HOUSE PRICE INDEXES AND CYCLICAL BEHAVIOR

Marcelo Bianconi  
*Department of Economics*  
*Tufts University*

Joe A. Yoshino  
*Department of Economics*  
*University of Sao Paulo & Fipe-USP*

Prepared for the Workshop on Measures of Cost of Living; Central Bank of Brazil, Brasilia, January 31-February 2, 2011
The basic idea:

- **Well known:**
  - A house price index calculated via the average method may overestimate or underestimate the actual change in house prices by the so-called composition effect.

- **Our main claim:**
  - A house price index calculated via
    - the time dummies hedonic direct method
    - the average method
    - includes *cyclical behavior of observables and non observables that may overestimate or underestimate the actual change in house prices, well beyond the composition effects.*
What Do We Do?

- We propose the use of alternative characteristics hedonic functions to compute alternative house price indexes that differentiate the sources of observable shocks in the index.
  - We can potentially filter out some sources of shocks.

- We use data on new apartment offerings in the municipality of Sao Paulo, Brazil.

Bianconi and Yoshino 28-Jan-11
Data: Embraesp

- **Brazilian Property Studies (Embraesp):** Collects data on all residential and commercial initial offerings in São Paulo.
- We use information about vertical residential initial offerings.
- Monthly observations on residential properties from January 2001 to March 2008: 1487 obs total.
- Other variables:
  - Location and size of parks: Department of the Environment of São Paulo;
  - Location of subways and trains stations: Laboratory of Urban Metropolis, University of Sao Paulo;
  - Location and size of slums: Centre for Metropolitan Studies;
  - Macroeconomic variables: Central Bank of Brazil
Price Indexes

- $p(i,t)$: nominal price per square meter of livable space

- Average:
  \[ \text{Mean}(\log p_t) - \frac{1}{n_t} \sum_i \log p_{i,t} \]

  where $n_t$ is the number of new offerings in period $t$.

- Hedonic Time Dummies Direct:
  \[
  \log p_{i,t} = \beta_0 + \beta_1 \text{bedr}_{i,t} + \beta_2 \text{bedr}^2_{i,t} + \beta_3 \text{bath}_{i,t} + \beta_4 \text{gar}_{i,t} + \beta_5 \text{elev}_{i,t} + \beta_6 \text{u_floor}_{i,t}
  \]
  \[
  + \sum_{m=\text{Feb,2001}}^{\text{March,2008}} \beta_m \text{month}_{m,i} + \epsilon_{i,t}
  \]

Bianconi and Yoshino

28-Jan-11
Price Indexes: Average and Hedonic Direct Time Dummy

House Price Indexes: Geometric Mean and Hedonic Characteristics
December 2005 - March 2008

Bianconi and Yoshino

28-Jan-11
Thought experiment:
- Denote hedonic time dummy direct index \(td\_index_t\)
- Regress \(td\_index_t\) on a set of variables representing observable aggregate factors:

\[
\begin{align*}
    td\_index_t &= \beta_0 + \beta_1 \text{sharpe\_bov}_t + \beta_2 \text{cred\_gdp\_br}_t + \beta_3 \text{selic}_{i,t} \\
    &\quad + \beta_4 \text{fx\_br}_t + \beta_5 \text{case\_shiller}_t + \beta_6 \text{sharpe\_sp500}_t + \epsilon_t
\end{align*}
\]

Nominal variables:
- Selic (overnight) nominal interest rate in Brazil (rate per month)
- Nominal exchange rate with the US (Fx, BRL$/US$)

Real variables:
- Sharpe ratio of the Bovespa Brazilian stock market
- Proportion of total credit over GDP

US variables:
- Case-Shiller house price index
- Sharpe ratio of the SP500.
**Price Index and Aggregate Behavior**

- **Thought Experiment:**

<table>
<thead>
<tr>
<th>Table 8: Time Dummies Index Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dep. Vble</td>
</tr>
<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td>L. td_index</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sharpe_Bov</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Cred/GDP</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Selic</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fx</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Case_Shiller</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sharpe_sp500</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Cons</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N</th>
<th>86</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adj R-sq</td>
<td>0.935</td>
</tr>
</tbody>
</table>

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

---

F-Tests
- Real Variables: Sharpe_Bov; Cred/GDP
  - $F(2, 78) = 8.81***$
- Nominal Variables: Selic; Fx
  - $F(2, 78) = 5.86***$
- US Variables: case_shiller; Sharpe_sp500
  - $F(2, 78) = 9.42***$

---

Bianconi and Yoshino 28-Jan-11
### Table 8: Time Dummies Index Regression

<table>
<thead>
<tr>
<th>Dep. Vble</th>
<th>td_index</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. td_index</td>
<td>0.571***</td>
</tr>
<tr>
<td>(0.0679)</td>
<td></td>
</tr>
<tr>
<td>Sharpe_Bov</td>
<td>0.445</td>
</tr>
<tr>
<td>(0.478)</td>
<td></td>
</tr>
<tr>
<td>Cred/GDP</td>
<td>1.332***</td>
</tr>
<tr>
<td>(0.335)</td>
<td></td>
</tr>
<tr>
<td>Selic</td>
<td>-4.019</td>
</tr>
<tr>
<td>(2.496)</td>
<td></td>
</tr>
<tr>
<td>Fx</td>
<td>4.744**</td>
</tr>
<tr>
<td>(1.400)</td>
<td></td>
</tr>
<tr>
<td>Case_Shiller</td>
<td>0.113***</td>
</tr>
<tr>
<td>(0.0262)</td>
<td></td>
</tr>
<tr>
<td>Sharpe_sp500</td>
<td>-0.335</td>
</tr>
<tr>
<td>(0.457)</td>
<td></td>
</tr>
<tr>
<td>Cons</td>
<td>24.33*</td>
</tr>
<tr>
<td>(11.05)</td>
<td></td>
</tr>
</tbody>
</table>

| N              | 86       |
| Adj R-sq       | 0.935    |

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard errors in parentheses</td>
<td></td>
</tr>
<tr>
<td>* p&lt;0.05; ** p&lt;0.01; *** p&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

**F-Tests**
- Real Variables: Sharpe_Bov, Cred/GDP
  - $F(2, 78) = 8.81***$
- Nominal Variables: Selic, Fx
  - $F(2, 78) = 5.86***$
- US Variables: case_shiller, Sharpe_sp500
  - $F(2, 78) = 9.42***$

- Thought Experiment:
  - All blocks are statistically significant

**Aggregate variables covary with the index**

---

Bianconi and Yoshino 28-Jan-11
Price Index and Cyclicality

Real Variables - Sharpe_Bov and Credit/GDP

Cross-correlogram

House Price Index
Credit/GDP
Sharpe_Bov

Cross-correlogram

D.House Price Index and D.Sharpe_Bov

Cross-correlogram

D.House Price Index and D.Credit/GDP

Bianconi and Yoshino

28-Jan-11
Price Index and Cyclicality

Nominal Variables - Selic and Fx

Cross-correlogram

House Price Index and D.Selic

D.House Price Index and D.Selic

D.House Price Index and D.Fx

D.House Price Index and D.Fx

Bianconi and Yoshino

28-Jan-11
Price Index and Cyclicality

US Variables - Case_Shiller and Sharpe_sp500

Cross-correlogram

D.House_Price Index and D.Case_Shiller

D.House_Price Index and D.Sharpe_sp500

Bianconi and Yoshino

28-Jan-11
Price Index by the Characteristics Method

- For each year $t=2002, \ldots, 2007$ estimate the regressions

$$\text{lag } p_{it} = \beta_{0,t} + \beta_{1,t} \text{dorn}_{it} + \beta_{2,t} \text{hath}_{it} + \beta_{3,t} \text{gar}_{it} + \beta_{4,t} \text{dist}\_shuns}_{it} + \beta_{5,t} \text{selic}_{it} + \beta_{6,t} \text{sharpe\_bov}_{it} + \beta_{7,t} \text{cred}\_gdp\_br}_{it} + \beta_{8,t} \text{fx\_br}_{it} + \beta_{9,t} \text{case\_shiller}_{it} + \beta_{10,t} \text{sharpe}\_sp500}_{it} + \epsilon_{it}.$$
Price Index by the Characteristics Method

- For each year \( t=2002, \ldots, 2007 \) estimate the regressions

\[
\text{lag } p_{t,t} = \beta_{0,t} + \beta_{1,t} \text{dorm}_{t,t} + \beta_{2,t} \text{hath}_{t,t} + \beta_{3,t} \text{gar}_{t,t} + \beta_{4,t} \text{dist}_{t,t} + \beta_{5,t} \text{selin}_{t,t} \\
+ \beta_{6,t} \text{sharpe}_t + \beta_{7,t} \text{cred}_t + \beta_{8,t} \text{fx}_t + \beta_{9,t} \text{case}_t + \beta_{10,t} \text{sharpe}_t + \epsilon_{t,t}
\]

- Price index is obtained by using two consecutive yearly regressions; Laspeyres case:

\[
\text{Index}_{t+1} = \exp \left( \sum_{j=0}^{10} \beta_{j,t+1} q_{j,t} - \sum_{j=0}^{10} \beta_{j,t} q_{j,t} \right)
\]

Bianconi and Yoshino 28-Jan-11
Price Index by the Characteristics Method: Alternative Blocks

Hedonic Characteristics Method
Annual 2003-2007

Bianconi and Yoshino

28-Jan-11
Price Index by the Characteristics Method: Contribution of Blocks
## Price Index by the Characteristics

**Method: Regressions with All Variables**

<table>
<thead>
<tr>
<th>F-tests: Year</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics Block: Bedr Bath Garag Dist_slum</td>
<td>F(4, 227)=123.27***</td>
<td>F(4,245)=96.03***</td>
<td>F(4,187)=85.26***</td>
<td>F(4,169)=45.25***</td>
<td>F(4,151)=48.03***</td>
<td>F(4,192)=72.25***</td>
</tr>
<tr>
<td>Real Variables: Sharpe_Bov Cred/GDP</td>
<td>F(2,76)=0.30</td>
<td>F(2,76)=0.22</td>
<td>F(2,76)=0.19</td>
<td>F(2,76)=0.24</td>
<td>F(2,76)=1.38</td>
<td>F(2,76)=4.81**</td>
</tr>
<tr>
<td>Nominal Variables: Selic Fx</td>
<td>F(2,76)=0.08</td>
<td>F(2,76)=0.40</td>
<td>F(2,76)=1.72</td>
<td>F(2,76)=0.63</td>
<td>F(2,76)=0.32</td>
<td>F(2,76)=0.76</td>
</tr>
<tr>
<td>US Variables: Case_shiller Sharpe_sp500</td>
<td>F(2,76)=0.04</td>
<td>F(2,76)=0.42</td>
<td>F(2,76)=0.27</td>
<td>F(2,76)=0.29</td>
<td>F(2,76)=0.31</td>
<td>F(2,76)=1.19</td>
</tr>
</tbody>
</table>

* p<0.05, ** p<0.01, *** p<0.001

Bianconi and Yoshino  
28-Jan-11
What Have We Learned?

- Averages and the hedonic time dummies methods incorporate sources of level and cyclical behavior in the index that may overestimate or underestimate the value of the index, well beyond the composition problem.

- There can be alternatives that filter out the blocks of variables:
  - We propose one alternative that highlights the problems above.

Bianconi and Yoshino 28-Jan-11