Imperfect Knowledge, Asset Price Swings and Structural Slumps: A Cointegrated VAR Analysis of their Interdependence

Katarina Juselius
Department of Economics
University of Copenhagen
There is more persistence and breaks in the data than standard (REH based) models can explain.

Two important theories addressing this persistence:

- The theory of Imperfect Knowledge Economics (IKE) developed in 2007 by Roman Frydman and Michael Goldberg addresses speculation in the foreign currency market.

Phelps theory is based on REH and does not fully incorporate financial market persistence, whereas the IKE theory does. To combine Structural Slumps with IKE seems a promising avenue.
Rational expectations based models

The REH-based monetary model assumes that PPP holds as an equilibrium condition so that the real exchange rate, \( q_t \), is a stationary process, i.e.

\[
q_t = \rho q_{t-1} + \varepsilon_{1,t}
\]

(1)

where \( \rho < 1.0 \). The stationarity of the real exchange rate is consistent with UIP as a market clearing mechanism:

\[
i_{1,t} - i_{2,t} = \Delta s_{t+1}^e + r_p t
\]

(2)

where \( r_p t \) is a stationary risk premium. Provided (1) and (2) holds, the Fisher parity holds as a stationary condition:

\[
i_t = \bar{r} + \Delta p^e
\]

(3)

where \( \bar{r} \) is an average real interest rate. Similarly, under the above conditions the term spread is stationary and the term structure of interest rates is well described by the expectations hypothesis.
Imperfect Knowledge Based Models:

Risk adjusted UIP is replaced by Uncertainty Adjusted UIP:

\[(i_{d,t} - i_{f,t}) = s_{t+1}^e - s_t + up_t\]

where \(up\) is an uncertainty premium measuring individuals risk averseness.
The IKE equilibrium relation

A cointegration relation between the real exchange rate, the nominal interest rate differential, and the inflation rate differential:

\[(p_{1,t} - p_{2,t} - s_{12,t}) = \omega \{(i_{1,t} - i_{2,t}) - (\Delta p_{1,t} - \Delta p_{2,t})\} + e_t\]
The assumption of uncertainty (imperfect knowledge) has important implications

- A tendency to generate more persistence than otherwise in nominal interests rates and nominal exchange rates, but not in goods prices. The latter are not in general affected by currency speculation.
- The result is real exchange rate persistence
- Empirically this is manifested in error-increasing financial behavior over the medium run while error-correcting behavior over the longer run.
Real exchange rate persistence

Under IKE, the real exchange rate is a near I(2) process:

\[ \Delta q_t = \zeta_t + \varepsilon_{1,t} \]

and

\[ \zeta_t = \rho \zeta_{t-1} + \varepsilon_{2,t} \]
The Cointegrated VAR: Using persistence as a structuring device

• The CVAR model is inherently consistent with a world where unanticipated shocks cumulate over time to generate stochastic trends which move the economic equilibria (the pushing forces) and where the deviations from these equilibria are corrected by means of the dynamics of the adjustment mechanism (the pulling forces).

• A theory consistent CVAR scenario translates all basic assumptions about the model's shock structure, equilibrium relations and steady-state behavior into testable hypotheses on common stochastic trends, cointegration, long-run impact and dynamic adjustment.

• Because the CVAR is able to structure the relevant data into economically meaningful directions without subjecting them to prior restrictions, it can provide broadly defined `confidence intervals' within which empirically relevant models should fall.
All basic assumptions of the REH and IKE based models were translated into hypotheses on the CVAR and tested

• The REH based model was rejected on all accounts, whereas the IKE based model obtained a remarkable support for every single hypothesis.

• For example, treating the real exchange rate as I(1) rather than near I(2) would leave two large characteristic roots in the model (0.96, 0.96).
Illustration

- The dollar/Dmk rate
- US-German prices
- PPP US-Germany
- Real interest rate differential US-Germany
The long-term bond rate differential with a 12 months moving average

The inflation rate differential with a 12 months moving average
Illustration: short-long interest rate spreads

US short-long interest rate spread

German short-long interest rate spread
Why is IKE based speculation potentially so important for the macro economy?

1. IKE predicts persistent swings in the real exchange rate and similar persistent swings in the real interest rate differential.
2. IKE predicts that the Fisher parity (international as well as domestic) does not hold as a stationary condition.
3. As a consequence the term structure of interest rates is no longer well described by the expectations hypothesis.
4. Persistent swings in real exchange rates, real interest rates and the term spreads are likely to generate persistent fluctuations in the macro economy.
The structural slumps theory explains how open economies connected by the world real interest rate and the real exchange rate can be hit by long episodes of unemployment.

It predicts that an exogenous shock to the world level of public debt and/or capital stock will change the world level of interest rates, whereas an exogenous shock to the public debt of an individual open economy tend to increase its interest rate relative to the world interest rate.

Johansen et al. (2010), Frydman et al. (2010) and Juselius (2010) find that shocks to the long-term US bond rate (a proxy for the world interest rate) and to the US-German interest rate differential (measuring relative debt levels between the two countries) are the exogenous forces in a system comprising US-German prices, nominal exchange rates, and long-term interest rates.
The importance of a nonstationary Fisher Parity

• Under IKE, nominal interest rates and nominal exchange rates exhibit a pronounced persistence due to the uncertainty premium.
• Prices of tradable goods are essentially determined by supply and demand in a very competitive global world and, therefore, less susceptible to speculative currency movements.
• When the nominal long-term interest rate increases but CPI inflation does not, the real interest rate will increase.
• Increasing real interest rates are likely to increase the speculative demand for the domestic currency, hence increasing its price.
• Thus, as predicted by IKE, there will be a tendency for the domestic real interest rate to increase and the real exchange rate to appreciate at the same time, aggravating domestic competitiveness.
• As the competitiveness of the economy worsens and the macroeconomic imbalances grow, this is likely to generate a reflexive process between changes in the real interest rates and the real exchange rate (Soros 1987).
Why can swings be so long-lasting?

• As long as the real interest rate differential moves in a compensating way, the deviations from long-run PPP benchmark values can be very persistent.
• The I(2) model is formulated precisely to describe an economy where persistent deviations from long-run static equilibrium values are compensated by similar deviations in other variables.
• Because a persistent movement away from long-run benchmarks is counteracted by another similar movement, an IKE economy is still characterized by equilibrating forces but in a dynamic rather than a static set-up.
Fluctuations in the real economy

• When speculative behavior drives nominal exchange rates away from fundamental PPP values, enterprises cannot use constant mark-up pricing without losing market shares.
• In the struggle for market shares, enterprises will be forced to adjust profits rather than prices: profits are likely to be squeezed in periods of persistent appreciation and increased during periods of depreciation.
• Thus, Phelps customer market pricing is likely to replace constant mark-up pricing in an IKE economy.
Implications for unemployment

• As enterprises struggle to survive in a period of real appreciation and increasing real long-term interest rates, they will tend to improve labor productivity by laying off the least productive part of the labor force.

• Thus, unemployment will tend to rise/decrease in periods of appreciation/depreciation while prices stay reasonably unchanged.

• The long-term real interest rate, unemployment rate and inflation rate would be co-moving in a relationship that Phelps (1994) calls an augmented Phillips Curve: $\Delta p = -b_1(u-u^*)$ where $u^* = f(r)$ describes a nonstationary natural rate as a function of the (long-term) real interest rate level.

• However, this relationship would no longer hold in the present post crisis period due to large scale financial consolidation behavior (Koo, 2010).
Discussion

• Macroeconomic data have a reputation for not being sufficiently informative, thereby justifying the use of `mild force' to make them tell an economically relevant story.
• However, macroeconomic data are surprisingly informative, but only if you let them tell the story they want to tell.
Which stories do the data tell if they are allowed to speak freely?

- There is more persistence in the data than standard REH based theories can explain.
- In particular, basic parity conditions such as purchasing power parity, real interest rates, uncovered interest rate parity, and the term spread seem to exhibit a pronounced persistence untenable with I(0) type stationarity.
- This persistence seems to originate from complex interactions between speculative financial markets and the real economy.
- A synthesis between the theory of structural slumps by Phelps and the IKE theory by Frydman and Goldberg' (2007) is likely to improve our understanding of the long recurrent spells of high unemployment in our economies.
Difference between IKE and REH in simulated data

REH: Real exchange rate at most I(1)

\[ x_{1,t} - x_{1,t-1} = \varepsilon_t, \quad \varepsilon_t \sim N(0, 1), \quad t = 1, \ldots, 500 \]

IKE: Real exchange rate near I(2)

\[ x_{2,t} - x_{2,t-1} = \zeta_t + \varepsilon_{1,t}, \quad \varepsilon_{1,t} \sim N(0, 1), \quad t = 1, \ldots, 500 \]
\[ \zeta_t = 0.95 \zeta_{t-1} + \varepsilon_{2,t}, \quad \varepsilon_{2,t} \sim N(0, 0.15^2) \]
A differenced near I(2) process with a 12 months MA

A differenced random walk process with a 12 months MA
Illustrations: real interest rates
Testable empirical regularities under REH and IKE

• Under IKE, the real exchange rate is near I(2). Under REH it is I(0) or most near I(1).

• Under IKE, the real exchange rate is co-moving with the real interest rate differential, so both are near I(2). Under REH the real interest rate differential is I(0) or at most near I(1).

• Under IKE, the real exchange rates and the real interest rate differential cointegrate to a stationary equilibrium relation. Under REH, they are individually stationary.

• Under IKE, the Fisher parity does not hold as a stationary condition. Under REH, the Fisher parity is stationary.

• Under IKE, interest rate spreads are nonstationary but cointegrated. Under REH, the expectations hypothesis holds and the spreads are stationary.
The purpose is to discuss:

• The role of speculative behavior in currency markets as a potentially important cause to persistent fluctuations in aggregate activity.

• The ability of REH based versus IKE based models to explain the observed nonstationary movements in basic parity conditions.

• How to combine the theory of IKE with the structural slumps theory in Phelps (1994) and its implication for the macro economy.