The main points of this submission are

- 1. recessions and their subsequent recoveries can be fitted rather well by a single 3-parameter function that contains both of them. As a consequence this result links the two parts of the curve rather than considering them as separate events, yielding much better estimates of the decaying and expansion rates.
- 2. The shape of this function is the *simplest one* that respects the underlying economic process: economies growth and shrink exponentially. More complex superpositions of exponentials or non-constant parameters are of course possible, as discussed in the submission.

Assuming that the referees, the editor and the readers can accept these two points, we believe that we can easily modify our manuscript in order to explain better our point of view, and also take into account better the methodological, cultural and stylistic specificities of economics journals.

For example, both the comments of Prof. Popov and Dr. Ormerod allude to the various possible economic natures of recessions and their respective underlying mechanisms. The fitting equation that we propose does not contain any reference to such mechanism. It may seem a weakness at first sight, but since it works very well for a whole variety of countries, it is in fact a strength. Thus there is no logical link between the fact that the recessions of capitalist countries are not of the same kind and are much shorter than the ones affecting the previously communist countries and the fact that the fitting equation may be incorrect. This is shown by the fit for Finland, for instance: the recession of 2001 is also perfectly fitted by our equation. We do not know nor need to know what happens during a particular recession and recovery; what we have shown is that our fitting equation, despite its simplicity and its somewhat extreme assumptions, reproduces with a rather remarkable accuracy the evolution of GDP of a variety of countries. A better counter-argument to our proposal would be to find an example of a recession/recovery of a capitalist country not fitted well by our equation.

In passing, if most of the 23 countries studied in this submission are not capitalist (but Sweden and Finland are), it is (as explained in the submission) because our yearly dataset imposes to focus on long-lasting recessions (at least 3 years): we need 2-3 points for fitting the decay rate. In addition, it is worth pointing out that it is much more difficult to fit 13 years of data of a deep recession and its subsequent recover with a single equation that short recessions that seem to charaterise capitalist countries. In the same vein, the fact that the parameters of the best fits vary substantially among countries merely reflects the variety of the countries considered (Chile, Sweden, Russia, Kazakhstan, etc.). However, what does not vary substantially is the asymptotic growth  $\lambda_+$  of industrialised countries; unsurprisingly, the fraction of decaying economy and the rate at which it happens depends much on the initial state of the various countries.

We understand from his papers that Dr Ormerod possesses quarterly data for capitalist countries. We would be very happy to use them to fit their recessions and show that our fitting equation is right indeed, and that our claim of universality holds. Fortunately, it so happens that the quarterly GDP of the UK is readily available; we fitted the recessions clearly present in the timeseries with the proposed equation (Figs 1 and 2). Let us first start with the later part of the timeseries which is less noisy and hence proves our point more accurately. We can fit remarkably faithfully the 19 points of the recession/recovery episode starting in the first quarter of 1990 (Fig. 1); it is indeed difficult to have a better fit (note that we plot the GDP in linear scales, not in lin-log scale, which would be more natural, but would also compress the residuals and make the fit even more impressive), which we believe shows unambiguously that the nature of recession seems to be irrelevant to the *shape* of the recession/recovery pattern. Then according to our model, the set of parameters changes at a date that corresponds to the burst of the real estate bubble: the ability to detect such events is one of the nice features of our model. Then in about year 2000 another regime change occurs (but no recession), which corresponds to end of the Internet stock market bubble. Interestingly, there seems to be two additional epochs between 2000 and 2008, which in fact advocates even further the remark of Dr Ormerod that recessions are much more frequent that people think: instead of recessions, one can speak of frequent small shocks that change the parameter set, but do not lead to recessions; the consistency of this approach lies in the fact that the asymptotic growth rates of the last three periods  $\lambda_{+} = 0.00757, 0.00898, 0.00783$  respectively, are very similar, while that of the period corresponding to the real estate bubble differs considerably  $(\lambda_{+} = 0.0288).$ 

Since the data are more noisy for the 1980 recession, the results are less



Figure 1: rescaled GDP of the United Kingdom, starting from March 1990. The dashed black line is the result of a fit of Eq (1) to the first 17 points. The blue dashed line is the result of a fit from point 19 to point 43; the green on from point 43 to 56, and the red one from 56 to 72.

clear cut (see Fig. 2), although the general shape of the recession and recovery is well fitted for more than 4 years (17 quarters).

The need for considering recessions and recoveries as a single episode is better understood by looking at Fig. 3 where the recession and recovery parts of a synthetic GDP timeseries were split and fitted separately by exponentials. It shows that one is led to fit these episodes with the wrong function; as a consequence, the factor-based analysis of the average rate of the recession and the average rate of recoveries is biased since the values of the rates of decay and growth are not measured correctly.

Finally, we have nothing against adding an analysis of the residuals, if considered necessary by the editor. In our respective field, fits so precise in linear scales do not need such sophisticated analyses to be convincing, but we can perfectly well understand that help convincing an audience used to them.

We are very grateful for the very relevant comments of Prof. Popov and Dr Ormerod, and of the anonymous referee. They helped us much understanding how to improve our paper. Their open mindsets and criticism make it possible to bridge the ideas of several scientific communities.



Figure 2: rescaled GDP of the United Kingdom, starting from December 1979. The dashed red line is the result of a fit of Eq (1) to the first 17 points. The green dashed line is the result of a fit encompassing the first 35 points.



Figure 3: Synthetic GDP timeseries and two best exponential fits of the recession and recovery parts.