Author's response to reviews

Title: Identification and quantification of change in Australian illicit drug markets

Authors:

Stuart Gilmour (stuart.gilmour@unsw.edu.au)  
Inge Koch (inge@maths.unsw.edu.au)  
Louisa Degenhardt (l.degenhardt@unsw.edu.au)  
Carolyn Day (cday@nchechr.unsw.edu.au)

Version: 2 Date: 23 March 2006

Author's response to reviews: see over
Response to reviewers

Reviewer 1

Discretionary Revisions

1. The figures have been changed as suggested.

2. Implications for policy have been added to the end of the discussion

Reviewer 3

The abstract has been revised to include the research question.

Specific points:

1. The research question is given at the end of the last paragraph of the Introduction, but we agree with the reviewer that the text does not include all aspects of the question, and we have added the following to the last paragraph to properly describe the research question:
   “… Furthermore we identify the scale over which significant changes occur in data series which show evidence of epidemic behaviour, and compare the relative importance of epidemic and non-random shock patterns to the long-term development of the illicit drug markets.”

2. The first paragraph of the methods has been amended and given the italicised title “Data”

3. The first paragraph of the methods has been modified to include this point, by adding the phrase “from January 1997 to June 2002.”

4. The first paragraph of the methods states that “The data series represent counts of all events in NSW”. We presume that this is what the reviewer means when asking if the counts represent monthly aggregate data.

5. The following reference has been added: J.M Lattin, J.D Carroll and P.E Green: Analyzing Multivariate Data, Thomson, 2003. The authors consider this to be an introductory text. The paragraph describing PCA was included in order to relate the outline of the method (extraction of components by means of the covariance matrix and their ordering by magnitude of variance explained) to the subsequent conclusions of the paper, which rest on these aspects of the method. This paragraph has not been shortened.

6. The authors agree with the reviewer that this sentence is irrelevant, and it has been removed.
7. The section headed *Data Standardisation* has been added to the end of the section labelled *Data*, which now completely describes the data set and comes before the section on PCA.

8. Because the method used here is principal component analysis and not factor analysis, no rotation can be applied to the data. The reviewer appears to be confusing principal component analysis as a statistical method in itself with principal component analysis as an extraction method for factor analysis. As the reviewer observes, PCA is a well-known method and we do not believe it is necessary to further elaborate on the distinction between the method and factor analysis in the text of the paper.

9. Serial dependence and multiple testing are discussed in the following paragraph, which has been added to the discussion of the SiZer:

   SiZer tests of the significance of slopes over the entire data set are adjusted for the additional type I error in multiple tests. Serial dependence is not incorporated into the SiZer model as presented here, but the authors have previously estimated that there is only limited serial dependence in the heroin deaths series. Serial dependence in the cocaine possession offences data has been estimated as a positive AR(1) term that will only inflate variance of regression parameter estimates by about 11%. Serial dependence will therefore have a limited effect on the significance of results presented here.

   The issue of handling the end points of the data series is implicit in the method mentioned in response to point 10.

10. The reviewer is correct, the SiZer uses a kernel density estimator when applied to histograms, and a local linear smoother (with Gaussian kernel) when applied to time-dependent data of the sort presented here. This error has been changed in the text. The use of a kernel regression estimator includes implicit information on the handling of end points of the data, which we leave to those who wish to read the paper by Chaudhuri and Marron.

11. The work was done in Matlab, and this has been noted in the text.

12. We too assume that the article will be printed in colour, and assure the reviewer that the graphs are easily viewed in this context.

13. We have chosen to adopt the suggestion of reviewer 1, simply marking the heroin shortage at month 50, rather than using month-by-month labels.

14. The labels of figure 4 have been changed to say “Month” as suggested, but the months themselves retained in their numeric form (according to reviewer 1’s suggestion).
15. The method of assessing ‘best fit’ is described in the original paper of Chaudhuri and Marron and is rather complex. As described in our response to point 9, fitting methods are unlikely to be highly affected by serial dependence in this particular data.

16. This point has been corrected as above.

17 and 19. These points appear to represent a certain view of how much inference can be drawn from findings of structure based on statistical testing. The SiZer plots support a conclusion of two clear points of change in the heroin deaths data. The first of these (between months 5 and 35) corresponds with the first jump in the second principal component plot; while the second of these corresponds with the only jump in the first principal component. These jumps are statistically uncorrelated, and appear to be supported by evidence at all bandwidths in the SiZer presentation. It is difficult to imagine how one can find stronger statistical evidence for an event than this, and the suggestion that this could be just a ‘natural’ part of the variation in the series, while plausible, could be equally applied to any other form of modelling of this data. For example, were we to present an ARIMA model in which the jump at month 50 were modelled as clearly significant, this too could be presented as a ‘natural’ part of the development of the series. In this case no conclusions about any phenomenon, no matter how large or unlikely it might be, could be drawn. Rather, we have chosen to infer that this strong statistical evidence, coupled with external knowledge about the illicit drug markets (referenced extensively in the paper) constitutes strong evidence for a shortage uncorrelated with the long-term downward trend in this data.

18. The research question has now been described explicitly at the start of the paper, and as a consequence the discussion of the SiZer results for cocaine possession offences is now related back to the research question. The discussion has a specific reference to the scale over which changes occur and the nature of the changes, which are two key parts of the research question.

20. Although the reviewer is correct that PCs are uncorrelated by design, it is general practice to infer meaningful structure in the data from the behaviour of the uncorrelated PCs. The conclusions presented here are in keeping with such methods, which are well described in our references.

21. As with point 20, if one assumes that PCA gives information about meaningful structure in the data then the uncorrelatedness of components 1 and 2 serves as justification for the conclusion that the concepts they represent are uncorrelated, and could represent separate phenomena. This is a standard approach to data analysis with these multivariate methods, and we have chosen to use this standard approach in drawing our conclusions.

Reviewer 2

This reviewer’s response was complex and involved a lot of economic theory that is not relevant to the central purpose of the article. Much of the review is also presented as
Background to the paper: the motive the reviewer ascribes to our work is incorrect, and the background discussion seems quite irrelevant to the work at hand. While it is true that some authors in the field have disputed the magnitude of the shortage and its interpretation, and we have referred to one such paper (Dietze and Fitzgerald) it is not the case that addressing these theories was the driving motivation behind this work. Our main goal, which is now more clearly described in the introduction, was to quantify the scale of the changes in the heroin market using a statistical method suitable to the task, to estimate whether different changes in the market were part of closely related phenomena, and to investigate the relative magnitude of effects of the heroin shortage and other structural patterns in the data. These tasks can be completed using the statistical tools presented here without reference to competing theories of heroin markets and without particular reference to whether or not the heroin shortage really happened. It is our hope that the work presented here will provide additional theoretical support for the type of debate about the nature of drug markets which the reviewer so eloquently puts in this and the next section of the review.

2. Clarity of exposition: again, the reviewer suggests that the purpose of this article is rebuttal of specific arguments presented by other authors, and then suggests that the lack of clarity in these other arguments prevents us from presenting a clear argument in response. We have only presented a reference to one interpretation of the heroin shortage by other authors (Dietze and Fitzgerald) and in keeping with its minor place in the current manuscript, we have presented a single sentence of the discussion in which we address the idea presented in that paper. The sentence in question is that sentence which commences *It is unlikely that the heroin shortage represented a natural ‘correction’ to the illicit drug market…* This is not a sentence to which we feel a considerable amount of energy needs to be devoted. The main thrust of the discussion of our article does not concern this sentence, but a discussion of the main research question, which we have stated more clearly in the introduction. We leave arguments as to the *reasons* for the lack of correlation between the epidemic and shortage components of our model to economists such as the reviewer.

3. Second point re: Clarity of exposition. The reviewer has given too much attention to semantics. To clarify, we have simply referred to peaks and troughs because they are a convenient language to use when describing the visual depiction of the principal components presented in figure 4. We have merely chosen to present the structure of the market as the PCA depicts it.

As requested by reviewer 1, we have expanded the discussion to include some possible policy implications of the information presented here, and hope that this expanded
conclusion will help to defend our claim in this response that we do not privilege a particular theory, but simply present the results “for what they are”.

**Technical material**

Paragraph 1: PCA uses the correlation matrix to extract the principal components. In this case, with months as the dimension of the problem, autocorrelations form the structure of the correlation matrix and are used by PCA.

Paragraph 2: It is hard to understand what the reviewer is asking of us here, and we have not addressed this point. See the above general comments regarding our use of the words “peak” and “trough”. The final sentence of this paragraph, in which the reviewer presents an alternative explanation for principal component 2, actually describes principal component 1.

Paragraph 3: We have adopted the reviewer’s suggestion, and described the components as ‘distinct’ and ‘distinguishable’.

Paragraph 5: We agree that these are interesting topics, but beyond the scope of the current paper. We have presented the frequencies or bandwidths on which changes in the data series occur and made some suggestions for how these numbers might be useful when incorporated into further research or policy development. Debates about elasticity, electronic circuits vs. socio-economic systems, and other such issues, we leave to others.

Paragraph 6: The exposition has been changed in keeping with the suggestions of reviewer 3.

Paragraph 7: This error has been corrected.

Paragraph 8: This sentence has been changed according to the reviewers suggestions, to the following:

   The first derivative for the ‘best fit’ smoother suggests a significant increase in deaths (months 5 – 12), which plateaus (months 12 – 25) and then shows a significant decrease (months 25 – 35). This represents a broad pattern of increase and decrease in a 30 month period between May 1997 and November 1999

Paragraph 9: This suggestion has been incorporated

Paragraph 10: This paragraph is confusing and difficult to respond to. The concept of a ‘double dip’ in the review seems somewhat arbitrary. We have included the full range of bandwidths over which estimation is performed so that readers can see the size of the area in which significant results were impossible due to small numbers (the grey areas) and can confirm that the results on broader bandwidths (those greater than the ‘best fit’) are consistent with broader patterns in the data.
Paragraph 11: The observed decrease after month 60 has been included in the discussion of figure 6. The details of this are discussed further in the paragraph, where we refer to a reversal of the increase. Reasons for showing the entire bandwidth plot were given in the response to paragraph 10. The final note, regarding whether a change over 6 months is ‘sudden’, seems to be a matter of semantics.

*Discretionary revisions*

Paragraph 1: the separation of plots suggested here would not make the data stand out any more clearly, since the differing scales of the series is a problem in any set of plots. Figure 1 was presented only to show these differing scales and to justify our decision to examine the standardised data. We have chosen to keep figure 1, since the other two reviewers seemed to find these figures acceptable.

Paragraph 2: standardised data series are no easier to separate when divided into two sets of 8 or 10 series, and no benefit would be gained from this suggestion. This figure was presented to show the lack of structure in the raw data set, and because exposition of the data is necessary before further analysis.