highly relevant to what can be inferred about individual harm using an average overcharge approach. If the average overcharge model does not yield an accurate average overcharge, the extent to which individual inference is possible using the average overcharge approach will be misstated.

**32.** Second, what is the explanatory power of the average overcharge model at the individual level? In the United States, claimants' experts often emphasize that their estimates of average overcharges are statistically significantly different from zero. While this may be relevant if the goal is to estimate the average overcharge, the statistical significance of the average overcharge estimate is less important for individual inference. A regression model may find that an individual paid a price that was higher than expected, but if the model does not explain the variation in prices paid across individuals, unmodeled non-conspiratorial factors cannot be ruled out as the sole cause of the individual's higher than expected price.

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# Concurrences

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