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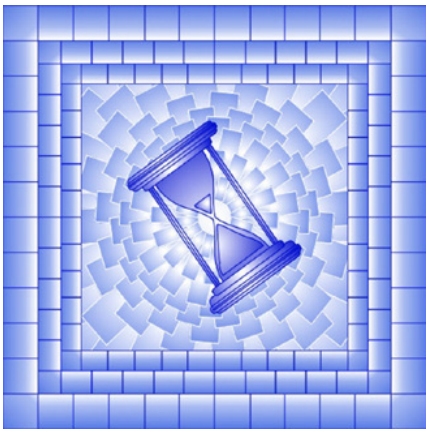

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New approach for estimating the rent component of the Consumer Price Index

by **Roobina Keshishbanoosy** and **Lance Taylor**

The Consumer Price Index (CPI) measures the change of prices of consumer goods and services over time. To accurately reflect trends in the market and in consumer behaviour, Statistics Canada periodically reviews and updates the methods applied to various components of the CPI.

The release of the January 2019 CPI (published on February 27th, 2019) marks the implementation of methodological changes for the calculation of the rent index.[1]

The rent index represents around 6.24% of the 2017 CPI basket and is part of Shelter, one of the major CPI components.

This document describes the new methodology in estimating the rent index.

A new hedonic model for estimating the rent index

The new methodology based on a hedonic model uses data collected from the Labor Force Survey (LFS) to estimate the rent index.[2] The LFS uses a rotating panel multi-stage stratified sample. Households in the sample are surveyed for a period of 6 months (one-sixth of the sample is replaced every month). The dwellings are followed (not the households), so the tenants might change during the survey period.

Following a review of different methods, a characteristics approach hedonic index is proposed to replace the current methodology that is based on the matched-model approach. A hedonic model is estimated using monthly cross-sections of LFS data at the national level. The lowest geographical level indices are constructed using average characteristics as quantities and estimated coefficients as prices, while the higher level indices use weighted averages of lower level estimated expenditures.

The hedonic model is a log-linear regression in which the explanatory variables include observed dwelling characteristics, such as the number of bedrooms, as well as locational characteristics captured by postal codes.

The regression specification is as follows:

$$y^* = \beta_0 + \beta_1 services + \beta_2 age + \beta_3 bedrooms + \beta_4 dwelling + \beta_5 FSA + \epsilon$$

where:

y^* is the log of observed rent.

All explanatory variables (characteristics) are dummy variables such that:

$services$ represents whether the rent cost includes furniture, a washing machine, a refrigerator, cable or heat, age represents the age of building, $bedrooms$ represents the number of bedrooms, $dwelling$ represents the type of the building, and FSA is a vector of dummies defined from the first three digits of the postal codes.[3]

The intercept represents the baseline observation, which is a studio in a high rise apartment that is over 40 years old with no included services, in FSA C1A, which is the most sampled FSA in the LFS data.

Before running the regression model, the subject-matter experts analyze the data to flag and remedy some of the possible errors and other anomalies in the data. After that, for each period, a regression is run twice for all observations across Canada, with the first regression being used to calculate the Cook's distance of each

1. Details on the previous rent index methodology are available in Soumare (2017) and Statistics Canada (2015a).
2. Hoffman and Kurtz (2003) paper provides a similar application of hedonic models to the measurement of rent index in Germany.
3. FSA stands for Forward Sortation Area and is the first 3 digits of a postal code. As a geographic unit, it roughly corresponds to a neighbourhood in an urban area or a broad region in a rural area.

observation to filter out outliers. The optimal filtering threshold for the Cook's distance has been chosen based on rigorous tests.

Overall, based on all monthly cross-sectional data available, the model tests and estimation results are quite satisfactory with an average adjusted R-squared of around 0.65, and the coefficients for the major dwelling characteristics are mostly significant and stable over time with the expected signs. In addition, the regression results for the locational characteristics support the claim that conurbation matters.

Aggregation Methodology

Quantity and Expenditure Aggregations

In order to build indices, it is necessary to construct quantity and expenditure aggregates. To do so, for each characteristic the average of its dummy variable is calculated by Census Metropolitan Area (CMA). As a simple example, if there are 100 observations in a CMA and 40 of them are 2 bedrooms, then the quantity of that characteristic is 0.4. In practice, a weighted average is used where the weights are the number of renters in each LFS stratum. In short, the quantity $x_j^{char,cma}$ of characteristic char in CMA cma during period j is:

$$x_j^{char,cma} = \sum_{n=1}^{N_{cma}} w_n^{strat,j} \, x_{n,j}^{char,cma,strat}$$

where $strat$ is the LFS stratum of the observation and $strat$ belongs to the CMA cma, N_{cma} is the number of observations in the CMA cma, and w is the weight.

The estimated average rent expenditures at the CMA level are calculated as the exponent of the fitted values from inserting the average characteristics by CMA back into the model. Formally, the estimated average rent expenditure $pq_{i,j}^{cma}$ in a CMA cma using period i prices B_i and period j quantities is[4] $pq_{i,j}^{cma} = e^{B_i X_j^{cma}} e^{\frac{\hat{\sigma_i^2}}{2}}$ where B_i is the vector of coefficient estimates from period i and X_j^{cma} is the vector of quantities for all characteristics in CMA cma during period j.

CPI Strata Expenditure and Index Aggregation

To build the final indices at the CPI strata level, the average cost of rent is calculated as the mean of the CMA level expenditures, using the estimated count of renters in each CMA as weights. That is:

$$pq_{i,j}^{CS} = \sum_{cma=1}^{N_{CS}} w^{cma} pq_{i,j}^{cma}$$

where w^{cma} is the CMA cma's share of renters in the CPI stratum CS, and i and j are the periods of the prices and quantities used, each taking the values 1 (current period) or 0 (previous period). Finally, N_{CS} is the number of CMAs in the CPI strata CS.

The final price index I_p^{CS} for prices going from the previous period to current period in a given CPI strata CS is:

$$I_p^{CS} = \left(\frac{pq_{1,0}^{CS}}{pq_{0,0}^{CS}} \, \frac{pq_{1,1}^{CS}}{pq_{0,1}^{CS}} \right)^{\frac{1}{2}}$$

As of the release of the January 2019 CPI (published on February 27th, 2019) this new index replaces the previous matched model rent index.

4. The adjustment factor $e^{\frac{\hat{\sigma_i^2}}{2}}$ is used since the mean of a log normal variable with mean μ and variance σ^2 is $e^{\mu+\frac{\sigma^2}{2}}$. This is a similar adjustment to what was done in Pakes (2003) in the context of hedonic price indices.

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