

## Memo

To: **Rainer Becker (DG Competition, European Commission)**  
Date: 25 January 2010  
From: Paul Hofer, Associate Director  
Subject: **Interface between econometric conventions and burden/standard of proof**  
Status: Draft for discussion purposes  
Copy: Participants at workshop of economic experts on the quantification of antitrust harm

### Introduction

1. This Memo discusses the interface between conventions in econometric analysis and the burden and standard of proof. These issues are relevant to a wide range of areas, including the quantification of harm in damages actions for antitrust infringements, both in terms of anti-competitive agreements and of abuse of dominance.
2. The points raised in this Memo reflect an economist's perspective on issues that lie at the confluence of law and economics and therefore would also require legal analysis. They are intended to serve as an impulse for discussion at the European Commission's workshop of economic experts on the quantification of antitrust harm (held in Brussels on 26 January 2010), and potentially also in other fora.
3. All observations set out below are personal. Thanks for stimulating discussions are due to my colleagues Sam Brown, Fabien Curto Millet, Greg Leonard, Patrick Smith, and Mark Williams.

### Hypothesis testing and statistical significance

4. The basic idea behind the statistical analysis of a given hypothesis – called the "null hypothesis" – is that a test statistic, calculated from observed data, would very likely fall within one particular range of values if the null hypothesis were correct, but within a different range of values if the null hypothesis were incorrect. Random variation or statistical noise is the reason why it is only possible to specify the likely range of values within which the test statistic would fall if the null hypothesis were correct, rather than a single particular value.
5. A hypothesis test asks whether the observed test statistic, i.e. the evidence calculated from actual data, is consistent or inconsistent with the hypothesis being tested.
6. If the null hypothesis is correct, the test statistic will follow a specified probability distribution. This distribution can be used to calculate the probability that the observed test statistic will exceed a particular threshold: the larger the chosen threshold, the lower the probability that the calculated test statistic will exceed it under the null hypothesis.
7. A hypothesis test therefore involves comparing the calculated test statistic to a critical threshold. The null hypothesis is said to be "rejected" if the observed test statistic exceeds the critical

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threshold; otherwise the null hypothesis is said to be "not rejected". A test statistic that exceeds the critical threshold is also said to be "statistically significant".

8. The choice of suitable null hypothesis is determined by a "default" view. When testing the effect of a particular explanatory variable on another variable (e.g. the effect of education on wages), the customary approach is to assume as the null hypothesis that this effect does not exist, i.e. that the coefficient on the explanatory variable is equal to zero. Given the widespread use of this null hypothesis, it is typically not stated explicitly, and practitioners often use "statistically significant" to refer to "statistically significant when assessed against the null hypothesis of no effect".
9. The appropriate critical threshold for testing the null hypothesis is chosen so that the probability of observing a test statistic of equal or greater magnitude – on the assumption of the null hypothesis being correct – is equal to a pre-specified level, called the "significance level".
10. Determining the significance level, and thus the critical threshold, for the test is ultimately a somewhat arbitrary decision. However, among professional statisticians the standard and most commonly used significance level is 5%. In other words, the null hypothesis is rejected when the probability that the evidence – i.e. the observed test statistic – could have been generated under the null hypothesis is below 5%.
11. Strictly speaking, when the test statistic exceeds the critical threshold associated with a 5% significance level, one says that the test statistic is "statistically significant at the 5% level"; however, the 5% significance level is so well established as the customary convention that the clarification of "at the 5% level" is often omitted.

### Burden and standard of proof

12. The "burden of proof" essentially refers to the obligation to demonstrate that a specific proposition is true. For example, a presumption of innocence places the burden of proof on the prosecution to establish guilt. The evidentiary burden of proof may over time shift between the parties.
13. The "standard of proof" is in basic terms the level or degree of proof necessary to discharge the burden of proof. The "beyond reasonable doubt" standard used in criminal cases is more demanding than the "balance of probabilities" standard used in civil cases. There is a debate on whether particular standards of proof can be quantified as a probability.
14. The issues of who bears the burden of proof and what standard of proof is required are legal questions. However, they interface with the interpretation of econometric analysis, as described below.

### Potential issues arising in quantification of antitrust harm

15. The following example illustrates the interface between conventions in econometric analysis and the burden and standard of proof, based on a hypothetical cartel damages scenario:
  - 15.1 The European Commission has issued a decision (which has not been appealed) on a *per se* illegal price fixing agreement, in which the documentary evidence shows that the cartel had agreed to raise prices by 10%.
  - 15.2 A customer has brought a follow-on damage action against one of the cartel parties, for 9% of its purchases (calculated as 10/110).

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- 15.3 The defendant has responded with econometric analysis using the dummy-variable approach for quantifying the price overcharge.
- 15.4 The econometric analysis has found a coefficient on the cartel dummy variable that implies a 7.8% price uplift, but this estimate would only be statistically significant at or above the 15% level. On that basis, the defendant has argued that in statistical terms the cartel had no effect on price and therefore no damages should be awarded.
16. Faced with this situation, the plaintiff has not disputed the data, assumptions and/or methodology underlying the defendant's econometric analysis, but has endorsed it. Furthermore, it has argued that the econometric analysis is either uninformative or establishes its claim for damages, as follows:
  - 16.1 The defendant's test of the null hypothesis of no effect would not be very powerful because of the imprecise econometric estimate of the effect, i.e. if the true effect of the cartel were substantial, the defendant's hypothesis test would nevertheless likely fail to reject the null hypothesis of no effect. Accordingly, the econometric results would provide very little ability to distinguish between no price effect and a large effect.
  - 16.2 If relying on the econometric analysis, the defendant's approach of using as the null hypothesis the view that the cartel had no effect would be inconsistent with the evidentiary burden of proof. Given the documentary evidence that the cartel agreed to raise price by 10%, the burden of proof should be on the defendant to show that the 10% price uplift did not happen, and accordingly the appropriate null hypothesis should be a 10% price effect. Given the estimated 7.8% price uplift, that null hypothesis (of a 10% price effect) would only be rejected at a significance level above 60%.
  - 16.3 Alternatively, assuming that the defendant's null hypothesis of no effect was appropriate, the significance level of 5% would run the risk of being associated with an excessively demanding standard of proof. At any significance level above 15% the defendant's null hypothesis should be rejected.
17. Faced with the submissions from the plaintiff and the defendant, the court has appointed its own expert, who recommends that, in the absence of material insights from other types of evidence, damages should be awarded for 7.2% of the plaintiff's purchases (calculated as  $7.8/107.8$ ), i.e. the amount corresponding to the point estimate from the econometric analysis.