Gathering the Pieces of the U.S. Real Output Dynamics: New Challenges for Economic Policy

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Outline

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**Macro-Financial Linkages**

### Tranquil regimes:
- Markets and agents are rational, super-efficient machines, producing white noise processes.
- Computationally, quasi-linear models can describe their operations and estimators asymptotically are stable.
- DSGE models are capable of capturing most economy’s dynamics (Bernanke & Gertler, 1999; Kiyotaki & Moore, 1997)
- Short-run perturbations are permitted as markets need time to correct themselves.
- Extreme points (i.e. outliers) are exogenous, unpredictable and “innocent” events.

### Turbulent regimes:
- Modern economies obey dynamic, unorthodox and complex properties; subject to a plethora of shocks.
- Irrationality and asymmetry are detrimental parts of the observed outcome.
- Axiomatic models and linear approximations are quite restrictive to capture the complex interactions between profit-maximizing units.
- Extreme behaviors emerge endogenously, are repeated and can be accommodated in power lawed distributions.
(Un)Reliability of Macro data

- **Output gap** is a variable of ultimate importance in policy-making (Phillips curve, Taylor rule) and banking regulation (Basel III).

  \[
  \text{Output gap} = \text{GDP}_{\text{real}} - \text{GDP}_{\text{potential}}
  \]

- **Potential GDP** cannot be directly observed.
  - OECD: indirectly infers it from economic data using a production function
  - Detrending: several researchers use different types of filters (HP, linear trends, quadratic time trends) to decompose the log of real output into a trend and a cycle component.

- Shortcomings of Output gap estimations. All known methods are highly sensitive to several conditions (Orphanides, 2001; Gerke et al., 2012; Drehmann and Tsatsaronis, 2014):
  1. sample size, frequency, presence of noise
  2. statistical properties of data (heteroskedasticity, structural breaks)
  3. model-selection uncertainty
  4. data revisions
Motivation

- How the business cycle interact with credit and fiscal evolution?
- “Decompose” real output’s dynamics, especially during stressed regimes.
- Is there any predictive content on the credit and fiscal data?
- Which of the variables contribute the most?
- How our results coincide/or not with NBER recession announcements?
Application on Macro cycles

**Data:** quarterly observations for two sets of variables, downloaded from FRED. For credit data selection see Hancock and Edge (2009), US Department of the Treasury.

**Credit:** 1949Q1-2013Q4 (257 obs.)
- Home mortgages
- Consumer credit
- Commercial mortgages
- Nonfinancial credit

**Public:** 1947Q1-2013Q3 (267 obs.)
- Tax receipts
- Current expenditures
Why RPs are useful for Macroeconomics?

- Recurrence Plot (RP): sophisticated graphical method, able to clearly depict the phase transitions that a dynamical system may come across with.
- The RP framework addresses efficiently several debating issues of standard regression time series analysis, since it makes no assumptions about the nature or the generating process of the observational data.
- Features of RP analysis:
  - indifferent to stationary
  - recognition of path-dependent dynamics
  - turning points (outperforms linear structural tests)
  - quantification of phase transition
Recurrence Plots and Entropy

- **Recurrence Plot (RP)**, firstly introduced by Eckmann et al., (1987), constitute a clear representation of the topological features of the underlying signal and, by construction, is independent of all the limiting constrains imposed by linear parametric peers.
- The construction of the \( n \times n \) Recurrence matrix is achieved by calculating the distances:
  \[
  R_{i,j}^{m,\tau}(\epsilon) = \Theta(\epsilon - \|\vec{x}_i - \vec{x}_j\|)
  \]
- Recurrence Plot depicts pixels of the distance value owed than the threshold \( \epsilon \), for all \((i, j)\) coordinates.
  \[
  R_{i,j}^m(\epsilon) = \begin{cases} 
  1 : \vec{x}_i \approx \vec{x}_j \\
  0 : \vec{x}_i \neq \vec{x}_j
  \end{cases}
  \]
Recurrence Plots and Entropy

- **Shannon Entropy (ENTR)** refers to the probability \( p(l) = P(l)/N_l \) to find a diagonal line of exactly length \( l \).

\[
ENTR = - \sum_{l=l_{\text{min}}}^{N} p(l) \ln p(l)
\]

- ENTR addresses the complexity in the RP (i.e. for uncorrelated noise, ENTR takes small values indicating low complexity).
- ENTR can be useful as an early warning indicator.
increased cross-ENT evolution from 1990s and so on, highlighting the importance of credit in the output evolution

cross-ENTs are “synchronised” at the beginning of the 2007-2009 recession
Figure: Evolution of cross-ENTR and prices for fiscal variables

- after 1995 cross-ENTs are negatively associated
- increased cross-ENT evolution from 1990s and so on
Non-productive growth of GDP is followed by a recession.

Several factors contributed, in different ways, to the recent crisis.

Credit, fiscal and real spheres are more connected than earlier years.

In a complex environment, no unique tool is useful for policy purposes.

Increasing entropy highlights the intrinsic complexity of economic relations, the changing behavior of the economic system that is able to turn an expansionary regime, in the aftermath of an incomplete intervention, into a severe recessionary phase.

We need to better understand market’s reaction, public policy responses and their subsequent impact on real output.

“... no indicator is infallible, policymaking requires judgment...” and “...all indicators and models are subject to error and the future is, by definition, unknown...” (Drehmann and Tsatsaronis, 2014)