

On the explosive nature of hyper-inflation data  
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*Reply to Invited Reader*  
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Many thanks for your comments to the paper. They were very helpful for the revision of the paper.

1. *Explosive roots absent in differenced data?* In principle explosive roots should be present when differencing the data once or several times, bearing in mind that the noise-to-signal ratio increases with differencing. Looking at the differenced data I did however find explosive roots.

A first example is given in equation (2.12) in the paper:

$$\Delta_1^2 p_t = \frac{0.15}{(0.09)} \Delta_1 p_{t-1} - \frac{0.68}{(0.19)} \Delta_1^2 p_{t-1} + \frac{0.04}{(0.08)} + 0.32 \hat{u}_t, \quad (2.12)$$

using 91:4-93:10, or equivalently,

$$\Delta_1 p_t = \frac{0.47}{(0.17)} \Delta_1 p_{t-1} + \frac{0.68}{(0.19)} \Delta_1 p_{t-2} + \frac{0.04}{(0.08)} + 0.32 \hat{u}_t.$$

Here, mis-specification tests for serial dependence pass, whereas normality cannot be accepted. The characteristic roots are 1.09 and  $-0.62$ , so an explosive root is still there, but a bit reduced compared to what is found when modelling  $p_t$  in levels. The augmented Dickey-Fuller t-statistic is  $0.15/0.09 = 1.6$ , which is larger than the 95% quantile (against the explosive alternative) of  $-0.07$ , see Hendry & Nielsen (2007, Table 16.3).

A second example is to fit a vector autoregression with a constant to  $\Delta p_t, \Delta m_t, \Delta s_t$  as suggested until 93.10. Three lags is needed to get well-specified errors. The roots are

$$1.15, \quad 0.38 \pm 0.48i, \quad -0.10 \pm 0.80, \quad -0.35 \pm 0.33i, \quad -0.56 \pm 0.83i.$$

Fitting only two lags, which result in some autocorrelation, gives more or less the same:

$$1.13, \quad 0.07, \quad -0.11 \pm 0.47i, \quad -0.51 \pm 0.40i.$$

Again the explosive roots are present, albeit slightly reduced compared to the model for the levels. I find similar results for the bivariate systems:  $(\Delta p_t, \Delta m_t)$ ,  $(\Delta p_t, \Delta s_t)$ ,  $(\Delta m_t, \Delta s_t)$ . Fitting three lags there is an explosive root in each case of 1.13, 1.13, and 1.17, respectively.

2. *Discuss rational bubbles as in Diba and Grossman (1988).* A discussion is now included. The data does, however, give evidence against four variants of the rational expectations model both with and without bubble.

3. *Why different sample lengths in the two analyses?* The aim is to model the full data set. This is not possible in the first model since the price series,  $p_t$ , is very noisy in the end. With the transformed analysis a full sample analysis is, however, possible. As far as I am aware this is the first instance of a linear model fitted successfully to the full sample of an extreme hyperinflation.

4. *Characteristic roots for model for transformed data.* The characteristic roots are now shown in Table 8 and 10. Indeed, the explosive root appearing in the unrestricted VAR is insignificant.

5. *Comparison with result in Petrovic and Mladenovic (2000).* A discussion is added.

#### *References*

- Diba, B.T. and Grossmann, H.I. (1988) Rational inflationary bubbles. *Journal of Monetary Economics* 21, 35-46.
- Hendry, D.F. and Nielsen, B. (2007) *Econometric modeling*. Prince, NJ: Princeton University Press.
- Petrović, P. and Mladenović, Z. (2000) Money demand and exchange rate determination under hyperinflation: Conceptual issues and evidence from Yugoslavia. *Journal of Money, Credit, and Banking* 32, 785-806.