The Two Greatest. Great Moderation vs Great Recession

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Conference in Honor of James Hamilton.
Federal Reserve Bank of San Francisco

The views expressed here are those of the authors and do not express the views of the Bank of Spain or the Eurosystem.
"Where Danger Lurks", Olivier Blanchard, IMF Finance and Development (September, 2014)

Until 2008, mainstream U.S. macroeconomics had a benign view of economic fluctuations in output and employment. The crisis has made it clear that this view was wrong and that there is a need for a deep reassessment.
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Where Danger Lurks

- We thought of the economy as roughly linear, constantly subject to different shocks, constantly fluctuating, but naturally returning to its steady state over time.

- Even when we later developed techniques to deal with nonlinearities, this generally benign view of fluctuations remained dominant.
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- The Great Moderation had fooled not only macroeconomists. Financial institutions and regulators also underestimated risks.
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"Dark corners". Situations in which the economy could badly malfunction. We thought we were far away from those corners, and could for the most part ignore them.

Measuring systemic risk, can be used to give warning signals that we are getting too close to dark corners, and that steps must be taken to reduce risk and increase distance.
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One lesson and one assumption

- Dark corners should be seen in advance and can be seen in advance. Early warning systems.
- Great Moderation is over (otherwise we would be still fooled). Thanks to its end, we can observe the dark corners.
- $1+1=2$. Two missperceptions of the Great Recession??
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Searching for dark corners

1 Early warning systems.
   - "The failure to predict the Great Recession. The failure of Academic Economics? A view through the role of credit" (Gadea and Perez-Quiros, JEEA 2014)

2 Great Moderation is over
   - "Great Moderation and Great Recession: From plain sailing to stormy seas?" (Gadea, Gomez-Loscos and Perez-Quiros, Documento de Trabajo Banco de España, 1423, Working Paper CEPR DP10092)
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Motivation

The failure to predict the Great Recession
The Great Moderation is over

Conclusions

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Conclusions
Outline

1 Motivation

2 The failure to predict the Great Recession

3 The Great Moderation is over

4 Conclusions
Searching for dark corners

- "Credit to GDP growth is a particularly reliable indicator of recession when the experiences of both advanced and emerging economies are considered together"
Why nobody saw the credit crunch coming? LSE, Nov 2008
Why nobody saw the credit crunch coming?

The failure of economists to foresee the Great Recession has been globally commented... and has been widely criticized

- Olivier Blanchard (2014). Fooling of the Great Moderation
- Paul Krugman (2009) "Profession blindness to the possibility of catastrophic failures in the market economy"
- Colander et al (2009) "Misallocation of research efforts in economics"..."an insistence on constructing models that disregard the key elements driving output in the real world"
- Smets and Wouter (2007) and others do not incorporate any financial accelerator mechanism
Motivation
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Credit to GDP. Reliable indicator of recessions

IMF Global Financial Stability Report (September, 2011)
Credit to GDP. Reliable indicator of recessions

  - Kaminsky y Reinhart (1999)
  - Alesi and Detken (2009)
  - Jorda et al (2011)
  - Gourinchas and Obstfeld (2011)
    - Logit model
  - Terrones and Mendoza (2011)
    - Threshold models
These papers are so clear that economists must have been blind not to see the crisis coming.

More importantly, they have dramatically changed the way in which monetary policy is conducted because they all indicate that price stability does not guarantee macroeconomic stability and that monetary policy should coordinate with macroprudential policy. The combination of these two policies by controlling financial imbalances, should reach a new objective, financial stability (IMF 2013 and FSB, IMF and BIS 2011).
Stylized facts

- GREAT PAPERS but badly read by policymakers
- They provide considerable evidence that financial markets, credit in particular, play an important role in shaping the economic cycle, in the probability of financial crises, in the intensity of recessions and in the rhythm of recoveries
Econometric approach

- All of them consider that recessions are known a priori, either by using historical records or by pinpointing them with non-parametric techniques.
- Crises are usually treated as exogenous to the model and the behaviour of some financial and macroeconomic variables are analysed in their environment.
Credit to GDP. Reliable indicator of recessions? Some caveats

Standard analytical approach

\[ Z_{ti} = \alpha + \beta Y_{ti} + \gamma X_{ti} + \epsilon_{it} \]  

(1)

where

- \( Z_{ti} \) is a dummy that takes value of 1 if there is a recession in period \( t + i \), where \( i = 1,2,3 \)
- \( Y_{ti} \) is the credit to GDP ratio
- \( X_{ti} \) are the control variables
- \( \beta \) is positive and significant in a logit model and that is evidence that credit is a reliable indicator of recession
Credit to GDP. Reliable indicator of recessions? Some caveats

Four main concerns

1. Uncertainty
2. Cumulation effect of credit
3. Endogeneity
4. Financial crises, real crises and the Great Recession
Credit to GDP. Reliable indicator of recessions? Some caveats

1. Uncertainty of the recession periods
   - The results are only descriptive. Basically, the previous literature is more interested in the "anatomy" of financial crises, once these have occurred, than in "clinical medicine", that is, diagnosis from the symptoms
   - This literature is not designed to make inference.
Anatomy of the crisis

Forensic medicine
Symptoms of the Crisis

Clinical medicine
Motivation

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Cumulation effect of credit

Graph showing the cumulative effect of credit over time with markers for recessions.

Gadea, Gomez-Loscos and Perez-Quiros

The Two Greatest. Great Moderation vs Great Recession
Credit to GDP. Reliable indicator of recessions? Some caveats

2. Cumulation effect of credit

- Credit is a variable that increases during expansion periods.
- Credit to GDP accumulates over time endogenously in different theoretical models, as in Gertler and Karadi (2011), Gertler and Kiyotaki (2010), Christiano, Motto and Rostagno (2010) or Nuño and Thomas (2012), and, therefore, it is endogenously high when the expansions are long.
- But does this behaviour...imply any predictive power of this ratio on the turning points?
**TABLE 1**

**REGRESSION ON TRENDING EXPANSIONS**

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>$t_{ratio}$</th>
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<tr>
<td><strong>US DATA</strong></td>
<td></td>
<td></td>
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<tr>
<td>ratio</td>
<td>0.0010</td>
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<tr>
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<td><strong>OECD 39 COUNTRIES</strong></td>
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<tr>
<td>ratio</td>
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<td>17.0298</td>
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<tr>
<td>variation in ratio</td>
<td>0.0224</td>
<td>8.9129</td>
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<tr>
<td>credit intensity</td>
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<td>5.1895</td>
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<tr>
<td><strong>JORDA ET AL. (2011)'S DATA</strong></td>
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<td></td>
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<tr>
<td>ratio</td>
<td>0.0030</td>
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<tr>
<td>variation in ratio</td>
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<tr>
<td>credit intensity</td>
<td>0.0444</td>
<td>3.0135</td>
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</tbody>
</table>
Credit to GDP. Reliable indicator of recessions? Some caveats

3 Endogeneity

- In the literature, crises, both their location and their typology, are treated as exogenous variables.
- In the definition of turning points, credit is one of the variables which is considered.
- A fall in credit in period "t, t + 1....t + k" contributes to the definition of a turning point in period "t".
- Credit is strongly autocorrelated

\[ z_t = \alpha + \beta \times credit_t + \epsilon_t \]

- Then \( E(\epsilon_t, credit_t) \neq 0 \) and, therefore, \( \beta \) is upwardly-biased and no conclusions can be drawn from its estimation.
4 Financial, real crisis and the Great Recession

a) For the sample of 39 OECD countries, between 1950.q1 and 2011.q2, we identify 149 recession periods. Out of these, only 45 coincide financial crises documented by Gourinchas and Obstfeld (2011), and 31 of them correspond to the recent crisis.

b) For this sample Gourinchas and Obstfeld (2011) identify 143 financial crises, of which only 45 correspond to a real crisis.

c) Eliminating the last 31 recent crises out of the 230 financial or real crises (143-31 financial, 149-31 real), we find that only 14 cases (6%) are both financial and real.
Previous literature is not design to make inference. If we read those papers properly, you do not have tools to provide the policymakers the rules that they are demanding. Because they do not want to be blindfolded when looking at credit.
A policymaker looking at credit
Credit (which should be?). The relevant question

- Does the level of credit to GDP (or its variation) observed in period \( t \) increase the probability of being in a recession in \( t + 1 \)?
- Does that level affect the characteristics of future cyclical phases?
- If the answer to this questions is YES...credit is a variable to control...otherwise, the policymakers could cut good and healthy expansions in order to avoid a not-forthcoming recession...
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- Does that level affect the characteristics of future cyclical phases?
- If the answer to this questions is YES...credit is a variable to control...otherwise, the policymakers could cut good and healthy expansions in order to avoid a not-forthcoming recession...as they have done with the level of debt and future growth
We need a methodology that does not just describe the past.

We need to provide a tool that allows policymakers to infer, in real time, future probabilities of recession (or characteristics of the cycles).

Credit will matter if, when we include this variable in our analysis, it changes the inferences about the future in a statistically significant way.
Credit. Providing solutions

On standard method very successful in the literature of business cycle to infer in real time the probability of recessions is the estimation of Markov Switching models (Hamilton, 1989)

\[ dy_{ti} = \mu_{S_j} + \epsilon_{ti} \]  \hspace{1cm} (2)

where \( \mu_{S_j} \) is the vector of Markov switching intercepts \( \epsilon_{tc|S_j} \sim N(0, \sigma_{S_j}) \).

\[ dy_{ti} = \mu_1 + \epsilon_{ti} \text{ for state 1} \] \hspace{1cm} (3)
\[ dy_{ti} = \mu_2 + \epsilon_{ti} \text{ for state 2} \] \hspace{1cm} (4)

\[ P(S_t = j|S_{t-1} = i, \Omega_{t-1}) = P(S_t = j|S_{t-1} = i) = \begin{bmatrix} p_{11} & \ldots & p_{1m} \\ \ldots & \ddots & \ldots \\ p_{m1} & \ldots & p_{mm} \end{bmatrix} \] \hspace{1cm} (5)

where \( p_{ij} \) controls the probability of a switch from state \( j \) to state \( i \).
This is definitely better methodology than a logit with credit in sample. Because the Root Mean Squared Error of the forecast:

Table 5. Credit Performance with Logit Model.

<table>
<thead>
<tr>
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<th>Logit</th>
<th>GM</th>
<th>GM_prob_credit</th>
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<tr>
<td><strong>QPS</strong></td>
<td>0.12</td>
<td>0.08</td>
<td>0.08</td>
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<tr>
<td><strong>Out-of-sample</strong></td>
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<tr>
<td><strong>FQPS</strong></td>
<td>0.14</td>
<td>0.11</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>DM test</strong></td>
<td>5.80</td>
<td>4.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td></td>
</tr>
</tbody>
</table>
Credit. Providing solutions

An alternative model, where credit matters would be: Credit can affect the dynamics of the business cycle by modifying:

1. the means of the states, $\mu_1$ and $\mu_2$

$$d\tilde{Y}_t = \mu_1 + \alpha_1 \ast CR_{t-1} + \epsilon_i \text{ for state } i=1$$
$$d\tilde{Y}_t = \mu_2 + \alpha_2 \ast CR_{k,t-1} + \epsilon_i \text{ for state } i=2$$

$$\mu_{1t} = \mu_1 + \alpha_1 \ast CR_{t-1}$$
$$\mu_{2t} = \mu_2 + \alpha_2 \ast CR_{t-1}$$

(6)

2. the transition probabilities, $p$ and $q$.

$$\Pr(St = j/S_{t-1} = i, \Omega_{t-1}) = f/CR_{t-1})$$
$$\Pr(St = 1/S_{t-1} = 1, \Omega_{t-1}) = p + \delta_1 CR_{t-1}$$
$$\Pr(St = 0/S_{t-1} = 0, \Omega_{t-1}) = q + \delta_2 CR_{t-1}$$

$$p_t = p + \delta_1 \ast CR_{t-1}$$
$$q_t = q + \delta_1 \ast CR_{t-1}$$

(7)
Some implications of the two models: 
\( \mu_1, \mu_2, p \) and \( q \) contain all the information on the main business cycle characteristics, amplitude, duration, cumulation and excess (Harding and Pagan, 2002)
The failure to predict the Great Recession...the role of credit

Gadea, Gomez-Loscos and Perez-Quiros

The Great Moderation is over

Motivation

Credit. Providing solutions

**TABLE 2**
MS MODEL ESTIMATION

<table>
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<tr>
<th></th>
<th>$\mu_1$</th>
<th>$\mu_2$</th>
<th>$\sigma^2$</th>
<th>$p$</th>
<th>$q$</th>
<th>$\mu_1$</th>
<th>$\mu_2$</th>
<th>$\sigma^2$</th>
<th>$p$</th>
<th>$q$</th>
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</thead>
<tbody>
<tr>
<td>AG</td>
<td>1.84 (0.21)</td>
<td>-1.41 (0.40)</td>
<td>1.69 (0.33)</td>
<td>0.95 (0.02)</td>
<td>0.84 (0.08)</td>
<td>IS</td>
<td>1.30 (0.15)</td>
<td>-0.19 (0.27)</td>
<td>0.62 (0.15)</td>
<td>0.94 (0.03)</td>
</tr>
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<td>AU</td>
<td>0.95 (0.08)</td>
<td>-0.33 (0.60)</td>
<td>1.12 (0.13)</td>
<td>0.98 (0.01)</td>
<td>0.60 (0.25)</td>
<td>IT</td>
<td>1.64 (0.13)</td>
<td>0.28 (0.07)</td>
<td>0.59 (0.07)</td>
<td>0.87 (0.05)</td>
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<tr>
<td>BD</td>
<td>0.70 (0.06)</td>
<td>-2.96 (0.26)</td>
<td>1.00 (0.11)</td>
<td>0.98 (0.00)</td>
<td>0.23 (0.23)</td>
<td>JP</td>
<td>2.26 (0.02)</td>
<td>0.57 (0.09)</td>
<td>1.24 (0.13)</td>
<td>0.99 (0.00)</td>
</tr>
<tr>
<td>BG</td>
<td>1.17 (0.07)</td>
<td>0.33 (0.06)</td>
<td>0.24 (0.03)</td>
<td>0.91 (0.03)</td>
<td>0.94 (0.02)</td>
<td>LX</td>
<td>1.20 (0.24)</td>
<td>-2.26 (0.07)</td>
<td>2.69 (0.63)</td>
<td>0.95 (0.02)</td>
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<tr>
<td>BR</td>
<td>1.02 (0.18)</td>
<td>-3.31 (0.79)</td>
<td>2.03 (0.40)</td>
<td>0.94 (0.02)</td>
<td>0.29 (0.24)</td>
<td>MX</td>
<td>1.08 (0.07)</td>
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<td>1.08 (0.11)</td>
<td>0.99 (0.01)</td>
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<td>CL</td>
<td>1.57 (0.14)</td>
<td>-1.11 (0.62)</td>
<td>1.55 (0.27)</td>
<td>0.96 (0.01)</td>
<td>0.55 (0.21)</td>
<td>NL</td>
<td>0.69 (0.08)</td>
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<td>0.75 (0.11)</td>
<td>0.96 (0.01)</td>
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<td>CN</td>
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<td>-0.50 (0.31)</td>
<td>0.56 (0.06)</td>
<td>0.98 (0.00)</td>
<td>0.79 (0.10)</td>
<td>OE</td>
<td>0.78 (0.06)</td>
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<td>0.01 (0.09)</td>
<td>0.48 (0.06)</td>
<td>0.96 (0.01)</td>
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<td>1.32 (0.23)</td>
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<td>0.71 (0.24)</td>
<td>RS</td>
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<td>0.84 (0.11)</td>
<td>0.95 (0.02)</td>
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<td>ES</td>
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<td>0.21 (0.03)</td>
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<td>0.91 (0.04)</td>
<td>SD</td>
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<td>FN</td>
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<td>1.51 (0.18)</td>
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<td>0.33 (0.04)</td>
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<td>0.97 (0.00)</td>
<td>SW</td>
<td>0.62 (0.07)</td>
<td>-1.93 (0.54)</td>
<td>0.99 (0.10)</td>
<td>0.99 (0.01)</td>
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<td>GR</td>
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<td>1.44 (0.25)</td>
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<td>0.76 (0.07)</td>
<td>-1.67 (0.28)</td>
<td>0.31 (0.06)</td>
<td>0.98 (0.00)</td>
<td>0.79 (0.16)</td>
<td>UK</td>
<td>0.73 (0.07)</td>
<td>-1.05 (0.36)</td>
<td>0.79 (0.09)</td>
<td>0.97 (0.00)</td>
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<td>1.42 (0.23)</td>
<td>0.99 (0.01)</td>
<td>0.49 (0.35)</td>
<td>US</td>
<td>1.01 (0.07)</td>
<td>-0.54 (0.29)</td>
<td>0.65 (0.07)</td>
<td>0.95 (0.01)</td>
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<tr>
<td>IR</td>
<td>1.19 (0.09)</td>
<td>-1.56 (0.61)</td>
<td>1.43 (0.15)</td>
<td>0.99 (0.00)</td>
<td>0.86 (0.11)</td>
<td>Mean</td>
<td>1.16 (0.11)</td>
<td>-1.87 (0.48)</td>
<td>1.10 (0.17)</td>
<td>0.96 (0.01)</td>
</tr>
</tbody>
</table>
The main problem is that we only have a few recessions in the sample for each country (8 at most...which imply those huge standard errors.

We would like to pool the information in a panel when we will have different recessions for different countries...but that is definitely mixing apples and orange...isn´t it?
Credit. Providing solutions

CRISSES

CRISIS(1,1)
CRISIS(1,2)
CRISIS(1,3)
CRISIS(2,1)
CRISIS(2,3)
CRISIS(3,1)
CRISIS(3,2)
CRISIS(3,3)

COUNTRY 1

CRISIS(1,1)
CRISIS(1,2)
CRISIS(1,3)

COUNTRY 2

CRISIS(2,1)
CRISIS(2,2)
CRISIS(2,3)

COUNTRY 3

CRISIS(3,1)
CRISIS(3,2)
CRISIS(3,3)

PERIOD 1

CRISIS(1,1)
CRISIS(2,1)
CRISIS(3,1)

PERIOD 2

CRISIS(1,2)
CRISIS(2,2)
CRISIS(3,2)

PERIOD 3

CRISIS(1,3)
CRISIS(2,3)
CRISIS(3,3)
We test this hypothesis more formally in two ways:

1. We apply the Kruskal-Wallis test that compares samples from two or more groups and tests the null hypothesis that all samples are drawn from the same populations.

2. We mix the features of all the recessions, make clusters with similar characteristics and analyse the concentration of periods and countries in each cluster using the Herfhindal index.
**TABLE 3**

**KRUSKAL-WALLIS TEST**

<table>
<thead>
<tr>
<th></th>
<th>Duration</th>
<th>Amplitude</th>
<th>Cumulation</th>
<th>Excess</th>
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<td><strong>By country</strong></td>
<td>29.09</td>
<td>42.85</td>
<td>38.35</td>
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<tr>
<td></td>
<td>(0.6146)</td>
<td>(0.0953)</td>
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<tr>
<td><strong>By periods</strong></td>
<td>50.39</td>
<td>64.62</td>
<td>59.08</td>
<td>43.40</td>
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<tr>
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<td>(0.0082)</td>
<td>(0.0002)</td>
<td>(0.0008)</td>
<td>(0.0418)</td>
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</table>
We know that there is information in combining the evidence from different countries

\[ Y = (Y_{1t}, Y_{2t}, ..., Y_{Nt}) \] (8)

Where \( Y_{it} \) is the normalized growth rate of country \( i \)
Motivation

The failure to predict the Great Recession

The Great Moderation is over

Conclusions

30-countries GDP growth

Virtual country series

Probability of recession

Gadea, Gomez-Loscos and Perez-Quiros

The Two Greatest. Great Moderation vs Great Recession
Motivation
The failure to predict the Great Recession
The Great Moderation is over

Conclusions
**Credit. Providing solutions**

**TABLE 5**

**GLOBAL MODEL ESTIMATION**

<table>
<thead>
<tr>
<th>$\mu_1$</th>
<th>$\mu_2$</th>
<th>$\sigma^2$</th>
<th>$p$</th>
<th>$q$</th>
<th>$\delta_1$</th>
<th>$\delta_2$</th>
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MS MODEL

Gadea, Gomez-Loscos and Perez-Quiros
Credit. Providing solutions

- We compare the forecast that we obtain with the country model (CM) with the result of using the global model (GM) forecast details.
- As our benchmark model representing the true state of the business cycle, we use the results of applying the BB algorithm.
- We apply the Diebold and Mariano (1995) test for predictive ability (DM).
- Probabilities of recession estimated with the global model match the BB states better than country estimates. The results of the DM test show that this difference is significant when we compare the CM with GM (9.16) with a p-value of 0.000.
- Bayesian interpretation of the analysis.
Motivation

The failure to predict the Great Recession
The Great Moderation is over

Conclusions

Credit. Providing solutions

Gadea, Gomez-Loscos and Perez-Quiros

The Two Greatest. Great Moderation vs Great Recession
Credit. Providing solutions

- Comovements?
- Our model:
  \[ d\tilde{y}_{t,c} = \mu S_{t,c} + \epsilon_{t,c} \]  
  \[ (9) \]
- Taking into account comovements of the shocks
  \[ d\tilde{y}_{t,c} = \mu S_{t,c} + \lambda F_t + \epsilon_{t,c} \]  
  \[ (10) \]
- Where \( F_t \) represents time varying comovements of the shocks
- Correlation of 0.92 of the probabilities estimated with and without comovements.
We introduce credit in the global model

<table>
<thead>
<tr>
<th>$\mu_1$</th>
<th>$\mu_2$</th>
<th>$\sigma^2$</th>
<th>$\rho$</th>
<th>$q$</th>
<th>$\delta_1$</th>
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Gadea, Gomez-Loscos and Perez-Quiros

The Two Greatest. Great Moderation vs Great Recession
We introduce credit in the global model
## Out of sample. Probability Recession

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<tr>
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<th>GM_credit_prob</th>
<th>GM_dd</th>
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<td>DM_test=4.4121 (0.0000)</td>
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<td>GM_dd</td>
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<td></td>
<td>DM_test=0.6499 (0.6869)</td>
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Notes: The first value corresponds with rows and the second with columns. The third values display the Diebold and Mariano test and its associated p-values of the null hypothesis that the predictive performance of model in row and model in column is equal.
Our of sample. Probability Recession and other characteristics

<table>
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<th>TABLE A0.4</th>
<th>FORECASTING BUSINESS CYCLE CHARACTERISTICS</th>
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<tbody>
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<td>FQPS at turning points (1,2.period, total)</td>
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<td>MSE duration recessions at first point</td>
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<tr>
<td>MSE amplitude recessions at first point</td>
<td>20.47</td>
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<tr>
<td>MSE cumulation recessions at first point</td>
<td>494.14</td>
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Notes:
FQPS of the difference between BB states and MS forecast probabilities. MSE of the difference between BB characteristics and MS forecast characteristics.
## TABLE 3
GLOBAL MODEL ESTIMATION

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<tr>
<th>$\mu_1$</th>
<th>$\mu_2$</th>
<th>$\sigma^2$</th>
<th>$p$</th>
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</table>
Motivation
The failure to predict the Great Recession
The Great Moderation is over

Conclusions
Credit. Final analysis

Last robustness check: Control for the accumulation effect. Duration dependence MS models of Diebold and Rudebusch (1990), Durland and McCurdy (1994) and Filardo and Gordon (1998)

<table>
<thead>
<tr>
<th>$\mu_1$</th>
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<th>$\sigma^2$</th>
<th>$\rho$</th>
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<th>$q$</th>
<th>$\delta_1$</th>
<th>$\delta_2$</th>
<th>$\alpha_1$</th>
<th>$\alpha_2$</th>
<th>$\delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.87</td>
<td>-1.81</td>
<td>1.02</td>
<td>0.97</td>
<td>0.60</td>
<td>0.09</td>
<td>0.04</td>
<td>-0.39</td>
<td>-0.65</td>
<td>-0.09</td>
</tr>
<tr>
<td>(0.02)</td>
<td>(0.19)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.04)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Out of sample. Probability Recession

<table>
<thead>
<tr>
<th></th>
<th>GM</th>
<th>GM_credit_μ</th>
<th>GM_credit_prob</th>
<th>GM_dd</th>
<th>GM_dd_credit_μ</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM</td>
<td>FQPS1=0.1110 FQPS2=0.1140 DM_test=-1.4507 (0.2786)</td>
<td>FQPS1=0.1110 FQPS2=0.1168 DM_test=-2.6116 (0.0084)</td>
<td>FQPS1=0.1110 FQPS2=0.1068 DM_test=3.7780 (0.0000)</td>
<td>FQPS1=0.1110 FQPS2=0.1068 DM_test=2.1192 (0.0845)</td>
<td></td>
</tr>
<tr>
<td>GM_credit_μ</td>
<td>FQPS1=0.1140 FQPS2=0.1168 DM_test=-0.7630 (0.5935)</td>
<td>FQPS1=0.1140 FQPS2=0.1068 DM_test=3.5999 (0.0004)</td>
<td>FQPS1=0.1140 FQPS2=0.1068 DM_test=5.3019 (0.0000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM_credit_prob</td>
<td>FQPS1=0.1168 FQPS2=0.1068 DM_test=4.4121 (0.0000)</td>
<td>FQPS1=0.1168 FQPS2=0.1068 DM_test=2.7186 (0.0198)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM_dd</td>
<td>FQPS1=0.1088 FQPS2=0.1068 DM_test=0.5499 (0.6869)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Notes: The first value corresponds with rows and the second with columns. The third values display the Diabold and Mariano test and its associated p-values of the null hypothesis that the predictive performance of model in row and model in column is equal.*
Dark corners are difficult to find. We may find ones and the next recession could come associated to new ones.

But definitely, we need to revise the methods that we are currently using for the search of early warning indicators.

We review the results of previous literature with an empirical exercise and obtain a controversial finding: "Credit does not help to forecast recessions or business cycle characteristics"

There was no empirical evidence to support that a policymaker decide to cut credit in the middle of an expansion to prevent future recessions
Looking for Dark Corners. Conclusion

- Dear Queen, nobody saw the credit crunch coming because credit was not so closely related to business cycle. This is a new feature of the data associated with just one particular period.

- Macroeconomics did not include credit in their models because other features of the data (stickiness in wages and prices, for example) explained better the business cycle features than anything else.
One lesson and one assumption

- Dark corners should be seen in advance and can be seen in advance. Early warning systems.
- Great Moderation is over (otherwise we would be still fooled). Thanks to its end, we can observe the dark corners.
One lesson and one assumption

- Dark corners should be seen in advance and can be seen in advance. Early warning systems.

- Great Moderation is over (otherwise we would be still fooled). Thanks to its end, we can observe the dark corners.
Motivation

The failure to predict the Great Recession

The Great Moderation is over

Conclusions
Motivation

The failure to predict the Great Recession

The Great Moderation is over

Conclusions

Outline

1 Motivation

2 The failure to predict the Great Recession

3 The Great Moderation is over

4 Conclusions
The Great Domination
The Great Domination
The Great Domination

The failure to predict the Great Recession
The Great Moderation is over

Motivation

Conclusions

Gadea, Gomez-Loscos and Perez-Quiros

The Two Greatest. Great Moderation vs Great Recession
The Great Humiliation
The Great Humiliation
A structural break for Spain?

- The Spanish team closes a cycle
- Failure and end of cycle for the Spanish team
- Xabi Alonso says that cycles come to an end after a defeat, pointing to an unavoidable loss of hunger
- Fernando Torres: "One day this cycle had to end"
- Editorial in the news. Theoretical models:
  - The effects of ageing on soccer
  - The effect of lack of motivation in soccer
  - The effect of competitive leagues on the national team
But we are econometricians

- Definitely...too soon to say:
- We need more observations. Lack of power at the end of the sample
- Too few observations. Wait until Euro 2016

... by the way... why we did not see this thing coming up earlier?
The Great Moderation (GM)


- Consensus before the Great Recession that the GM was a permanent phenomenon
  - Blanchard and Simon (2001): "The decrease in output volatility appears sufficiently steady and broad based that a major reversal appears unlikely" 
  - Bernanke (2004): "The reduction in the volatility of output is also closely associated with the fact that recessions have become less frequent and severe"
  - Robert Lucas (2003). Presidential address to the AEA: "the central problem of depression-prevention has been solved, for all practical purposes".
The Great Recession (GR)

- The global economic decline in the late 2000 decade
- GDP growth in US negative between 2008Q3 to 2009Q2
- Worst recession since WWII
Great Moderation vs Great Recession

- John Taylor blog: Sunday, December 23, 2012
  Five-Year Anniversary of the End of the Great Moderation

  "Five years ago this month the GM ENDED. To be precise Dec 2007 is the month in which the NBER designed the peak and it was the end of the Great Moderation and the beginning of the Great Recession".
GR ended the GM because:

- Financial accelerator. Gourinchas and Obstfeld (2012) and many others, IMF, BIS, FSB...the effect of credit
GR ended the GM. Empirical evidence:

- Ng and Tambalotti (2012): DSGE model with parameters of the GM make impossible to describe the GR

- Ng and Wright (2013): the financial origin of this recession makes it more explosive, killing the stability of the GM

- Keating and Valcarcel (2012), Cannarella et al. (2008)
On the opposite side, GR did not end GM:

- **Clark (2009):** The volatility rise was not widespread across sectors; the economy undergoes occasional shifts while low volatility is the norm.

- **Coubion and Gorodnichenko (2011, AER):** The GM continues as it is determined by improved policy rather than luck.
GM vs GR. Policymakers looking for answers:


- If the GM still holds... shed light on the possible explanations
Motivation
The failure to predict the Great Recession
The Great Moderation is over
Conclusions

Great Moderation Revisited

US GDP Growth 1953.1 - 2013.4

Gadea, Gomez-Loscos and Perez-Quiros
The Two Greatest. Great Moderation vs Great Recession
Great Moderation Revisited


\[ y_t = \mu + \rho y_{t-1} + \epsilon_t \]

\[
\sqrt{\frac{\pi}{2}} |\epsilon_t| = \alpha_1 D_{1t} + \alpha_2 D_{2t} + u_t
\]

\[
D_{1t} = \begin{cases} 
  1 & \text{if } t \leq T \\
  0 & \text{if } t > T 
\end{cases}
\]

\[
D_{2t} = \begin{cases} 
  1 & \text{if } t \geq T \\
  0 & \text{if } t < T 
\end{cases}
\]

where \( y_t \), growth rate of GDP; \( T \), break point; \( \alpha_1 \) and \( \alpha_2 \), the corresponding estimators of the standard deviation.
Great Moderation Revisited


### Structural Breaks in Variance

<table>
<thead>
<tr>
<th>Null</th>
<th>Sup</th>
<th>Exp</th>
<th>Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\sigma_1^2 = \sigma_2^2)</td>
<td>15.70</td>
<td>5.28</td>
<td>7.05</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.000)</td>
<td>(0.003)</td>
</tr>
</tbody>
</table>

Estimated break data 1984.2
Great Moderation Revisited


- Only one break
- As usual... first we need to re-test for the possibility of a change in mean
- At the end of the sample. Trimming of the data
- Too few observations of the new post GR period
Testing for multiple breaks in the mean


- They consider $m$ breaks in a general model:
  \[ y_t = x_t'\beta + z_t'\delta_j + u_t \]

  - $y_t$ is the dependent variable
  - $x_t(px1)$ and $z_t(qx1)$ are vectors of independent variables, the first is univariate and the second can change
  - $\beta$ and $\delta_j (j = 1, \ldots, m + 1)$ are the vectors of coefficients
  - $T_i, \ldots, T_m$ are the break points considered endogenous
  - Number of breaks: use the $UDmax$ and $WDmax$ double maximum tests and the $supF_{(l+1/l)}$ sequential procedure
Testing for multiple breaks in the mean

### Table 3: Multiple structural breaks (Bai-Perron methodology)

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Model 2</th>
<th>5%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$supF_{(k)}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$k=1$</td>
<td>5.98</td>
<td>6.30</td>
<td>9.10</td>
</tr>
<tr>
<td>$k=2$</td>
<td>7.55</td>
<td>6.58</td>
<td>7.92</td>
</tr>
<tr>
<td>$k=3$</td>
<td>6.80</td>
<td>3.12</td>
<td>6.84</td>
</tr>
<tr>
<td>$supF_{(l+1/l)}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$l=1$</td>
<td>0.99</td>
<td>0.88</td>
<td>9.10</td>
</tr>
<tr>
<td>$l=2$</td>
<td>4.70</td>
<td>5.31</td>
<td>10.55</td>
</tr>
<tr>
<td>$UD_{max}$</td>
<td>7.55</td>
<td>6.57</td>
<td>9.52</td>
</tr>
<tr>
<td>$WD_{max}$</td>
<td>9.04</td>
<td>8.15</td>
<td>13.07</td>
</tr>
<tr>
<td>$T(SBIC)$</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$T(LWZ)$</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$T$ (sequential)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** We look for changes in the mean in a pure structural model (Model 1) and including an autoregressive (Model 2). The trimming parameter is $\epsilon = 0.10$ and the maximum number of breaks is 3. Serial correlation and heterogeneity in the errors are allowed. The consistent covariance matrix is constructed using the Andrews (1991) method.

- All the tests agree that $\Delta GDP$ does not have any structural change in mean
Testing for multiple breaks in variance


\[ IT = \sup_k \left| \sqrt{T/2D_k} \right| \text{ where } C_k = \sum_{t=1}^k \varepsilon_t^2 \quad D_k = \frac{C_k}{C_t} - \frac{k}{t} \quad \text{with } D_0 = D_T = 0 \]

Big size distortions when the assumption of normally distributed innovations fails in the fourth order moment or for heteroskedastic conditional variance processes. Proposed corrections:

- High kurtosis

\[ II(T_1) = \sup_k \left| \sqrt{T/B_k} \right| \]

\[ B_k = \frac{C_k - \frac{k}{T} C_T}{\sqrt{\hat{\eta}_4 - \hat{\sigma}^4}} \]

- Persistence

\[ \hat{\eta}_4 = T^{-1} \sum_{t=1}^T y_t^4, \quad \hat{\sigma}^4 = T^{-1} C_T \]

\[ IT(T_2) = \sup_k \left| \sqrt{T/G_k} \right| \]

\[ G_k = \hat{\omega}_4^{-1/2} \left( C_k - \frac{k}{T} C_T \right) \]

where \( \hat{\omega}_4 \) is a consistent estimator of \( \omega_4 = \lim_{T \to \infty} E \left( T^{-1} \left( \sum_{t=1}^k (\varepsilon_t^2 - \sigma^2) \right)^2 \right) \)
Other alternative approaches:

  - Zhou and Perron (2008) prove the suitability of this procedure when there are no changes in mean
  - See Herrera and Pesavento (2005) and Stock and Watson (2002)

- Extending the McConnell and Perez-Quiros (2000) [Andrews test (1993) and critical values correction of Hansen (1997)] to more than one break
Testing for multiple breaks in variance

<table>
<thead>
<tr>
<th>Detecting changes in variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICSS algorithm</td>
</tr>
<tr>
<td>$IT(\kappa_1)$</td>
</tr>
</tbody>
</table>

- Only one break in volatility. 1984.2... even when we allow for more than one break. But still...
  - At the end of the sample. Trimming of the data
  - Too few observations of the new post GR period
Experiments 1 and 2. Dealing with the end of the sample

Experiment 1. Introduce the GR at each point of the GM

Experiment 2. Randomly mix the observations of the GM and the GR

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM SB</td>
<td>92.6</td>
<td>90.9</td>
</tr>
<tr>
<td>No SB</td>
<td></td>
<td>8.9</td>
</tr>
<tr>
<td>Random SB(s)</td>
<td>7.4</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Detecting changes in variance (Bai-Perron)

<table>
<thead>
<tr>
<th></th>
<th>GM SB + 1 random SB</th>
<th>GM SB + 2 random SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Experiments 3 and 4. Dealing with the short sample

Experiment 3: enlarge the duration after 2007.4 with the GR data (5, 10 and 15 years)

Experiment 4: enlarge the period after 2007.4 with the pre-GM data (5, 10 and 15 years)

<table>
<thead>
<tr>
<th></th>
<th>GM SB</th>
<th>No SB</th>
<th>Random SB(s)</th>
<th>GM SB + GR SB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+ 1 random SB</td>
</tr>
<tr>
<td>Experiment 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>100.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>10 years</td>
<td>100.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>15 years</td>
<td>100.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Experiment 4</td>
<td></td>
<td></td>
<td>GR</td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>68.0</td>
<td>1.4</td>
<td>1.4</td>
<td>29.2</td>
</tr>
<tr>
<td>10 years</td>
<td>24.2</td>
<td>17.3</td>
<td>10.0</td>
<td>0.0</td>
</tr>
<tr>
<td>15 years</td>
<td>5.6</td>
<td>41.4</td>
<td>0.0</td>
<td>12.8</td>
</tr>
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</table>
Experiment 3: enlarge the duration after 2007.4 with the GR data (5, 10 and 15 years)

Experiment 4: enlarge the period after 2007.4 with the pre-GM data (5, 10 and 15 years)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>GM SB</th>
<th>No SB</th>
<th>Random SB(s)</th>
<th>GM SB + 1 random SB</th>
<th>GM SB + 2 random SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 years</td>
<td>100.0</td>
<td></td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>10 years</td>
<td>100.0</td>
<td></td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>15 years</td>
<td>100.0</td>
<td></td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td></td>
<td></td>
<td></td>
<td>GR</td>
<td></td>
</tr>
<tr>
<td>10 years</td>
<td>68.0</td>
<td>1.4</td>
<td></td>
<td>1.4</td>
<td>29.2</td>
</tr>
<tr>
<td>15 years</td>
<td>24.2</td>
<td>17.3</td>
<td></td>
<td>10.0</td>
<td>0.0</td>
</tr>
<tr>
<td>15 years</td>
<td>5.6</td>
<td>41.4</td>
<td></td>
<td>12.8</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Experiments 3 and 4. Dealing with the short sample

Experiment 3: enlarge the duration after 2007.4 with the GR data (5, 10 and 15 years)

Experiment 4: enlarge the period after 2007.4 with the pre-GM data (5, 10 and 15 years)

<table>
<thead>
<tr>
<th>Detection changes in variance (Bai-Perron)</th>
<th>GM SB</th>
<th>No SB</th>
<th>Random SB(s)</th>
<th>GM SB + GR SB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+ 1 random SB</td>
</tr>
<tr>
<td>Experiment 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>100.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>10 years</td>
<td>100.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>15 years</td>
<td>100.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Experiment 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>68.0</td>
<td>1.4</td>
<td>1.4</td>
<td>29.2</td>
</tr>
<tr>
<td>10 years</td>
<td>24.2</td>
<td>17.3</td>
<td>10.0</td>
<td>48.5</td>
</tr>
<tr>
<td>15 years</td>
<td>5.6</td>
<td>41.4</td>
<td>0.0</td>
<td>40.1</td>
</tr>
</tbody>
</table>

Gadea, Gomez-Loscos and Perez-Quiros
The Two Greatest. Great Moderation vs Great Recession
One little thing... why does it take so long to capture the structural break?

Camacho and Perez-Quiros (2007, SNDE)
Experiment 5

Perhaps the key is that the pre-GM volatility is 1.12, and the GR volatility is 0.80 ⇒ Experiment 5: Enlarge the duration after 2007.4 with the GR data (5, 10 and 15 years) and the pre-GM volatility

<table>
<thead>
<tr>
<th></th>
<th>GM SB</th>
<th>No SB</th>
<th>Random SB(s)</th>
<th>GM SB</th>
<th>GM SB + GR SB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+ 1 random SB</td>
</tr>
<tr>
<td>Experiment 5</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5 years</td>
<td>96.9</td>
<td>3.0</td>
<td></td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>10 years</td>
<td>91.8</td>
<td>8.1</td>
<td></td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>15 years</td>
<td>77.8</td>
<td>19.1</td>
<td></td>
<td>0.5</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Data features

Illustration:
**Motivation**

The failure to predict the Great Recession

The Great Moderation is over

**Conclusions**

**Data features**

Illustration:

![Graph showing squared residuals of PGM and Squared residuals of GR with PGM volatility from 1953.2 to 2014.1.](image_url)
What is in the post GR data?

- Good luck?? There is GM even if we have 4 recessions in the next 15 years even bigger that the one we have recently live

- Good policy?? What kind of good policy allows for 4 recessions in the next 15 years

- Good practices?? Ramey and Vine (2006), Gali and Gambetti (2013), Camacho et al (2008), etc...
What do the pre-GM data have that is not present in the post GR data?

Wilcoxon test:

- Recessions before the GM are equal to the recession of the GR ⇒ Wilcoxon test, p-value 0.61

- First year of expansions before the GM are different from the first year of expansion of the GR ⇒ Wilcoxon test, p-value 0.02

- Second and third year of expansions. Statistically equal before and after the GM
Experiment 6

- Experiment 6 enlarge the post GR period with changes in the first year of the expansion

<table>
<thead>
<tr>
<th></th>
<th>GM SB</th>
<th>No SB</th>
<th>Random SB(s)</th>
<th>GM SB + GR SB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+ 1 random SB</td>
</tr>
<tr>
<td>Detecting changes in variance (Bai-Perron)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GR (Exp 3)</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GR+vol (Exp 5)</td>
<td>77.3</td>
<td>18.7</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>GR+Hrec</td>
<td>48.8</td>
<td>4.6</td>
<td></td>
<td>25.0</td>
</tr>
<tr>
<td>GR+Hrec+vol</td>
<td>9.6</td>
<td>74.0</td>
<td>0.1</td>
<td>10.2</td>
</tr>
</tbody>
</table>

GR and recovery

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GR and recovery</td>
<td>3.5</td>
<td>21.1</td>
</tr>
<tr>
<td></td>
<td>6.1</td>
<td></td>
</tr>
</tbody>
</table>
How big is the GM?

Gadea, Gomez-Loscos and Perez-Quiros

The Two Greatest. Great Moderation vs Great Recession
Table 3: Detecting changes in variance

<table>
<thead>
<tr>
<th>ICSS algorithm</th>
<th>Bai-Perron</th>
<th>McConnell-Perez-Quiros</th>
</tr>
</thead>
<tbody>
<tr>
<td>$IT(\kappa_2)$</td>
<td>Model 1</td>
<td></td>
</tr>
<tr>
<td>1917.4</td>
<td>1917.3</td>
<td>1951.1</td>
</tr>
<tr>
<td>1946.2</td>
<td>1947.1</td>
<td>1984.3</td>
</tr>
<tr>
<td>1984.1</td>
<td>1984.2</td>
<td></td>
</tr>
</tbody>
</table>

The first break found in the recursive analysis is 1984.2
How big is the GM?

(b) Smoothed states probabilities

(c) Time series segmentation based on smoothed states probabilities
Conclusions GM vs GR

- The GM still holds

- Papers that assume the end of the GM contradict the empirical evidence. They obtain conclusions before testing. As the sport press

- The fact that the GM still holds puts a question mark on the papers that postulate good luck or good policy

- The GM is not necessarily a good feature. It implies slower recoveries
Motivation

The failure to predict the Great Recession

The Great Moderation is over

Conclusions
One lesson and one assumption

- Dark corners should be seen in advance and can be seen in advance. Early warning systems

- Great Moderation is over (otherwise we would be still fooled). Thanks to its end, we can observe the dark corners
What recent crisis has brought to economics is the pressure to provide policymakers with solutions

Policymakers need stable rules that can support their policy decisions

We should be careful in explaining which evidence is descriptive and which can be used for normative purposes

The Great Moderation has not been killed by the Great Recession