Bernanke’s 2010 US Economic Recovery: Evidence From A Minimal Spanning Tree Study

Siew Ann CHEONG

Econophysics Colloquim 2010 | 4–6 Nov 2010 | Taipei, TAIWAN
Acknowledgments

• **Past Students**
  – Jian Cheng WONG, BSc (Mathematical Sciences), NTU, 2009
  – Gladys Hui Ting LEE, BSc (Mathematical Sciences), NTU, 2010
  – Yiting ZHANG, BSc (Mathematical Sciences), NTU, 2010

• **Present Students**
  – Jun Liang KOK, Physics & Applied Physics/4, NTU
  – Dr Manamohan PRUSTY, Research Fellow, NTU

• **Funding**
  – Two startup grants, NTU
‘Green Shoots’ of US Economy

Bernanke sees 'green shoots' of US recession ending

(AFP) – Mar 15, 2009

WASHINGTON (AFP) — In his first television interview, Federal Reserve Chairman Ben Bernanke predicted that America's worst recession in decades will likely end this year as the economy gathers steam next year.

The "green shoots" of economic revival are already evident, Bernanke told George Stephanopoulos in the interview broadcast late Sunday, which the network said was the first time the US central banker was sitting Fed chairman in 20 years.

His assessment chimed with a new tone of cautious optimism from President Barack Obama's administration as top economic aides took to the airwaves earlier Sunday.

"It is an economic war. We haven't won yet. We have staged a wonder show," Finance Secretary Timothy Geithner, chairwoman of the White House Council of Economic Advisers, said.

Echoed by Lawrence Summers, director of Obama's National Economic Council, who said Geithner's proposal for more aid to states financially hard-pressed due to the economic downturn "came out very soon."

Predicting that no more big banks will fail, Bernanke also called on Washington and states to show the will needed for recovery, arguing the world came "close to meltdown last September before government intervention.

Recession officially ended in June 2009

POST WORLD WAR II RECESSIONS

<table>
<thead>
<tr>
<th>Period</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 1948 - Oct. 1949</td>
<td>11 months</td>
</tr>
<tr>
<td>Jul. 1953 - May 1954</td>
<td>10 months</td>
</tr>
<tr>
<td>Aug. 1957 - Apr. 1958</td>
<td>8 months</td>
</tr>
<tr>
<td>Apr. 1960 - Feb. 1961</td>
<td>10 months</td>
</tr>
<tr>
<td>Dec. 1969 - Nov. 1970</td>
<td>11 months</td>
</tr>
<tr>
<td>Nov. 1973 - Mar. 1975</td>
<td>16 months</td>
</tr>
<tr>
<td>Jul. 1981 - Nov. 1982</td>
<td>16 months</td>
</tr>
<tr>
<td>Jul. 1990 - Mar. 1991</td>
<td>8 months</td>
</tr>
<tr>
<td>Mar. 2001 - Nov. 2001</td>
<td>8 months</td>
</tr>
<tr>
<td>Dec. 2007 - Jun. 2009</td>
<td>18 months</td>
</tr>
</tbody>
</table>

Source: National Bureau of Economic Research

NEW YORK (CNNMoney.com) — The Great Recession ended in June 2009, according to the body charged with dating when economic downturns begin and end.
Time Series Segmentation

• Non-stationary time series
  – $\mathbf{x} = (x_1, x_2, \ldots, x_N)$
  – Assume consists of $M$ stationary segments
  – Data points in segment $m$ drawn from $N(\mu_m, \sigma_m^2)$

• Recursive segmentation
  – One time series $\rightarrow$ two segments
  – Each segment $\rightarrow$ two subsegments
  – Iterate + optimize
  – Terminate
Jensen-Shannon Divergence

• Single-segment likelihood for \((x_1, x_2, \ldots, x_N)\)

\[
L_1 = \prod_{i=1}^{N} \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[-\frac{(x_i - \mu)^2}{2\sigma^2}\right]
\]

• Two-segment likelihood for \((x_1, \ldots, x_t, x_{t+1}, \ldots, x_N)\)

\[
L_2(t) = \prod_{i=1}^{t} \frac{1}{\sqrt{2\pi\sigma_L^2}} \exp\left[-\frac{(x_i - \mu_L)^2}{2\sigma_L^2}\right] \prod_{i=t+1}^{N} \frac{1}{\sqrt{2\pi\sigma_R^2}} \exp\left[-\frac{(x_i - \mu_R)^2}{2\sigma_R^2}\right]
\]

• ML estimates \(\hat{\mu}, \hat{\mu}_L, \hat{\mu}_R, \hat{\sigma}^2, \hat{\sigma}_L^2, \hat{\sigma}_R^2\)

• Jensen-Shannon divergence \(\Delta(t) = \ln \frac{L_2(t)}{L_1} \geq 0\)
Segmentation + Clustering
Dow Jones Industrial Average

Asian Financial Crisis

Crisis

Chinese Correction

US housing market/
Chinese market corrections

shocks

shocks

Eco
Dow Jones US Economic Sectors

Econophysics Colloquium 2010 | 4–6 Nov 2010 | Taipei, TAIWAN
Macroeconomic MSTs

\[ C_{ij} = \frac{\langle (x_i - \bar{x}_i)(x_j - \bar{x}_j) \rangle}{\sigma_i \sigma_j} = \frac{\langle \delta x_i \delta x_j \rangle}{\langle \frac{\sigma_i}{\sigma_j} \delta x_j \rangle} \]


Econophysics Colloquim 2010 | 4–6 Nov 2010 | Taipei, TAIWAN
Mesoeconomic MSTs
Early Signs of Economic Recovery?

Sep 2009

21 Jan to 15 Feb 2010
1-31 Mar 2010
1 May to 15 Jul 2010

2004-2005
Conclusions

• Previous study on US economy
  – 1.5-year recovery from previous crisis
  – 2-month descent into present crisis
  – Strong driving from Fed rate cuts

• Present study on US economy
  – Robust star-like MST within growth phase
  – Robust chain-like MST within crisis phase

• Early indication of economic recovery
  – Nearly star-like MST in Sep 2009
  – Robust star-like MSTs throughout Greek Debt Crisis
Thank You!

• Contact Information
  Siew Ann CHEONG
  Division of Physics and Applied Physics
  School of Physical and Mathematical Sciences
  Nanyang Technological University
  21 Nanyang Link, Singapore 637371
  Republic of Singapore
  Tel: +65-6513-8084
  Fax: +65-6795-7981
  Email: cheongsa@ntu.edu.sg