The Great Moderation in Peruvian Time Series

with an application to welfare analysis

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Outline

- Introduction
- A naive approach
- Knowing the volatility reduction
- Some possible explanations
- An application to welfare analysis
- Concluding remarks

Introduction

Motivation

- A reduction in real GDP volatility is found in Castillo *et. al.* (2006) while describing stylized facts about the Peruvian economy.
- Volatility can be lowered by propagation mechanisms or shocks. Can we determine which was the main cause? What can we infer for policy issues about this?
- The reduction in real GDP volatility can be described as a structural break or a downward sloping trend? In the case of breaks, how many?
- Can we evaluate some possible explanations to gain further insight about what could have caused this?

Introduction

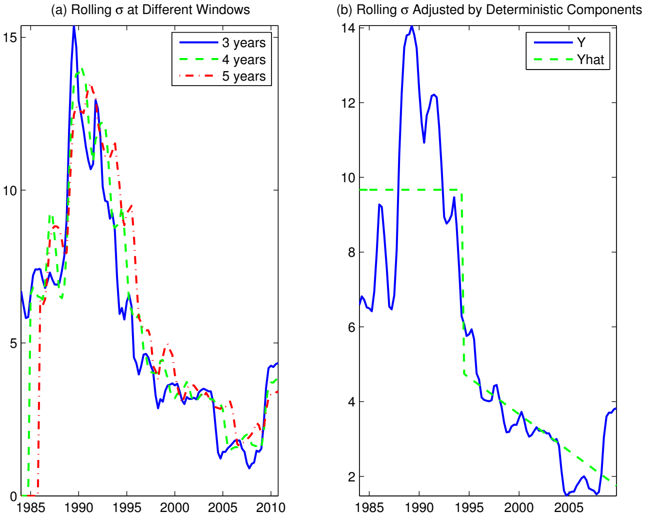
Previous Studies

- A reduction in volatility has ocurred in the main macroeconomic time series across the world. Kim and Nelson (1999), McConnell and Perez-Quiros (2000), Blanchard and Simon (2001), Stock and Watson (2002) have account that US real GDP has reduced its volatility around 1984. This is called 'The Great Moderation'.
- Multiple explanations: changes in the structure of economies, policy improvements and/or *good luck*.
- Multiple techniques: rolling window statistics, classical and bayesian structural break tests, TVP and stochastic volatility and others.
- In Peru, several studies have detected a reduction in volatility like Carranza *et. al.* (2003) and Castillo *et. al.* (2006)

Data Description and Techniques

- Year-to-Year differences in logs and seasonally adjusted
- Period: 1980.Q1 - 2010.Q3
- Rolling window estimates
- Bayesian changepoint models (and counterfactual analysis)
- Output gap estimates / MBBQ algorithm

A Naive Approach



Knowing the volatility reduction

Shocks or Propagation Mechanisms?: Specification

If real GDP is modelled as a AR(2)[1],

$$\triangle_4 y_t = \mu + \sum_{j=1}^{2} \phi_j \triangle_4 y_{t-j} + \epsilon_t$$

$$\epsilon_t \sim N(0, \sigma_\epsilon^2)$$

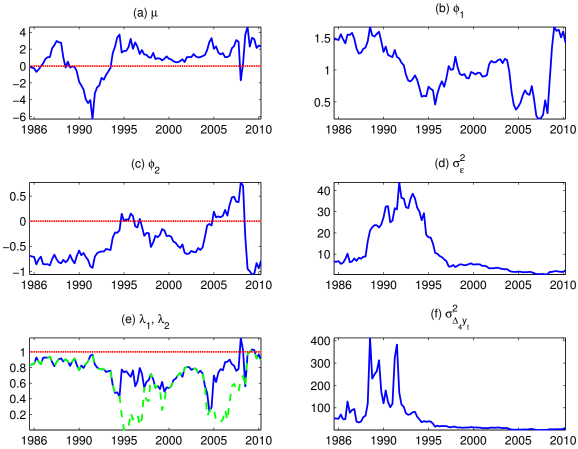
with unconditional variance,

$$\sigma^2_{\triangle_4 y_t} = \frac{(1-\phi_2)}{(1+\phi_2)((1-\phi_2)^2-\phi_1^2)}\sigma_\epsilon^2$$

[1] According to BIC

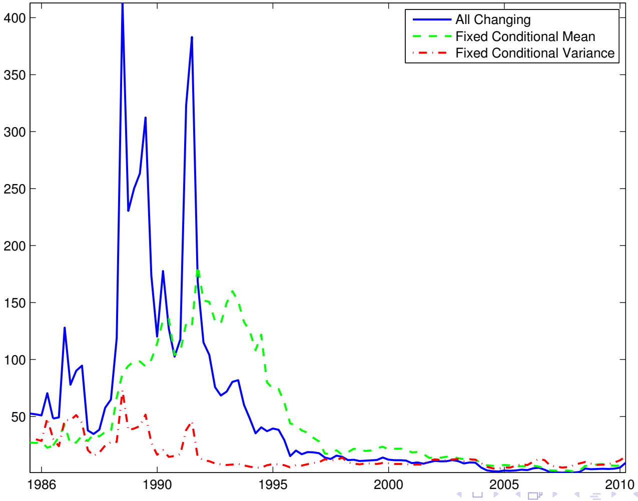
Knowing the volatility reduction

Shocks or Propagation Mechanisms?: Results - I



Knowing the volatility reduction

Shocks or Propagation Mechanisms?: Results - II



Knowing the volatility reduction

Dating the breakdate: Methodology - I

To investigate the volatility reduction, I expand the following empirical model based on Kim *et. al.* (2003)[2]:

$$x_t = \sum_{j=1}^{k} \phi_j x_{t-j} + \epsilon_t$$

$$\epsilon_t \sim N(0, \sigma^2_{D_t})$$

$$\sigma^2_{D_t} = \begin{cases} \sigma^2_{D_1} & 1 \leq t \leq \tau_1 \\ \sigma^2_{D_2} & \tau_1 < t \leq \tau_2 \\ \ldots & \\ \sigma^2_{k+1} & \tau_k < t \leq T \end{cases}$$

[2] nsim=11000, burn-in=3000

Knowing the volatility reduction

Dating the breakdate: Methodology - II

$$P = \begin{bmatrix} q_{11} & q_{12} & 0 & \dots & 0 \\ 0 & q_{22} & q_{23} & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & 0 & q_{kk} & q_{k,k+1} \\ 0 & 0 & \dots & 0 & 1 \end{bmatrix}$$

$$\begin{cases} \phi_i & \sim N(0,5) \\ \sigma_i^2 & \sim IG(1,1) \\ q_i & \sim Beta(8,0.5) \end{cases}$$

$$BIC(m) = 2lnL(\hat{\theta}/Y) - \lambda ln(T)$$

Knowing the volatility reduction

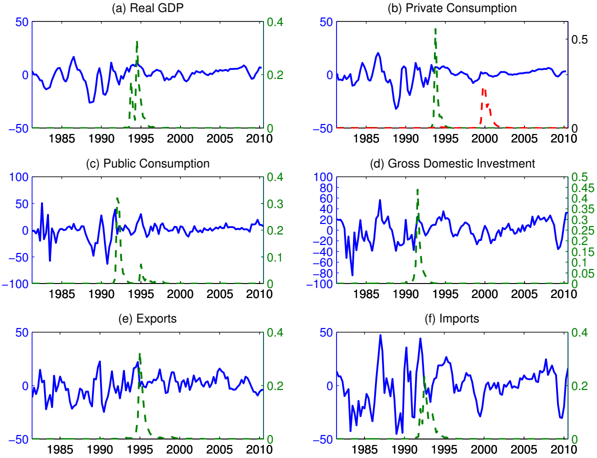
Dating the breakdate: Results - I

variable	AR(p)	No Break	1-Break	2-Breaks
Real GDP	2	-653.5211	-621.9083	-622.2594
Priv. Consumption	2	-703.0500	-616.6636	-616.1542
Pub. Consumption	1	-969.6630	-917.8549	-920.2225
Investment	1	-998.7201	-981.0700	-990.2610
Exports	1	-831.1650	-823.6528	-834.0881
Imports	1	-947.8313	-931.5743	-935.5539

Table: BIC model selection

Knowing the volatility reduction

Dating the breakdate: Results - II



Knowing the volatility reduction

Dating the breakdate: Results - III

variable	AR(p)	breaks	breakdates	$\frac{\sigma_1^2}{\sigma_0^2}$	$\frac{\sigma_2^2}{\sigma_1^2}$
Real GDP	2	1	1994.Q4	0.17	-
Priv. consumption	2	2	1994.Q1 / 2000.Q2	0.12	0.23
Pub. consumption	1	1	1993.Q4	0.11	-
Investment	1	1	1993.Q2	0.20	-
Exports	1	1	1995.Q1	0.26	-
Imports	1	1	1994.Q1	0.21	-

Table: Bayesian Results for demand and supply Real GDP components

Knowing the volatility reduction

Counterfactual Analysis: Main Idea

As a way to reinforce the importance of conditional variance (using information about the breakdates). I estimate an AR(2) using bayesian econometrics and performing counterfactual exercises. I obtain posterior distributions of $\phi^{(i)}$ -propagation- and $\sigma^2_{\epsilon_{(j)}}$ -shocks- where if i, j equals 1 or 2 corresponds to pre-break or post-break information. I obtain posterior distributions of unconditional variance $(\sigma^2_{\triangle_4 y_t})^{ij} = f(\phi^{(i)}, \sigma^2_{\epsilon_{(j)}})$ mixing pre-break and post-break posterior distributions of $\phi^{(i)}$ and $\sigma^2_{\epsilon_{(j)}}$.

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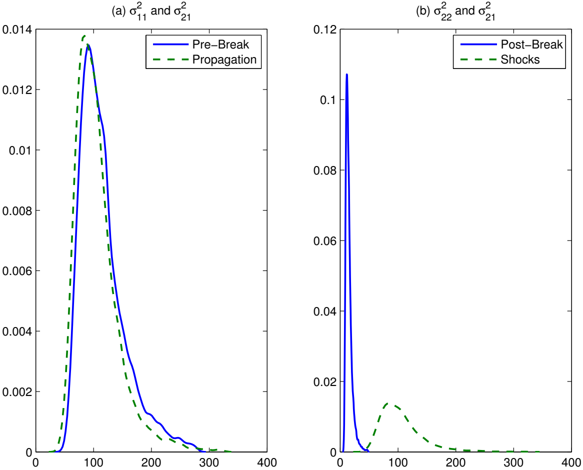
Counterfactual Analysis: Results



Knowing the volatility reduction

Was it in the trend or cycle component? - I

Following Gali (2002),

$$y_t = \overline{y_t} + \widetilde{y_t}$$

$$\Delta_4 y_t = \Delta_4 \overline{y_t} + \Delta_4 \widetilde{y_t}$$

$$\sigma_{\triangle_4 y_t} = \sqrt{\overline{s} + \widetilde{s} + 2\rho \overline{s}\widetilde{s}}$$

Knowing the volatility reduction

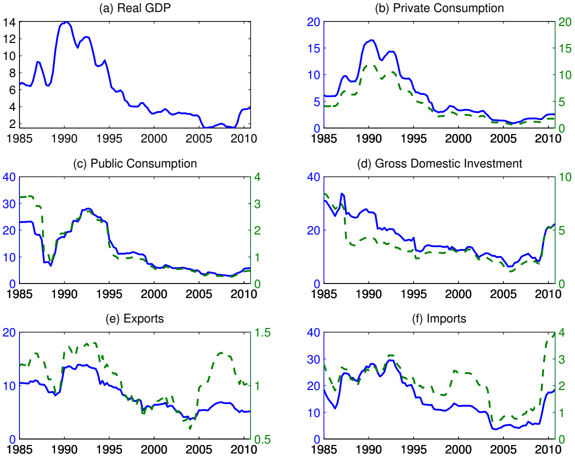
Was it in the trend or cycle component? - II

HP-filter			
	corr	std $(\Delta_4 \overline{y_t})$	std $(\Delta_4 \widetilde{y_t})$
full	0.19	3.12	6.30
1st	0.35	2.83	8.41
2nd	0.12	1.81	2.92
MNZ filter			
full	0.72	2.72	5.34
1st	0.73	3.37	7.03
2nd	0.71	1.29	2.58

Table: Real GDP Trend-Cycle Decompositions

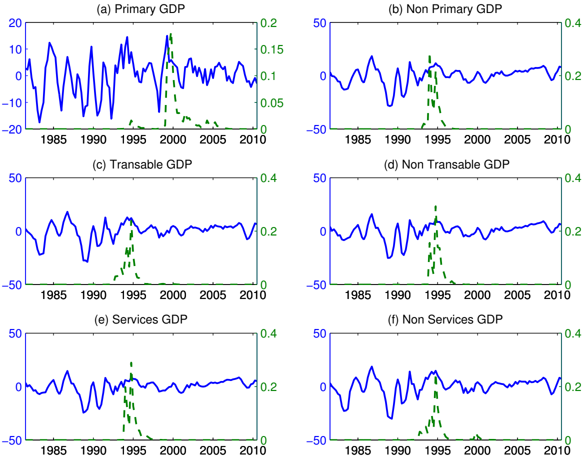
Some possible explanations

Real GDP supply and demand composition



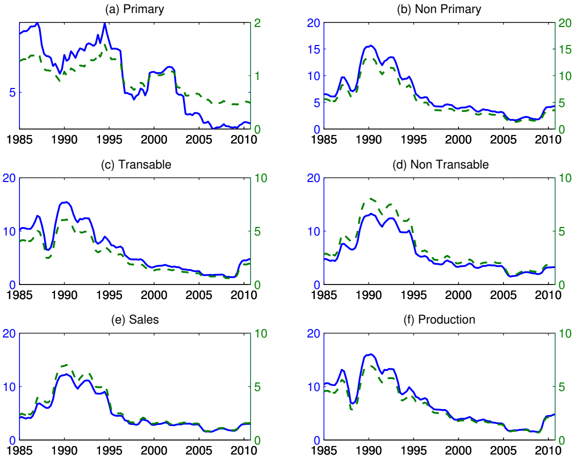
Some possible explanations

Real GDP production composition - I



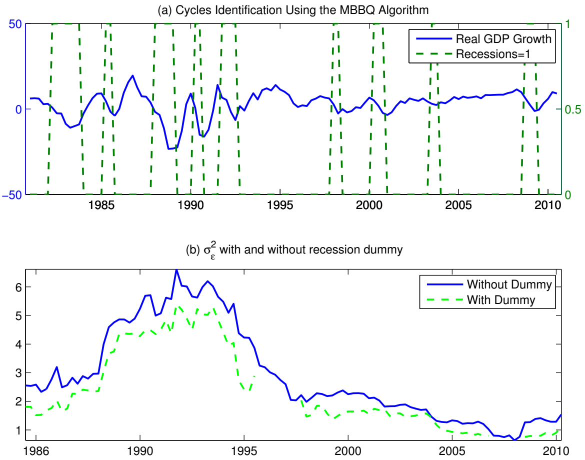
Some possible explanations

Real GDP production composition - II



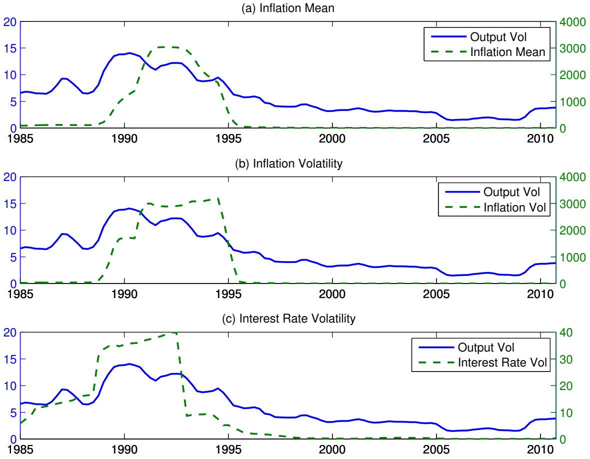
Some possible explanations

The role of large negative shocks



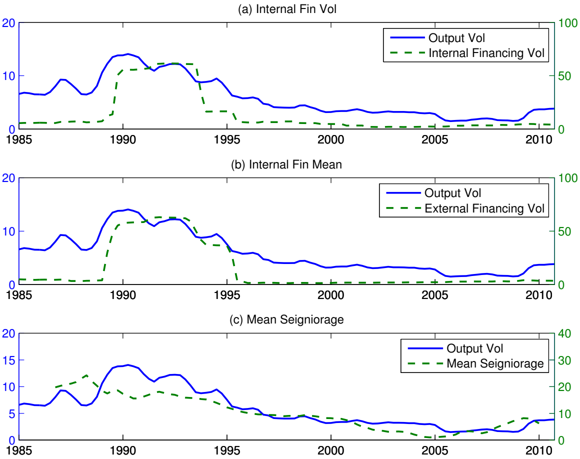
Some possible explanations

What kind of smaller shocks?: Monetary Variables



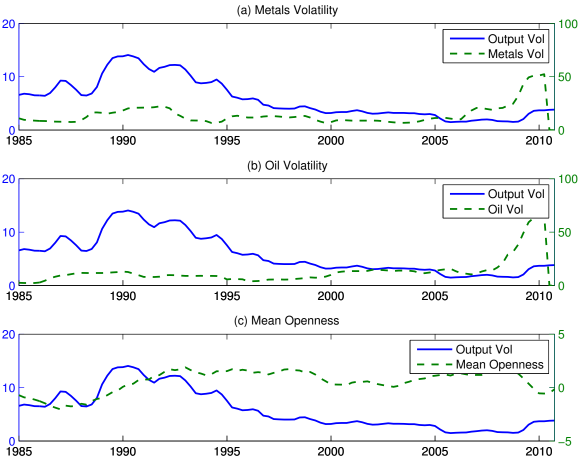
Some possible explanations

What kind of smaller shocks?: Fiscal Variables



Some possible explanations

What kind of smaller shocks?: Other Variables



An application to welfare analysis

Methodology

I consider a model similar to Reis (2009),

$$\sum_{t=0}^{\infty} \beta^t U(c_t^{certain}) = E(\sum_{t=0}^{\infty} \beta^t U((1+\lambda)c_t^{uncertain})$$

Imposing $c_t^{certain} = C_0 e^{gt}$ and $c_t^{uncertain} = C_0 e^{gt} e^{\hat{c}_t - \frac{1}{2} var(\hat{c}_t)}$, where $\hat{c}_t$ corresponds to the detrended private consumption and considering log-normality,

$$C_0^{1-\sigma}(1+\lambda)^{1-\sigma} e^{-\sigma(1-\sigma)\frac{1}{2} var(\hat{c}_t)} = C_0^{1-\sigma}$$

$$\lambda = e^{\frac{\sigma}{2} var(\hat{c}_t)} - 1$$

An Application to Welfare Analysis

Results

Under $\sigma = 1$

Concluding remarks

- Structural breaks on shocks were the main cause for the reduction in volatlity in real GDP and its components.
- As (mostly) all the breaks occur around 1994 and in conjunction with the greater volatility reduction in output gap, the event that caused this reduction should be: a) sudden and b) policy induced.
- After evaluating some possibilities, the event that most fits the description above is the inflation stabilization process that happened in the beginning of 1990s.
- Finally, as a policy recommendation all sorts of endogeneous shocks (fiscal, monetary, political) should be limited or eliminated and in the case of exogeneous shocks (commodities, external interest rate and/or demand), counterpolicies should be adopted to reduce their contemporary effects.

Concluding remarks

Further Research

- A structural approach: Stock and Watson (2001) compare the size of structural shocks (monetary, fiscal, external) through a SVAR by pre and post-break samples.
- Multivariate output gap estimates: Semistructural or model based.
- Include and evaluate a structural break in the intercept.