Measuring the Benefits of Political and Economic Integration of Hong Kong with China Mainland
A Panel Data Approach for Program Evaluation

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June 2008
Agenda

- Introduction
- Panel Data Approach for Program Evaluation
- Assessment of the Benefits of Political and Economic Integration
- Sector Analysis
  - Individual Visitor Program
  - Others
- Concluding Remarks
Some Facts about Hong Kong

- Ceded to U.K. after the opium war in 1842
- Reverted Sovereignty on July 1, 1997
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- Asian Financial Crisis in October 1997
- H5N1 Avian Flu in December 1997
- Severe Acute Respiratory Syndrome (SARS) in March 2003
CEPA (January 1, 2004)

Implementation in three phases:
- Jan 2004
- Jan 2005
- Jan 2006

To strengthen the linkage between mainland China and Hong Kong
- Liberalize trades
- Remove the tariff for various products (273 products in Jan 2004 to 713 products in Jan 2005; by Jan 2006, all Hong Kong products that meet the rules of origin criteria)

Enhance cooperation in the area of finance
Promote investment facilitation and mutual recognition of professional qualifications
Launch the Individual Visit Scheme for Mainland China residents
Some Statistics about Hong Kong

- **Population:**
  - 2.6 million in 1950
  - 6.5 million in 1997

- **Per capita income:**
  - USD 410 in 1961 (13.8% of U.S.)
  - USD 23,509 in 1997 (67.2% of U.S.)
  - USD 26,491 in 2003

- **Hang Seng Index**
  - 15,196 in July 1997
  - 10,722 in December 1997

- **Growth rate:**
  - -0.67% in 2003Q2
  - 6.9% in 2007Q4
  - 7.1% in 2008Q1
What We Try to Do

- Assess the economic impact of reverting the sovereignty to China
  - Compare HK’s Real GDP growth path with the Counterfactual’s growth path as if there were no change of sovereignty in 1997
- Quantify the effect of the economic integration
  - Compare HK’s Real GDP growth path with the Counterfactual’s growth path as if there were no CEPA signed in 2003
Nationalism vs. Western Supremacy

The Focus Group on Trade and Business proposed in Sept 2006 that the Hong Kong Administration should carry out researches on the economic benefits of CEPA on Hong Kong economy to facilitate CEPA promotional work.


Legislative Council Panel on Commerce and Industry has produced several reports on the impact of CEPA on the Hong Kong economy (CB(1)861/04-05(03), CB(1) 1259/04-05(03), CB(1) 1849/06-07(04))
Why An Additional One?

- Theoretical literature on growth and development highly abstract
- Econometric Modelling
  - translate theory into empirical studies often rely on highly improbable (or restrictive) assumptions
  - data demand is huge
  - policy change \( \rightarrow \) changes in expectation
  - Structural Change
  - (Not enough sample observations to estimate key parameters after structural break)
Challenges

- Observe either outcomes under the (policy) intervention or outcomes without intervention, but not both
- \( y_{it}^1 = \) outcomes of the \( i \)th unit at time \( t \) under treatment or intervention
- \( y_{it}^0 = \) outcomes of the \( i \)th unit at time \( t \) with no treatment or intervention
- Treatment effect for the \( i \)th unit at time \( t \)
  \[ \Delta_{it} = y_{it}^1 - y_{it}^0 \]
- Can only observe either \( y_{it}^1 \) or \( y_{it}^0 \)
- Observed data \( y_{it} = d_{it} y_{it}^1 + (1 - d_{it}) y_{it}^0 \)
- \( d_{it} = \begin{cases} 1 & \text{if } i \text{th unit at time } t \text{ is under treatment} \\ 0 & \text{otherwise} \end{cases} \)
Challenges

To assess the effect of policy intervention we need to be able to construct counterfactuals – outcomes of a subject had there been no such policy implemented

Need to know:

- How and why Hong Kong economy has grown over time?
- How China factor plays a role in Hong Kong’s investment, labor, entrepot, immigration, tourism, international finance center (the role of portfolio investment, transfer pricing, etc.), center for creativity, etc?
- Are there any common factors affecting the whole region?
- How changes in policy affects people’s expectation and behavior?
## Growth Rates for H.K., Taiwan, South Korea, Singapore, and Mainland China

<table>
<thead>
<tr>
<th>Year</th>
<th>H.K.</th>
<th>Taiwan</th>
<th>South Korea</th>
<th>Singapore</th>
<th>Mainland China</th>
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<tbody>
<tr>
<td>1961 – 1966</td>
<td>7.80</td>
<td>5.05</td>
<td>3.60</td>
<td>2.76</td>
<td>3.88</td>
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<tr>
<td>1966 – 1971</td>
<td>4.17</td>
<td>6.54</td>
<td>8.23</td>
<td>10.72</td>
<td>6.70</td>
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<tr>
<td>1971 - 1981</td>
<td>6.52</td>
<td>7.45</td>
<td>6.41</td>
<td>7.60</td>
<td>6.10</td>
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<td>1991 – 1996</td>
<td>3.51</td>
<td>5.52</td>
<td>6.22</td>
<td>6.60</td>
<td>12.08</td>
</tr>
<tr>
<td>1997 – 2003</td>
<td>2.61</td>
<td>3.50</td>
<td>4.04</td>
<td>3.98</td>
<td>8.09</td>
</tr>
<tr>
<td>2004 – 2006</td>
<td>7.41</td>
<td>2.60</td>
<td>4.55</td>
<td>7.49</td>
<td>10.30</td>
</tr>
</tbody>
</table>

A Panel Approach to Program Evaluation

Model

- Assume that $y_{it}^0$ is generated by a dynamic factor model of the form,

$$y_{it}^0 = \alpha_i + b'_i f_t + \varepsilon_{it}$$

  - $\alpha_i =$ individual-specific effects
  - $f_t = K \times 1$ (unobserved) common factors that vary over time
  - $b'_i = 1 \times K$ vector of constants that may vary across $i$
  - $K =$ number of common factors
  - $\varepsilon_{it} =$ $i$th unit idiosyncratic component

- Matrix representation

$$y_t^0 = \alpha + B f_t + \varepsilon_t , t = 1, ..., T_1 \quad (1)$$

$$y_t^0 = (y_{1t}^0, \ldots, y_{Nt}^0)'$$

$\alpha = (\alpha_1, \ldots, \alpha_N)'$

$\varepsilon_t = (\varepsilon_{1t}, \ldots, \varepsilon_{Nt})'$

$B$ is the $N \times K$ factor loading matrix $B = (b'_i)$
Assumptions

\[ y_{1t} = \begin{cases} y_{1t}^0 & \text{for } t = 1, \ldots, T_1 \\ y_{1t}^1 & \text{for } t = T_1 + 1, \ldots, T \end{cases} \]

\[ y_{jt} = \begin{cases} y_{jt}^0 & \text{for } j = 2, \ldots, N ; \text{ and } t = 1, \ldots, T_1, T_1 + 1, \ldots, T \end{cases} \]

Assumption 1: \( \lim \frac{1}{N} \sum_{i=1}^{N} \alpha_i^2 = O(1) \).

Assumption 2: \( \varepsilon_t \) is \( I(0) \) with \( E(\varepsilon_t) = 0 \) and \( E(\varepsilon_t \varepsilon_t') = V \), where \( V \) is a diagonal constant matrix.

Assumption 3: \( E(\alpha \varepsilon_t') = 0 \).

Assumption 4: \( \text{rank}(B) = K \).

Assumption 5: \( E(\varepsilon_{js}|d_{it}) = 0 \) for all \( j \neq i \).

Assumption 6: There exists a \( w \in N(B) \) such that in the neighborhood of \( w \),

\[
E \left[ \frac{1}{T_1} \left( y_1^0 - e\bar{\alpha} - Y\beta \right)' A \left( y_1^0 - e\bar{\alpha} - Y\beta \right) \right] 
\]

has a unique minimum.
The outcomes can be affected by:

- individual specific components: $\alpha_i$ and $\varepsilon_{it}$
- common factors $f_t$ at different levels $b_i \neq b_j$

No assumption is made about the time series properties of $f_t$

- nonstationary or stationary

A4 implies that $N > K$ which matches with the existing literature that the number of common factors driving many macro economic time series is usually quite small

Relax the assumptions about zero correlation between $\varepsilon_{it}$ and $f_t$
Transformation of Model (1)

- Notations:
  - \( w' = (1, -w'_{-1}) = 1 \times N \) vector that lies on the null space of \( B \)
  - \( y_{-1t} = (y_2t, ..., y_{Nt})' \)
  - \( \varepsilon_{-1t} = (\varepsilon_2t, ..., \varepsilon_{Nt})' \)

- Then:

\[
w'B = 0'
\] (3)

\[
y_{1t}^0 = \bar{\alpha} + w'_{-1}y_{-1t} + \varepsilon_{1t} - w'_{-1}\varepsilon_{-1t}
\] (4)
Transformation of Model (1)

The Mean

Then for any \( w \in N(B) \),

\[
y_{1t}^0 = E (y_{1t}^0 | y_{-1t}) + u_{1t},
\]

(5)

\[
E (y_{1t}^0 | y_{-1t}) = \bar{\alpha} + w_{-1}' y_{-1t} + E (\epsilon_{1t} | y_{-1t}) - E (w_{-1}' \epsilon_{-1t} | y_{-1t})
\]

(6)

\[
= \bar{\alpha} + \beta' y_{-1t}
\]

\[
\beta' = w_{-1}' \left( I_{N-1} - \text{Cov} (\epsilon_{-1t}, y_{-1t}) \text{Var} (y_{-1t})^{-1} \right)
\]

(7)

\[
+ \text{Cov} (\epsilon_{1t}, y_{-1t}) \text{Var} (y_{-1t})^{-1}
\]

\[
u_{1t} = w' \epsilon_{t} - \text{Cov} (\epsilon_{1t}, y_{-1t}) \text{Var} (y_{-1t})^{-1} y_{-1t}
\]

(8)

\[
+ w_{-1}' \text{Cov} (\epsilon_{-1t}, y_{-1t}) \text{Var} (y_{-1t})^{-1} y_{-1t}
\]
Then for any $\mathbf{w} \in N(B)$,

$$
\begin{align*}
\text{Var} \left( y_{1t}^0 | y_{-1t} \right) &= \text{Var} \left( \varepsilon_{1t} \right) - \text{Cov} \left( \varepsilon_{1t} , y_{-1t} \right) \text{Var} \left( y_{-1t} \right)^{-1} \text{Cov} \left( y_{-1t} , \varepsilon_{1t} \right) \\
&+ \mathbf{w}'_{-1} \text{Var} \left( \varepsilon_{-1t} \right) \mathbf{w}_{-1} \\
&- \mathbf{w}'_{-1} \left[ \text{Cov} \left( \varepsilon_{-1t} , y_{-1t} \right) \text{Var} \left( y_{-1t} \right)^{-1} \text{Cov} \left( y_{-1t} , \varepsilon_{-1t} \right) \right] \mathbf{w}_{-1}
\end{align*}
$$

(9)
For any $\mathbf{w} \in N(B)$, denote $\theta \equiv (\bar{\alpha}, \beta')$, the objective function is:

$$
\frac{1}{T_1} \left( \mathbf{y}_1^0 - \mathbf{e}\bar{\alpha} - \mathbf{Y}\beta \right)' A \left( \mathbf{y}_1^0 - \mathbf{e}\bar{\alpha} - \mathbf{Y}\beta \right)
$$

(11)

$\mathbf{y}_1^0 = (y_{1,1}, \ldots, y_{1,T_1})$

$\mathbf{e}$ is a $T_1 \times 1$ vector of 1’s

$\mathbf{Y}$ is a $T_1 \times (N - 1)$ matrix of $T_1$ time series observations of $(\mathbf{y}'_{-1t})$

$A$ is a $T_1 \times T_1$ positive definite matrix
Lemma 1 – The Estimator
Consistency and Efficiency

- **Consistency:**
  - Under A1-A6, the solution of (11), \( \hat{\theta} \equiv (\hat{\alpha}, \hat{\beta}') \) converges to a \( \theta \equiv (\bar{\alpha}, \beta')' \) that corresponds to a \( w \in N(B) \).

- **Efficiency:**
  - When \( A = I \), and \( y_t \) is stationary, the estimator (7) is the least squares estimator.
  - When \( A \) equals the inverse of \( E (u_1 u_1') \), where \( u_1 = (u_1,1, ..., u_1, T_1)' \), the estimator is efficient.
Lemma 2 – The Treatment Effect
Mean and Variance

- Notation:
  - \( Y'_t = (y_{-1,1}, \ldots, y_{-1,t}) \) is a \((N - 1) \times t\) matrix

- Estimator:
  \[
  \hat{\Delta}_1 t = y_{1t} - \hat{y}^0_{1t} \quad \text{for} \quad t = T_1 + 1, \ldots, T,
  \]
  (12)

- Mean:
  \[
  E \left( \hat{\Delta}_1 t \mid Y'_{T_1}, y_{-1t} \right) = \Delta_1 t \quad \text{for} \quad t = T_1 + 1, \ldots, T,
  \]
  (13)

- Variance:
  \[
  \text{Var} \left( \hat{\Delta}_1 t \right) = \text{Var} \left( u_{1t} \right) + (1, y'_{-1t}) \Sigma (1, y'_{-1t})'
  \]
  (14)

  where \( \Sigma \) is the variance covariance matrix of \( \hat{\theta} \)
Assumption 7: \( \{ \varepsilon_{it} \} \) is weakly dependent (mixing) for all \( i \)

Suppose the treatment effects, \( \Delta_{1t} \), follow an autoregressive moving average model (ARMA)

If the treatment effect is stationary, then the long-term treatment effect is:

\[
\Delta_1 = a(L)^{-1} \mu = \mu^*
\]  

If one of the roots of \( a(L) = 0 \) lies on the unit circle, \( \Delta_{1t} \) is nonstationary, \( I(1) \).

Box-Jenkins (1970) procedure:

\[
\tilde{a}(L) \hat{\Delta}_{1t} = \tilde{\mu} + \tilde{\theta}(L) \nu_t,
\]
Lemma 4: Suppose the roots of \( a(L) = 0 \) lie outside the unit circle, under A1 - A7, when both \( T_1 \) and \( (T - T_1) \) go to infinity,

\[
p \lim \tilde{a}(L)^{-1} \tilde{\mu} = p \lim \hat{\mu}^* = \mu^* = a(L)^{-1} \mu
\]

(17)

and

\[
\sqrt{T - T_1} (\hat{\mu}^* - \mu^*) \sim N \left( 0, \sigma_{\mu^*}^2 \right),
\]

(18)

where

\[
\sigma_{\mu^*}^2 = \frac{\partial \mu^*}{\partial \gamma} \text{Var} \left( \sqrt{T - T_1} \hat{\gamma} \right) \frac{\partial \mu^*}{\partial \gamma}
\]

(19)

and \( \gamma = (\tilde{\mu}, \tilde{a}_1, ..., \tilde{a}_p)' \), assuming \( \tilde{a}(L) \) is of \( p \)-th order.
Lemma 5: Suppose all the roots of $a(L) = 0$ lie outside the unit circle, under A1 - A7, when both $T_1$ and $(T - T_1)$ go to infinity,

$$p \lim_{(T - T_1) \to \infty} \frac{1}{T - T_1} \sum_{t=T_1+1}^{T} \hat{\Delta}_{1t} = \Delta_1$$

(20)

The variance of (20) can be approximated by the heteroscedastic-autocorrelation consistent (HAC) estimator of Newey and West (1987).
Data

- **Period:** 1993Q1 to 2007Q1
- **Quarterly Real Growth Rate**
- **Countries:** China, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, US

**Sources:**

- International Financial Statistics
- CEIC Database
- China’s National Bureau of Statistics
- U.S.’s Bureau of Economic Analysis
Political Integration

- Handover on July 1, 1997
- Use 1993Q1 to 1997Q2 to construct optimal weights
- Statistically insignificant result:

\[
\Delta_{1t} = -0.0021 + 1.2137 \Delta_{1t-1} - 0.5175 \Delta_{1t-2} + \eta_{1t} \tag{21}
\]
### Optimal Weights (Political Integration)

**1993Q1 – 1997Q2**

<table>
<thead>
<tr>
<th></th>
<th>Beta</th>
<th>STD</th>
<th>T-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.0178</td>
<td>0.0532</td>
<td>-0.3342</td>
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<tr>
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<td>Taiwan</td>
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<td>0.3293</td>
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<td>China</td>
<td>0.4389</td>
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</table>

**R-Square = 0.8861**
### Treatment Effect of Political Integration

1997Q3 – 2003Q4

<table>
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<th>Actual</th>
<th>Control</th>
<th>Treatment</th>
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<td>0.0569</td>
<td>0.0606</td>
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<td>Dec-97</td>
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<td>Sep-99</td>
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<td>Dec-03</td>
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<td><strong>MEAN</strong></td>
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<td><strong>STD</strong></td>
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Actual and Predicted Real GDP Growth (Political Integration)
1993Q1 – 1997Q2
Actual and Counterfactual Real GDP Growth (Political Integration)
1997Q3 – 2003Q4
Autocorrelation of Treatment Effect (Political Integration)
1997Q3 – 2003Q4
Error of Treatment Effect Model AR(2) (Political Integration)
1997Q3 – 2003Q4
Economic Integration

- CEPA signed in 2003Q2
- Given no significant effect of political integration, the data is pooled to construct optimal weight
- Use 1993Q1 to 2004Q1 to construct optimal weights
- Results: Statistically significant
### Optimal Weights (Economic Integration)

1993Q1 – 2003Q4

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<thead>
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<th></th>
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<td>-0.9952</td>
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<td>US</td>
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R-Square = 0.8948
## Treatment Effect of Economic Integration

### 2004Q1 – 2007Q1

<table>
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<td>Mar-07</td>
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<tr>
<td>STD</td>
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<td>0.0076</td>
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Actual and Predicted Real GDP Growth (Economic Integration)
1993Q1 – 2003Q4
Actual and Predicted Real GDP Growth (Economic Integration)

2004Q1 – 2007Q1
Autocorrelation of Treatment Effect (Economic Integration)
2004Q1 – 2007Q1
Regression Results of Log(Real GDP) I

\[ \log(GDP_t) = a + bt + v_t \]

<table>
<thead>
<tr>
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<tbody>
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<td></td>
<td>Beta</td>
<td>Std</td>
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<td>Constant</td>
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<td>Time</td>
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Time Plot of Log(Real GDP)

Quarter

Actual Path
Predicted Path
Time Trend of Log(Import)
Time Trend of Log(Re-Export from China)
Regression Results of Log(Real GDP) II

\[
\log(GDP_t) = a + b \log(Re - Export\ from\ China_t) + c \log(Import_t) + d \log(Visitor) + \nu_t
\]

<table>
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<th></th>
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</thead>
<tbody>
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<td>Beta</td>
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<td>T-test</td>
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<td>Constant</td>
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<td></td>
<td>0.1429</td>
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<tr>
<td>Log(Re-Export from China)</td>
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<tr>
<td>Log(Import)</td>
<td>0.3662</td>
<td>0.119</td>
<td>5.4312</td>
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<tr>
<td>Log(Visitor)</td>
<td>0.0648</td>
<td>0.0119</td>
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Regression Results of Log(Real GDP) III

<table>
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<td>3.1923</td>
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<td>Log(Import)</td>
<td>0.3538</td>
<td>0.0254</td>
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<tr>
<td>Log(Visitor)</td>
<td>0.0645</td>
<td>0.0114</td>
<td>5.6479</td>
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</table>

Structural Break Test:

\[
F[3, 59] = \frac{\left( SSR1 - SSR2 - SSR3 \right)}{3} \frac{1}{\left( SSR2 + SSR3 \right)/(T - 6)} = 3.4492 (> 2.76)
\]
Actual and Predicted Log(GDP) over time
Regression Results of Log(Real GDP) IV

<table>
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<tbody>
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<td>Log(Re-Export from China)</td>
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<td>Log(Visitor)</td>
<td>0.0618</td>
<td>0.0123</td>
<td>5.0086</td>
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</table>

Structural Break Test:

\[
F[3, 59] = \frac{(SSR1 - SSR2 - SSR3) / 3}{(SSR2 + SSR3) / (T - 6)} = 5.7488 (> 2.76)
\]
Actual and Predicted Log(GDP) over time

Quarter

JUN93  JUN95  JUN97  JUN99  JUN01  JUN03  JUN05  JUN07

Actual Path
Predicted Path
Concluding Remarks

- HK & Mainland are linked together in many ways (e.g. tourism, entrepot, FDI to and from China, immigration from China, financial arrangement)
- It is very difficult to identify these linkages and the implications of each linkage.
- This paper proposed a simple to implement panel data approach to provide a quantification measure of the impact of policy intervention.
- The method also allows us to bypass the selection (a participation) issue that often complicates the study of the effects of policy intervention with a short univariate time series approach (e.g. Box and Tiao (1975))
- We find that the reversion of sovereignty of HK to China had no effect on HK’s growth.
- On the other hand, CEPA has a significant impact. It raises HK’s real economic growth rate by 2.82% a year compared to without such an agreement
Concluding Remarks

- The future of Hong Kong hinges on its economic integration with China Mainland
- CEPA takes concrete steps to remove barriers between Hong Kong and the Mainland
- It has also helped rebuild confidence in the economy after a prolonged period of economic stagnation
  - For instance, the value of total receipts for the restaurant sector in 2008Q1 was at $19.5 billion, up by 15.8% compared with 2007Q1
  - The value of total retail sales in March was at $22.6 billion, increased by 20% compared with a year earlier
- Challenges of economic liberalization can only stimulate competitive spirits and entrepreneurship to transform Hong Kong economy