Replies to the two referees

by Katarina Juselius

I found the discussion by referee 1 of how my results can be understood in the framework of an unobserved components model very useful and will include this discussion in my revised paper. For many years we have been aware of the many parallels between the Cointegrated VAR and the Unobserved Components model approach and the referee report clearly shows that it is fruitful to address empirical issues from the perspective of both.

Both referee 1 and 2 point out that my argument about the low power of the univariate Dickey-Fuller tests is not correct and I agree. It will be changed in the revised version of the paper.

Referee 2 is concerned that an macroeconomist (or somebody with a macroeconomic background) would have difficulties to accept some of the empirical results of the paper, in particular that the real exchange rate is a near I(2) process. He/she wonders whether it 'would be damaging if one gets the conclusion wrong?' Also referee 2 has expressed some concern about this issue so clarification is obviously needed on this issue.

It is, in my view, crucial not to forget the epithet "near" when discussing the integratedness of economic time series otherwise the results will not necessarily make economic sense. Basically I am prepared to claim that there are very few (if any) true unit root series in economics, whether I(1) or I(2) but that it is, nevertheless, often advantageous to use these concepts as approximative descriptions of economic variables/relations. This is similar to the assumption that errors/variables are normally distributed which is extremely useful even though there may not be many (if any) truly normally distributed ones in real life.

I have found unit roots to be extremely useful to capture and describe persistent movements in economic variables/relations which are hit by shocks with a long-lasting, while not necessarily infinite, effect. Somewhat simplified, near I(1) variables describe situations where $x_{t+1} \simeq x_t + \varepsilon_t$ and expectations are formed as $E(x_{t+1}) = x_t$, i.e. just involving the level of the variable, whereas near I(2) variables describe situations where $x_{t+1} \simeq x_t + \mu_t + \varepsilon_t$ with $\mu_t \simeq \mu_{t-1} + \varepsilon_{\mu,t}$ and expectations are formed as $E(x_{t+1}) = x_t + \mu_t$ i.e. expectations also involve the growth rates. In financial markets, where momentum trading is a very typical feature, one should a priori expect expectations formation to follow the latter case.

Under the assumption that there exists a two-way interdependence between the real economy and financial markets, and all evidence points in this

direction, one should find a similar time-series persistence in many macrovariables. For example, if nominal exchange rate is determined primarily by expectations in the speculative part of the foreign currency market (only a few percent of the foreign currency transactions are related to the trade with goods) then the nominal exchange rate is not likely to closely reflect relative prices, thus producing real exchange rate persistence. If real exchange rates are very persistent so is the interest rate differential likely to be. With goods prices not moving much and nominal interest rates being very persistent real interest rates will exhibit the same persistence as nominal interest rates.

Thus, due to speculative behavior in the currency market, both the real exchange rate and the real interest rate (two of the most crucial determinants to macroeconomic behavior) are likely to exhibit pronounced persistence that then transmits to macroeconomic variables such as the unemployment rate, labor productivity, the profit share, etc. Ever since the onset of worldwide financial deregulation in the mid eighties, empirical applications based on the multivariate CVAR model have increasingly found such pronounced persistence both in financial and macroeconomics variables. Illustrations can for example be found in Juselius and Franchi, 2007 and Juselius and Ordonez, 2008 in this journal and in Juselius and Juselius (2014).

The question whether one should approximate this persistence with I(1) or I(2) remains to be addressed. In my own work I generally choose between the two based on multivariate unit root testing and by inspection of the largest unrestricted roots of the characteristic polynomial as illustrated in this paper. If one chooses an I(1) approximation when the model shows sign of I(2) persistence (a double near unit root), then the model will contain an unaccounted for near unit root and it has not been able to 'explain' all persistence in the data. Even though one's preferred economic model suggests that the real exchange rate is at most I(1) it is hard to argue that this is a justification to ignore conflicting features of the data. As a matter of fact, such features often provide the clues that ultimately lead to a better understanding of some very important macroeconomic transmission mechanisms.

The crucial thing in my view is however not to interpret a unit root as a deep structural economic parameter but rather as a statistical approximation that can help us to structure the variation in the data in a useful way. But by doing so we might also be able to distinguish between competing economic explanations.

Referee 2 argues that the empirical finding that $ppp_t = pp_t - s_t$ is (near)

I(2) "seems to contradict the statement that nominal exchange rate has shown a tendency to move in long persistent swings around its long-run purchasing power parity." This would clearly be the case with one (near) I(2) trends but not with two. In the latter case one of the near I(2) trends captures the long persistent swings in nominal exchange rate whereas the other captures the long persistent movements in relative prices (the long-run fundamental value of the nominal exchange rate). Thus, $pp_t - s_t$ should remove the latter trend but the long swings trend would still be there. Whether the long swings in the nominal exchange rate is better approximated by a near I(2) or a persistent I(1) process is very much dependent on the choice of sample period. In some cases the latter would be a better approximation and the ppp_t would be found to be I(1) (as would probably also the interest rate differential). In other cases (like in the present application) the results would be more in line with I(2) and similarly the interest rate differential. This I think is a good illustration why the order of integration should not be considered a deep structural parameter but instead a statistical approximation that can be used to structure the data in a useful way. If possible I would always prefer to analyze a sample that exhibits more rather than less persistence as this provides us with valuable data information about economic mechanisms in periods which are more extreme. Besides, a good theory should be able to explain behavior in anomalous periods and not be constrained to periods when little happens.