Hedonic Price Index: An Illustration with Residential Property Prices

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Executive Summary

- This paper reviews the method of hedonic regression and illustrates how price indices can be compiled using the regression output.

- Hedonic regression typically explains prices by quality or characteristic attributes, and as such is suitable for studying heterogeneous products like electronic products.

- We applied the approach to the local housing market, and compiled monthly and weekly residential price indices from the regression output. Because of the small sample size in this study, the hedonic indices compiled in this *experiment* are not as broad based as the Centa-City Leading Index, but they give similar trending indication. The hedonic indices, however, incorporated information on product quality.

- Our sample requires manual input of transaction details of 3 premises – Taikoo Shing, Grand Promenade and The Belcher's – for the period Jul, 2010 to Sep, 2011. These involve a total of 1542 observations.

- The Area Elasticity is 1.38 and statistically significant.

- For a 10-storey increase in location, the unit will be able to fetch a price that is 3.3% higher.

- Further away from MTR station also lowers the selling price. *Ceteris paribus,* every 100% increase in the distance corresponds to a 3.7% reduction in selling price.

1. Methodology

Hedonic price index is a way of price measurement that takes into account the inherent quality of the items being studied. The items are treated as heterogeneous goods instead of homogeneous as is commonly assumed. We will look at the general methodology of compiling hedonic price indices in this paper, and see how this can be experimentally applied to the local residential property market. Note the approach can be applied to other cases where quality-adjusted prices are of principal interest, e.g. consumer electronics.

There are many hedonic indexing approaches, but we will focus on what is called the time dummy hedonic (TD) method as it is more relevant to the distinct nature of the property market. Unlike other products that are more frequently traded, houses (residential units, apartments, etc.) are sold infrequently and have their unique characteristics, structural or locational. As a result, we cannot rely on matched observations over time to deliver price information. The TD method pools together observations (/transactions) of different units with a sample period and performs a regression analysis of the house characteristics on selling prices. The estimated parameters will then be used to compile the price index desired. Specifically,

$$lnP_{it} = \delta_0 + D_{it}\delta_v + \sum_{j=1}^{k} \beta_j X_{ijt} + \varepsilon_{it} \qquad (1)$$

where P_{it} is the selling price of house i, δ_0 is the intercept term that captures the time effect of the base period, D_{it} is a vector of dummy variables that takes on the value of 1 if the transaction takes place in period t, and 0 otherwise. X_{ijt} is a vector of quality or characteristics indicators. So the coefficients β_j can be interpreted as the marginal price of a particular characteristic.

We can then evaluate the TD price index based on the following relationship, details can be found in de Haan (2004):

$$P_t^{TD} = exp(\hat{\delta}_v) = \frac{\prod_{i \in S_t}(P_{it})^{1/n_t}}{\prod_{i \in S_1}(P_{i1})^{1/n_1}} exp\left[\sum_{j=1}^{k} \hat{\beta}_j \left(\bar{X}_{j1} - \bar{X}_{jt}\right)\right] \qquad (2)$$

where $\bar{X}_{jt} = \sum_{i \in S_t} X_{ijt}/n_t$ is the sample average of the j-th characteristic in period t. P_t^{TD} is an estimator of quality-adjusted price change, which from (2) is a function of the ratio of geometric mean prices.

2. Application: Residential Property Price Index based on Transaction Data

The data we used are actual transaction data recorded by the Land Registry. As we have no free access to the official data, we manually input the data of 3 premises on Hong Kong Island for the periods July, 2010 to September, 2011 found online in the Centaline Property Database. These premises are Taikoo Shing, Grand Promenade, and The Belcher's[1] and there are 1,542 related transactions. The characteristic vector X_{ijt} contains the following information:

1) Floor
2) Gross Floor Area (in natural log)[2]
3) Age of Building (square)
4) No. of Bedroom
5) No. of Bedroom with Bathroom
6) Walking Distance to Nearest MTR Station (in natural log)[3]
7) No. of Band One Secondary School in Neighborhood

Two separate estimations were performed, one using monthly intervals and the other weekly intervals. The table below shows the results. To save space, only the coefficients of the characteristic variables above are stated.

Table 1: Output of Hedonic Regression with Monthly and Weekly Time Intervals

Coefficients of Variables	Monthly Price Equation	Weekly Price Equation
Floor	0.0033**	0.0033**
Log Area	1.3835**	1.3905**
Age Square	-5.0e-6	12.0e-6
No. Bedroom	-0.0449**	-0.0482**
No. Bedroom w. Bath	0.0499**	0.0526**
Log Distance to MTR	-0.0369**	-0.0360**
No. B1 School	0.1366**	0.1321**
R-square	0.9403	0.9433
Durbin-Watson	0.9244	0.9630
No. of Variables in Equation	22	73

*Remarks: ** indicates significance at 5% level, and * at 10% level.*

The results are in line with general expectation:
- The Area Elasticity is 1.38 and statistically significant. So, a doubling (100% increase) in the floor area will lead to an increase in selling price by 1.38 times.

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[1] All three premises are constituent premises used in compiling the Centa-City Leading Index.
[2] We did not use per square foot selling price, as the elasticity of selling price to changes in floor area could be informative.
[3] The distance is measured using the built-in function of Google Map.

- For a 10-storey increase in location, the unit will be able to fetch a price that is 3.3% higher.
- Age of the premise is negatively related to price but is not statistically significant. This could due to the structure of our sample. Taikoo Shing has an average age of about 30 years and it accounts for 2/3 of our sample. The Belcher's has an average age of 10 years, while Grand Promenade has about 6 years. So, for instance, some of the most expensive tradings found in our sample (the Belcher's) are not necessarily the newest premises.
- The coefficient of no. of bedroom is negative. This is presumably the result of more spacious (instead of larger no. of) bedrooms found in The Belcher's and Grand Promenade.
- Further away from MTR station also lowers the selling price. Every 100% increase in the distance corresponds to a 3.7% reduction in selling price.
- The school network also turns out to be significantly and positively related to the selling price. Note, however, this variable is district specific, so the estimated impact might well pick up other factors that relate to the district as a whole.

3. The Time Dummy Hedonic Index

The following diagrams show the TD monthly and weekly indices compiled used equation (2). Major events that moved market sentiment were illustrated. One should take note that the Hedonic Index is not as broad-based as the other two series by construction. The monthly index compiled is smoother and the weekly index more volatile. Both indicate a peak in June 2011, but there is indication of sideway movements from Aug 2011 onwards.

Figure 1: Monthly TD Index compared with Government PPI and Centa-City Leading Index
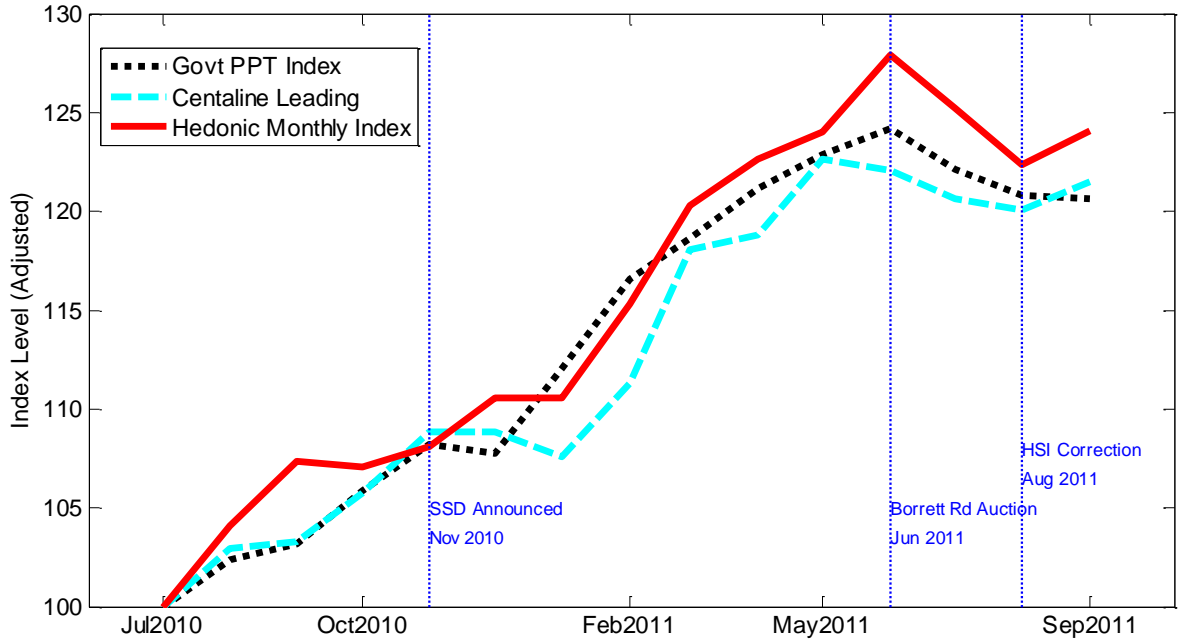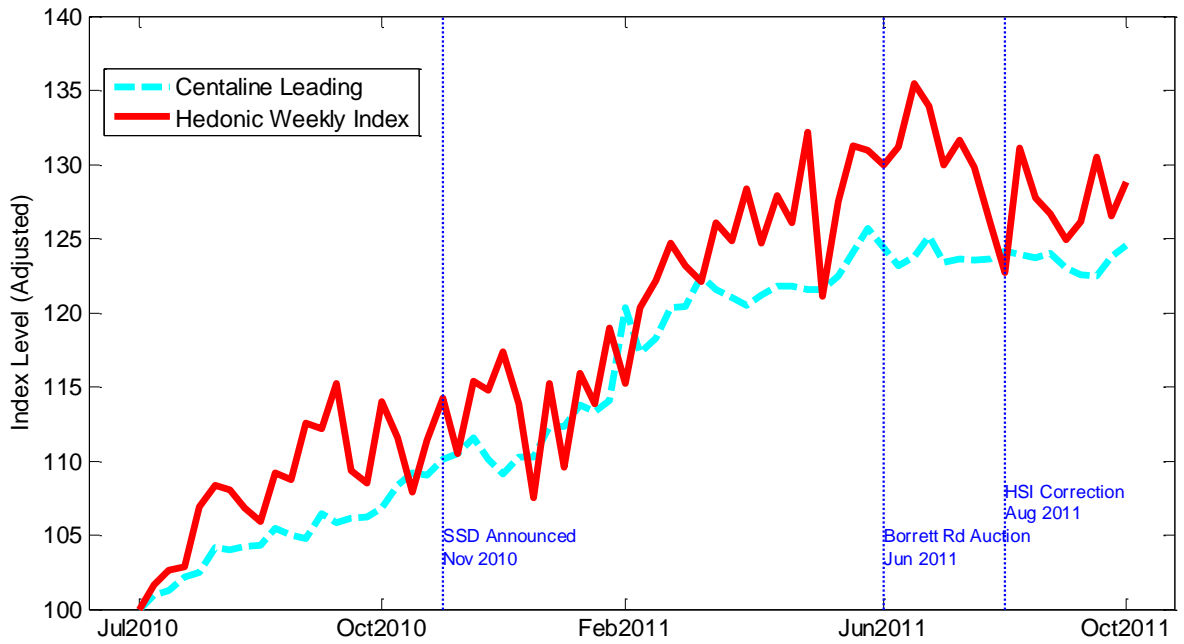

Figure 1: Weekly TD Index compared with Centa-City Leading Index

4. Reference

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