WORKING PAPERS
RESEARCH DEPARTMENT

**WORKING PAPER NO. 09-5
INTRODUCTION TO PRICE AND PRODUCTIVITY
MEASUREMENT FOR HOUSING**

Bert M. Balk
Erasmus University Rotterdam

W. Erwin Diewert
University of British Columbia

Alice O. Nakamura
University of Alberta School of Business
and
Visiting Scholar, Federal Reserve Bank of Philadelphia

March 2009

Introduction to Price and Productivity Measurement for Housing

Bert M. Balk, W. Erwin Diewert, and Alice O. Nakamura[1]

Abstract

This paper provides a brief introduction to a proposed new opportunity cost treatment of owner-occupied housing in measures of inflation for the United States. In addition, the paper introduces, and provides links to, a collection of nine other papers that discuss various aspects of the treatment of owner-occupied housing in measures of inflation for a number of nations, including Canada, Germany, Iceland, and the United States.

[1] Bert Balk is with the Rotterdam School of Management, Erasmus University Rotterdam, and Statistics Netherlands and can be reached at bbalk@rsm.nl. Erwin Diewert is with the Department of Economics at the University of British Columbia. He can be reached at diewert@econ.ubc.ca. Alice Nakamura is with the University of Alberta School of Business and can be reached at alice.nakamura@ualberta.ca. This paper is forthcoming as Diewert, W.E., B.M. Balk, D. Fixler, K.J. Fox, and A.O. Nakamura. *Price and Productivity Measurement: Volume 1 — Housing*. Trafford Press (2009). The views expressed here are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System. This paper is available free of charge at www.philadelphiafed.org/research-and-data/publications/working-papers/.

The start of 2009 finds many nations struggling with severe economic problems brought on by the burst of a bubble in residential housing prices. This situation incited urgent interest in whether the cost of owner-occupied housing (OOH) services is being properly accounted for in the inflation statistics for nations. There would be interest in this topic anyway, of course, because shelter accounts for a large share of consumer expenditures. Moreover, there are important differences in how OOH services are accounted for in the official statistics of nations. The main approach in current use is rental equivalence. For example, in compiling the consumer price index (CPI), the U.S. Bureau of Labor Statistics (BLS) uses rent data for rental units to form a rental equivalence measure for changes in the cost of OOH services.

It is often argued that the rental equivalence approach is justified because it can be derived from the fundamental equation of capital theory: the same theoretical framework that also gives rise to the user cost approach to accounting for OOH services in measures of inflation for nations. The user cost approach is one of three other approaches in current use besides rental equivalency. In **chapter 2**, **W. Erwin Diewert** of the University of British Columbia and **Alice O. Nakamura** of the University of Alberta provide an overview of the main types of approaches in use. The authors go on to develop a new opportunity cost approach, first introduced in a paper presented by Diewert in 2006 that is published as chapter 6 of this volume. We take up this aspect of the Diewert-Nakamura chapter in the concluding section of this introduction, since that material builds on the other papers included in this volume.

This volume is more than the sum of its parts. The papers are sequenced so that a reader new to the topic can pick up needed terminology in moving from one paper to the next. At the same time, the papers deal with some of the main unresolved issues of our time regarding the measurement of inflation for owner-occupied housing. The authors of the papers in this volume include many of the key participants over the recent decades in the vast literature on this topic.

In **chapter 3**, **Arnold J. Katz** of the U.S. Bureau of Economic Analysis (BEA) explains that within the European Union the standard method for evaluating owner-occupied dwelling services in the national accounts has been a stratification variant of the rental equivalence approach. Katz explains, however, that the unsubsidized rental markets are too thin in many of the Eastern European countries to permit the use of rental equivalency. His paper discusses an alternative method for evaluating dwelling services based on a simplified user cost measure. Katz notes that the standard user cost measure is derived under the principle that, in equilibrium, the purchase price of a durable good will equal the discounted present value of its expected net income (or benefits); that is, it will equal the discounted present value of its expected future services less the discounted present value of its expected future operating costs.

In **chapter 4**, **Theodore M. Crone** and **Leonard I. Nakamura** of the Federal Reserve Bank of Philadelphia and **Richard P. Voith** of Econsult argue that hedonic methods can be used to estimate the capitalization rate for owner-occupied housing. The authors specify a model for the value for house i in time period t, V_{it},

(1) $$\ln V_{it} = \beta_t X_{it} + e_{it}, \qquad\qquad i = 1,\ldots,I,$$

where X_i is a K element row vector of house traits, and β_t is a vector of the estimated percentage contributions to the house value of the housing traits. The stream of OOH services that implicitly is equal to the rent, R_{it}, is hypothesized to depend on the value of the dwelling

and a capitalization rate, C_t. If $R_{it} = C_t V_{it}$, then equation (1) can be rewritten as $\ln(R_{it}/C_t) = \beta_t X_{it} + e_{it}$, or as

$$(2) \qquad \ln(R_{it}) = \beta_t X_{it} + \ln(C_t) + e_{it}, \qquad\qquad i = 1,\ldots,I.$$

A corresponding hedonic regression for the rent for rental units is given by:

$$(3) \qquad \ln(R_{jt}) = \gamma_t X_{jt} + u_{jt}, \qquad\qquad j = 1,\ldots,J.$$

In this equation, unlike the case of owner-occupied units, the capitalization rate does not appear because the price of the service flow is observed directly for rentals.

The authors show that the capitalization rate affects the measured inflation index of owner-occupied housing. They also argue that if owners and renters value housing traits similarly, then $\beta_t = \gamma_t$ and the owner and renter hedonic equations, (2) and (3) respectively, will differ only by the constant, $\ln(C_t)$. In this case, they argue that the pooled owner and rental data can be used to estimate the capitalization rate as well as the housing characteristics prices. Making use of the capitalization rates and trait prices estimated using data from the bi-annual American Housing Survey (AHS), the authors calculate Fisher price indexes and inflation rates for both rented and owner-occupied housing services.

In **chapter 5**, **Claudia Kurz** and **Johannes Hoffmann** of the Deutsche Bundesbank explain that, while the importance of owner-occupied housing in Germany is less than in most other industrialised countries; nevertheless, a little over 40 percent of households live in their own homes. For the German CPI, the price component for owner-occupied dwellings is imputed using a rental equivalence approach, much as in the United States. To assess the appropriateness of the official German imputation method for owner-occupied housing service costs, Kurz and Hoffmann use data from the German Socio Economic Panel (GSOEP). The GSOEP reports major physical and locational characteristics of dwellings, rents actually paid by renters, and what owners say their dwellings could be rented for (i.e., the owner-reported *rent equivalents*). Kurz and Hoffmann restrict their analysis to West Germany and the period of 1985 through 1997.

The authors adopt a hedonic regression approach, building on their own prior research. In this new study, they use the same functional form for the equations for both owner-reported rent equivalents and for the rents of renters. Kurz and Hoffmann investigate the differences in the movements of their hedonic index versus the official CPI index for Germany. They find that until 1988 the measures were quite close. However, starting in 1989, the rates of increase for the hedonic indexes were higher than for the CPI rent subindex. The authors point out that 1989 is when migration from East Germany started to put pressure on the German housing market.

The papers by Katz, by Crone, L.I. Nakamura and Voith, and by Kurz and Hoffmann all start from the premise that, because both the rental equivalence and the user cost approaches can be derived from the fundamental equation of capital theory, it is therefore a matter of data availability and empirical convenience which of these approaches is used to account for shelter in measures of inflation. This premise is questioned in **chapter 7**. More specifically, **Alan Heston** of the University of Pennsylvania and **Alice O. Nakamura** of the University of Alberta question the presumption that housing cost information for *either* renters or owner occupiers can be used for assessing movements over time and space in the cost of housing for *both* renters and owners. They take a step in the direction of empirically exploring the questions they raise.

The empirical work reported by Heston and Nakamura is based on a survey of federal government employees conducted as part of a safe harbor process regarding a U.S. government cost of living allowance (COLA) program. This program pays an allowance above the federal salary schedule in three geographic areas (Alaska, the Caribbean, and the Pacific) based on prices in these areas relative to the Washington, D.C., area. The COLA survey data include a large number of dwelling characteristics, and both renters and owner occupiers were asked the question from the Consumer Expenditure Survey (designated as both CES and CE in the literature) about what they believe their dwellings would rent for. Using these data, Heston and Nakamura show that, in moving from relatively low to relatively high value homes, rent-to-value ratios fall. The authors argue that this result raises questions about the validity of using housing cost data collected *just from renters* to estimate price movements for owner occupiers too.

In **chapter 8**, **Thesia I. Garner** and **Randal Verbrugge** of the U.S. Bureau of Labor Statistics (BLS) provide empirical evidence for the United States that rents and *ex ante* user costs diverge markedly, and for extended periods of time. This temporal divergence is found not only for the United States as a whole but also for selected major metropolitan areas. This paper constructs, for the five largest cities in the United States, user costs and rents *for the same structure, in levels* (i.e., measured in dollars). These measures are constructed using Consumer Expenditure Survey data from 1982 to 2002, along with house price appreciation forecasts from Verbrugge (2008). These data are used to construct both a price/rent ratio and a user cost estimate for a hypothetical median-valued structure over time for each of the five metropolitan areas.

The overall picture that emerges bolsters the findings of Verbrugge (2008): the estimated user costs and rents diverge. According to Garner and Verbrugge, this divergence reflects out-of-scope financial asset movements and the costs associated with buying and selling homes. They conclude that, given the state of current-generation user cost measures, statistical agencies should use, if possible, use rental equivalence to measure homeowner user costs, rather than attempting to directly assess user costs. They acknowledge, however, that in some countries the use of rental equivalence may not be practicable. To price the service flow from an owned dwelling in those situations, they recommend the user cost approach.

Chapter 6 is a reprint of a paper that W. Erwin Diewert presented at a November 6-7, 2006 OECD-IMF workshop on real estate price indexes that was held in Paris. Diewert comments on the choice of appropriate target indexes for real estate prices. He argues that if the SNA is expanded to exhibit the service flows associated with the household and production sectors' purchases of durable goods, then the resulting durables augmented system of national accounts (DASNA) provides a natural framework for a family of real estate price indexes. He explains that in this proposed augmented system of national accounts, household wealth and consumption will be measured in real and nominal terms. This will entail measures of the household sector's stock of residential wealth, and it will be of interest to decompose this value measure into price and quantity (or volume) components.

Diewert next takes up the treatment of depreciation and renovations in the construction of constant quality real estate price indexes. He discusses stratification methods and methods that make use of periodic appraisals of real estate property that are carried out for taxation purposes. He also takes up the decomposition of real estate values into land and structure components. Diewert then turns his attention to a paper by Verbrugge: the paper that has now been published in revised form as Verbrugge (2008).

Diewert feels that for the opportunity costs of owning a house, from the viewpoint of an owner occupier, the relevant time horizon for an annualized average rate of expected price appreciation is at least 6 to 12 years. He notes that once we use annualized forecasts of expected price inflation over longer time horizons, the volatility in the ex ante user cost formula will be much diminished. Diewert also calls attention to Verbrugge's point that high real estate transaction costs presumably are what prevent the exploitation of arbitrage opportunities between owning and renting a property; user costs can thus differ considerably from the corresponding rental equivalence measures over the lifetime of a property cycle.

Diewert concludes this paper with a proposal for a new theoretical basis for accounting for the cost of owner-occupied housing in measures of inflation:

> [P]erhaps the "correct" opportunity cost of housing for an owner occupier is not his or her internal user cost but the maximum of the internal user cost and what the property could rent for on the rental market. After all, the concept of opportunity cost is supposed to represent the maximum sacrifice that one makes in order to consume or use some object and so the above point would seem to follow. If this point of view is accepted, then at certain points in the property cycle, user costs would replace market rents as the "correct" pricing concept for owner occupied housing, which would dramatically affect Consumer Price Indexes and the conduct of monetary policy.

Building on the Diewert proposal for an opportunity cost approach to accounting for owner-occupied housing in measures of inflation, in **chapter 2**, **W. Erwin Diewert** and **Alice O. Nakamura** of the University of Alberta argue that the time has come to accept the accumulated evidence of Verbrugge and others that user costs and rents do not reliably move together. They then turn their attention to the task of further developing Diewert's opportunity cost approach.

The term "opportunity cost" refers to the cost of the best alternative that must be forgone in taking the option chosen. They thus seek to compare implications for homeowner wealth of selling at the beginning of period t with the alternatives of planning to own a home for m more years and of either renting out or occupying the home for the coming year. This comparison is assumed to be carried out at the beginning of period t based on the information available then about the market value of the home, interest rates, and the forecasted average increase per year in home market value if the home is held for another m years. Refinancing can be viewed as a way for a homeowner to sell or buy back a fraction of a home.

Diewert and Nakamura define the OOH opportunity cost (OOHOC) index as follows:

> For each household living in owner-occupied housing (OOH), the *owner-occupied housing opportunity cost* (OOHOC) is the maximum of what it would cost to rent an equivalent dwelling (the rental opportunity cost, ROC) and the financial opportunity costs (FOC).

> The OOHOC index for a nation is defined as an expenditure share weighted sum of a rental equivalency index and a financial opportunity cost index, with the expenditure share weights depending on the estimated proportion of owner-occupied homes for which FOC exceeds ROC.

The authors explain the new OOHOC index in steps. First, they focus on the ROC and the FOC components of the index for an individual homeowner. Then, they address the issue of how to move from OOHOC values for individual homeowners to an OOHOC index for a nation. Finally, they review key features of the proposed OOHOC index.

Acceptance of the opportunity cost approach to the pricing of the services of owner-occupied dwellings would affect the CPI of countries. In addition, implementing the OOHOC approach would probably increase the measured per capita income gaps between rich and poor households within a nation like the United States and between rich and poor countries. The material in chapter 7 by Heston and Nakamura indicates that rent to asset value ratios for expensive homes in the United States are about half the corresponding values for entry level homes. It seems likely that this same sort of finding applies to other rich countries. Financial opportunity costs of owner-occupied homes are roughly proportional to asset values, so the finding in Heston and Nakamura implies that for high-end homes, financial opportunity costs may be twice or more the size of the corresponding rental equivalence opportunity costs. Thus, the opportunity cost approach to pricing owner-occupied housing services (which takes the *maximum* of the rental and financial opportunity costs) presumably will give a much higher estimate of the value of OOH services than is given by the rental equivalence approach.

In **chapter 9**, **Rósmundur Guðnason** and **Guðrún R. Jónsdóttir** of Statistics Iceland explain that the house price component of the Icelandic CPI is based on market prices for houses obtained from sales contracts collected by the Land Registry. Each year, close to a tenth of all dwellings in the country change hands. The sales contracts are standardized throughout the country. Every sales contract contains information on the property, its owners, and the sale price. A sales contract also contains details for how payment is arranged, and this information can be used for calculating the present value of a property.

In Iceland, the service flow from owner-occupied housing is measured using what Statistics Iceland refers to as a *simple user cost*. The housing price index is computed using information on changes in the present value of real estate as declared in sales contracts. This index is calculated as a superlative index (Fisher) using the values for 2002-2005 as the weights for the Laspeyres part and the values for 2003-2006 to calculate the Paasche part of the Fisher index. The weights are updated monthly. The owner-occupied housing depreciation rate used in the Statistics Iceland user cost calculation is mainly based on the age of the housing stock.

Finally, **in chapter 10**, **Andrew Baldwin** of Statistics Canada, **Alice O. Nakamura** of the University of Alberta and **Marc Prud'homme** of Statistics Canada present six alternative homeownership series based on four main concepts. These are the six types of series defined and updated periodically for the Statistics Canada analytical series program. All-items indexes embedding the various alternative owner-occupied housing price series are also presented so that the effects of the different owner-occupied housing concepts on the overall CPI can be observed. The estimates of comparative shelter costs are for houses in Ottawa for 1996 to 2005.

References

Baldwin, A., A.O. Nakamura, and M. Prud'homme (2009), "Owner Occupied Housing in the CPI: The Statistics Canada Analytical Series," chapter 10, pp. 151-160 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Balk, B.M., W.E. Diewert, and A.O. Nakamura (2009), "Introduction to Price and Productivity Measurement for Housing," chapter 1, pp. 1-6 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox, and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available as a free e-publication at www.indexmeasures.com.

Crone, T.M., L.I. Nakamura, and R.P. Voith (2009), "Hedonic Estimates of the Cost of Housing Services: Rental and Owner Occupied Units," chapter 4, pp. 51-68 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox, and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Diewert, W.E. (2009), "The Paris OECD-IMF Workshop on Real Estate Price Indexes: Conclusions and Future Directions," chapter 6, pp. 87-116 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox, and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Diewert, W.E. and Alice O. Nakamura (2009), "Accounting for Housing in a CPI," chapter 2, pp. 7-32 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Garner, T.I. and R. Verbrugge (2009), "The Puzzling Divergence of Rents and User Costs, 1980-2004: Summary and Extensions," chapter 8, pp. 125-146 in W.E., Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Guðnason, R. and G.R. Jónsdóttir (2009), "Owner Occupied Housing in the Icelandic CPI," chapter 9, pp. 147-150 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Heston, A. and A.O. Nakamura (2009), "Reported Prices and Rents of Housing: Reflections of Costs, Amenities or Both?" chapter 7, pp. 117-124 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox, and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Katz, A.J. (2009), "Estimating Dwelling Services in the Candidate Countries: Theoretical and Practical Considerations in Developing Methodologies Based on a User Cost of Capital Measure," chapter 3, pp. 33-50 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox, and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Kurz, C. and J. Hoffmann (2009), "A Rental Equivalence Index for Owner Occupied Housing in West Germany," chapter 5, pp. 69-86 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox, and A.O. Nakamura (2009), *Price and Productivity Measurement: Volume 1 -- Housing*. Trafford Press. Also available at www.indexmeasures.com.

Verbrugge, R. (2008), "The Puzzling Divergence of Rents and User Costs, 1980-2004," *Review of Income and Wealth* 54 (4), 671-699.