

# Rent Imputation for Welfare Measurement

## A Review of Methodologies and Empirical Findings

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## Abstract

As well acknowledged in the literature, housing is often the dominant consumption good for most households. As such, it should be included in a comprehensive welfare aggregate to measure people's living standards accurately. However, assigning a value to the flow of the dwelling for homeowners and nonmarket tenants is problematic. Over the last decades several estimation techniques have been proposed and implemented by practitioners covering from very simple to sophisticated approaches. This paper

provides an extensive review of different methods to impute rent, commonly used for welfare analysis. It also gives an overview of how this problem has been addressed by other economic domains, namely national accounts, price indices, purchasing power parities, and taxation. Finally, after setting up a theoretical framework, the paper summarizes the empirical findings about the distributional impact of including imputed rents in welfare aggregates.

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# **Rent Imputation for Welfare Measurement: A Review of Methodologies and Empirical Findings**

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## 1 Introduction

Desirably, all goods and services should be included as part of the welfare aggregate, which can be thought of as an empirical approximation to the indirect utility function or the money-metric measure of welfare (Deaton and Grosh, 2000). Only a comprehensive welfare aggregate can measure people's living standards accurately. In principle, households purchase or produce accommodation for themselves just as they purchase or make food or clothing (Malpezzi, 2000). Nevertheless, practitioners often overlook housing when estimating people's welfare measure using household survey data.

The importance of housing as part of the consumption aggregate has been well acknowledged in the literature for decades.<sup>2</sup> It is often the dominant consumption good for most households (see Norris and Pendakur, 2013). Both in developing and developed countries, for instance, housing represents between 14 and almost 25 percent of the total households' adjusted disposable income in 2012.<sup>3</sup> Additionally, evidence suggests that the share of housing consumption increases with levels of aggregate welfare when comparing across countries (see Blades, 2009).<sup>4</sup> Therefore, it is relevant to include housing expenditures when constructing the consumption aggregate for making more reasonable inter-household as well as international comparisons of economic well-being (Gaerner and Short, 2009).

The utility generated by housing is the value of the flow of services that the household receives from occupying its dwelling over the period of analysis rather than the expenditure for purchasing the dwelling itself. As a major durable good, a house purchase is a large and rare expenditure, thus it should never be included in the consumption aggregate. To measure this flow, the rent paid seems to be the natural choice to be included in the consumption aggregate. In the case where rental markets work perfectly and all households rent their dwellings, then market rents are a good approximation of dwelling services.

However, many households own the dwelling in which they live. For example, in 2011, homeownership in European countries ranged from 39 percent in Switzerland to above 90 percent in Romania.<sup>5</sup> Similarly, in Latin American countries the share goes from 44 percent in Colombia in 2012 to more than 80 percent in the case of Nicaragua in 2009.<sup>6</sup> Additionally, some tenant households receive housing free of charge or at subsidized rates by their employer, friends, relatives or government. In some European countries, such as Austria and Cyprus, social rents account for more than 20 percent of total households while in others, like Sweden and Denmark, they are non-existent (authors' results on EUSilc Dataset). Therefore, the main problem when constructing the consumption aggregate to measure individuals' well-being consists in assigning a value to the flow of the dwelling for homeowners and nonmarket tenants.

Over the last decades several estimation techniques have been implemented by practitioners covering from very simple to sophisticated approaches, which depend mainly on the data collected from household surveys or other external sources. These studies have produced a substantial amount of

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<sup>2</sup> See for instance: UN (1977); EC No. 1980/2003; Yates (1994); Citro and Michael (1995); Deaton and Grosh (2000); Malpezzi (2000); Canberra Group (2001); Gaerner and Short (2001); Stiglitz, Sen and Fitussi (2009); Gaerner and Betson (2010); Norris and Pendakur (2013) and OECD (2013).

<sup>3</sup> Based on OECD (2014), National Accounts at a Glance.

<sup>4</sup> Performing an updated correlation between housing shares and GDP per capita including a list of 38 countries from all continents; we found a significant and positive correlation, similar as previous studies (see Blades, 2009). Results are available upon request.

<sup>5</sup> Authors' calculation based on EU-Silc database. See also Andrews et.al (2011).

<sup>6</sup> SEDLAC (Socio Economic Database for Latin America and the Caribbean) database.

evidence on this topic not only on the welfare measurement domain but also in many others, including National Accounts, Consumer Price Index, Purchasing Power Parity and Income Taxation. Although progress has been made over the years, problems remain and great care must be taken to avoid erroneous interpretations of the results in cases where such imputations have an important effect on the total consumption measure or on the welfare rankings of households.

The objective of this paper is twofold. The first is to provide a comprehensive description of different methods used to impute rent for owner-occupied dwellings and non-market tenants; and the second is to present the distributional impacts of rent imputation discussed in the literature. The paper is organized as follows: section 2 focuses on the first objective by covering econometric methods, self-assessment as well as using information from external sources. Section 3 illustrates how other economic disciplines deal with this issue. Section 4 explains the impact of rent imputation on welfare measures by defining first a theoretical framework and then summarizing the findings in the literature. Section 5 presents concluding remarks.

## 2 Imputing flow-service of the dwelling for owners

In the case of dwellings as in many other major durable goods, expenditure and consumption are not closely related in the short run and the former is a poor measure of household's welfare.<sup>7</sup> The utility generated by housing is the value of the flow of services that the household receives from occupying its dwelling. Thus, a measure of flow of the dwelling's service must be included as part of the total household's consumption. It is fairly accepted that for tenants this flow of services is well approximated by the rent paid. However, rental values are observed only for tenants and not for owner-occupied dwellings. A way to solve this problem and to get a comprehensive measure of consumption is to estimate the implicit rent of owner-occupied housing by means of some imputation method. In the following, we present a thorough review of these methods implemented in the literature starting from the econometric and statistical methods up to self-assessment and use of external sources.

### 2.1 Econometric and statistical methods

The Hedonic Theory of Consumption is the theoretical justification of all econometric models that have been estimated in the rent-imputation literature. This theory establishes that utility derives from attributes or characteristics of goods and not from goods *per se* (Lancaster, 1966). In equilibrium, hedonic prices are defined as the implicit prices of the goods' attributes. These implicit prices are revealed to economic agents from observed prices of differentiated products and specific amounts of characteristics associated with them (Rosen, 1974).<sup>8</sup>

Particularly, housing may be considered as a composite commodity with characteristics ( $\mathbf{X}_h$ ) including *location* ( $\mathbf{L}_h$ ); *structural attributes* of the dwelling ( $\mathbf{S}_h$ ) like detached home or apartment, type of construction, age of the building, dimensions and number of rooms, etc.; and *neighborhood characteristics* ( $\mathbf{N}_h$ ) such as quality of school, accessibility to public transport, proximity of streets, crime rates, poverty rate, traffic congestion, etc. (Freeman, 1993).<sup>9</sup> In sum, the rent of the dwelling  $h$

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<sup>7</sup> For measuring welfare, consumption which is the destruction of goods and services by use is a more useful measure than expenditures (purchases). However, for more perishable goods it is safe to assume that consumption and purchases are much tied (Deaton and Grosh, 2000).

<sup>8</sup> Residential property value studies dominate the applied literature.

<sup>9</sup> For a review of the characteristics used in hedonic models in 120 studies, see Sirmans et. al. (2005).

$(R_h)$  could be expressed as a function of all its characteristics  $(\mathbf{X}_h)$  when the housing market is in equilibrium.<sup>10</sup> Formally:

$$R_h = R(\mathbf{X}_h) = R(\mathbf{L}_h, \mathbf{S}_h, \mathbf{N}_h) \quad (1)$$

The theoretical economic literature highlights the intrinsic nonlinearity in the relationship between house prices and its characteristics (Rosen, 1974 and Freeman, 1993). However, there is no consensus about the specific explicit form the hedonic price function might take (see Ekeland et al., 2004 and Lisi, 2013). For instance, Kang and Reichert (1987) emphasize the non-existence of a unique functional form or estimation technique which is superior in every aspect in the context of hedonic models for real market appraisals.

Therefore, let us assume that there are  $X_m$  observable attributes for a dwelling  $h$ , with  $m = 1, 2, \dots, M$ . A general functional specification may be represented as following:

$$g(R_h) = \alpha_0 + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \sum_{m=1}^M \sum_{k=1}^M f_m(X_{hm})f_k(X_{kh})\gamma_{hmk} + \varepsilon_h \quad (2)$$

where  $g(\cdot)$  can be either the identity function or the natural logarithm;  $f_j(\cdot)$ ,  $j = m, k$ , could be (i) the identity function, (ii) an indicator function taking value 1 if the dwelling has the characteristic and 0 otherwise, (iii) some high level polynomial, or (iv) a Box-Cox transformation, and  $\varepsilon_h$  represents the unobservables. At one extreme where no dwelling characteristic is observed and  $g(\cdot)$  is the identity function, the constant parameter  $\alpha_0$  would correspond to the average dwelling rent of the reference population.  $\beta_{hm}$  and  $\gamma_{hmk}$  are the parameters associated respectively to each (transformed) characteristic  $X_m$  and each interacted (transformed) characteristics  $X_m$  and  $X_k$ . Other parametric functional forms can be derived as a special case of equation (2). Once the model has been specified and calculated based on the set of tenants, the estimated parameters ( $\hat{\alpha}_0$ ,  $\hat{\beta}_{hm}$  and  $\hat{\gamma}_{hmk}$ ) are then used to predict the value of the rent for the owner-occupied dwellings.

In this section, we describe most econometric strategies used in the literature including parametric and non-parametric approaches as well as the stratification method, pointing out limitations and advantages of each approach.

### 2.1.1 Linear Model

Although the theory suggests that the relation between rents and dwellings' characteristics is nonlinear, several authors (mainly inspired by the seminal, influential work by Cropper et al., 1988), used a fully linear specification to estimate imputed rents:

$$R_h = \alpha_0 + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \varepsilon_h \quad (3)$$

This equation is obtained from (2) by choosing  $g(\cdot)$  as the identity function, and setting  $\gamma_{hmk}$  equal to zero. Moreover,  $f_m(\cdot)$  is restricted to be either the identity function or an indicator function (in case of binary variable characteristics). Cropper et al. (1988) conclude that the linear specification performs best when some attributes are unobserved or are replaced by proxies.

<sup>10</sup> Individuals maximize their residential choices given the market prices, and market prices clear the market given the houses stock.

Nevertheless, Rosen (1974) states that the equation defining the hedonic price is nonlinear and it may not be possible to find closed solutions. Furthermore, Ekeland et al. (2004) prove that the economic model that produces the linear equations is implausible (in particular, it is the closed solution of a linear-quadratic-normal model), and therefore any marginal perturbations to the underlying distributions of preferences and technology can produce large deviations from linearity.

### 2.1.2 Semi-Logarithmic (Log-Linear) Model

The most commonly used functional form in the hedonic price housing literature is semi-logarithmic, or log-linear (Malpezzi, 2002, Diewert, 2003):

$$\ln R_h = \alpha_0 + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \varepsilon_h \quad (4)$$

Equation (4) is obtained from (2) by imposing  $g(\cdot)$  to be the natural logarithm of the imputed rent ( $\ln R_h$ ), and  $\gamma_{hmk}$  equal to zero.  $\alpha_0$  and  $\beta_{hm}$  are the parameters we want to estimate under the hedonic model;  $f_m$  may be either an indicator function (in case of characteristics captured by dummy-variables), or the identity function, and  $\varepsilon_h$  is the error term.

As underlined by Malpezzi (2002), the semi-logarithmic model has several advantages. First, the coefficients have a straightforward interpretation: they show approximately the percentage change in the imputed rent for a given unit-change in the covariate.<sup>11</sup> It mitigates the heteroskedasticity problem (see also Diewert, 2003), and it is computationally simple.<sup>12</sup> Moreover, it allows for flexible specifications of the covariates which can either be continuous or binary. Most importantly, the semi-log model allows the marginal rent-value to be a non-linear function of size and quality of the dwelling, which is a theoretical requirement of the hedonic model (see Rosen, 1974, Freeman, 1993).

It is worth noticing that the anti-log of the predicted log rent  $\ln \hat{R}_h$  is not an unbiased and consistent estimator of the predicted rent and some adjustments are then required (Goldberger, 1968).

### 2.1.3 Higher-order Models

Seeking more flexible models than the semi-log, during the 1980s, there have been several applications of the Box-Cox transformations to the hedonic model theory (see for instance Halvorsen and Pollakowski, 1981, Cropper et al. 1988), and other non-linear models such as those introduced by Wooldridge (1992). The advantage of the Box-Cox model is that it nests the trans-log, the semi-linear, the linear, the quadratic and other forms as special cases. As noted by Hill (2013), interest in those models faded away when semi-parametric and non-parametric models became available to researchers.

Starting again from equation (2), the most general Box-Cox model assumes that:

$$g(R_h) = \begin{cases} \frac{R_h^\vartheta - 1}{\vartheta} & \text{if } \vartheta \neq 0 \\ \ln(R_h) & \text{otherwise} \end{cases}, \text{ and } f_j(X_{hj}) = \begin{cases} \frac{X_j^\lambda - 1}{\lambda} & \text{if } \lambda \neq 0 \\ \ln(X_j) & \text{otherwise} \end{cases}$$

According to the goodness of fit tests conducted by Halvorsen and Pollakowsk (1981), the quadratic Box-Cox model (with an estimated  $\vartheta = 0.06$  and  $\lambda = 0.28$ ) outperforms all other special cases. The same

<sup>11</sup> This is not accurate for dummy variables. In this case, Halvorsen and Palmquist (1980) demonstrate that the percentage change is better approximated by  $(100 * \exp(\hat{\beta}_i) - 1)$ ; see also Kennedy (1981), and Giles (2011).

<sup>12</sup> Wooldridge (2009)

conclusion is reached by Cropper et al. (1988), under the hypothesis that all dwelling attributes are observable.

Among other empirical applications, Laurice and Bhattacharya (2005) conclude that the third-degree polynomial model adds explanatory power to the linear and quadratic models, and it is even preferable to semi-parametric approaches. Malpezzi et al. (1980) advocate the need of imposing flexibility to the model by including, in addition to the linear, the squared and the cubic terms of continuous variables, such as the age of the dwelling.

Within a parametric framework, moreover, the maximum flexibility of the model is reached by adding the independent discrete variables as dummy variables, degrees of freedom permitting (see Malpezzi, 2002 and references therein). In this way, the model does not restrict the effect of adding one more bedroom to a one-bedroom apartment to be the same as one additional bedroom to a five bedroom apartment, as in the linear model; nor it would impose decreasing additional returns, as in a quadratic model, or decreasing and then increasing additional returns after a threshold, as cubic models do.

#### 2.1.4 Semi-parametric and non-parametric approaches

The lack of guidance from the economic theory about the functional form of hedonic price models and the risk of misspecification generated a stream of applications using semi-parametric or non-parametric models.<sup>13</sup> These allow for flexible modeling of the relation between (continuous) covariates and the dependent variable.

The seminal paper which explicitly applies a non-parametric technique to hedonic models for house pricing is Meese and Wallace (1991). Comparing the results of parametric specifications with estimates obtained using *locally weighted regressions*; the authors conclude that the non-parametric approach outperforms the parametric ones for in-sample predictions. Pace (1993) applies instead *nonparametric kernel estimations* and documents the superior statistical performance of the nonparametric estimator relative to its conventional counterpart in out-of-sample predictions. Gencay and Yang (1996) show that the semi-parametric model provides much more accurate residential housing price predictions in comparison to the linear, the Box-Cox and the Wooldrige (1992) transformation models, both in- and out-of- sample.

More recently, the literature about nonparametric hedonic house pricing moved away from unrestricted nonparametric models in favor of *additive nonparametric regression* (Brunauer et al. , 2010; Heckman et al., 2010; Martins-Filho and Bin, 2005; Bin, 2004; Clapp et al., 2002). The main advantages of additive nonparametric regression models are that, although they allow for multiple regressors, the models' estimation involves only univariate smoothing, and results are much easier to interpret than sophisticated graphical analysis of four or higher dimensions. The central idea of these types of models is to replace the usual linear function of a covariate with an unspecified smooth function while holding the additive structure of linear regression models.

With respect to the choice of the estimator, the nonparametric hedonic model literature mainly makes use of the Nadaraya-Watson estimator. Others (Martins-Filho and Bin, 2005; Bin, 2005; Bin 2004) use a backfitting procedure combined with a local polynomial estimator, which reduces multivariate regression to successive simple bivariate regressions. As in Gencay and Yang (1996), Bin (2004) finds that the semi-parametric model provides more accurate housing price predictions than conventional

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<sup>13</sup> Also the European Commission guidelines on imputation procedures for EU-SILC advocate the application of methods which take into account the correlation structure (or other characteristics of the joint distribution of the variables) as opposed to marginal or univariate approaches (EC, 2003).

parametric models in both in-sample and out-of-sample comparisons. In particular, the prediction errors from the semi-parametric model are smaller than those from the parametric models by 10 to 20 percent. Brunauer et al. (2010) use an additive mixed regression setting, where *penalized splines* are applied to continuous covariates, while discrete spatial effects are implemented as district specific intercepts.

Results of testing the superiority of semi-parametric and non-parametric models with respect to parametric ones are nevertheless not unanimous. In a study on three California counties, Laurice and Bhattacharya (2005) find that sales prices of dwellings are predicted more accurately by semi-parametric as opposed to parametric methods of estimation. They also find that parametric models with higher-order polynomials perform just as well as the semi-parametric forms. Fahrlander (2006) applies semi-parametric models for predicting the housing prices in Switzerland, finding that the predicting power of hedonic models can be increased by using nonparametric methods (cubic regression splines) but also piecewise log-linear and quadratic terms.

A set of three papers replicates results on the same data using different approaches, and finds different results. Anglin and Gençay (1996) show that the semi-parametric model provides more accurate mean predictions than the benchmark parametric log-log model. Parmeter et al. (2007) compare Anglin and Gençay (1996) results with those with a new fully non-parametric model, and conclude that a non-parametric procedure is more appropriate than the semi-parametric one. Finally, in a replication study of the work of Parmeter et al. (2007), Haput et al (2010) find that the parametric log-log model performs better than the semi-parametric and non-parametric ones.

### 2.1.5 Quantile approach

Gasparini and Escudero (2004) point out that the intercept of a standard regression model is the average of the market value of the non-observable housing characteristics. The intercept can be actually interpreted as the average rent paid by all the individuals in the sample if none of the characteristics were observed. As a consequence, the prediction of a standard regression model would assign to all households the same average value of the non-observable characteristics, spuriously inflating the value of the low-valued dwelling, and underestimating the value of high-valued dwellings. Moreover, as underlined in Zietz et al. (2007), the regression coefficients of some variables might behave differently at different house price levels, as buyers of higher-priced homes could price certain housing characteristics differently from buyers of lower-priced homes.

In order to overcome these problems, some authors (Gasparini and Escudero, 2004; Zietz et al, 2007; Cruces et al. 2008; Ebru and Eban, 2009) suggest to adopt a quantile regression approach. The model to be estimated is the following:

$$Q(R_h|q) = \alpha_{0,q} + \sum_{m=1}^M f_m(X_{hm})\beta_{hm,q} + Q(\varepsilon_h|q) \quad (5)$$

where  $Q(R_h|q)$  indicates the  $q$ th quantile of the conditional distribution of rents ( $R_h$ ),  $\alpha_{0,q}$  is the intercept associated to dwellings in the  $q$ th quantile,  $\beta_{hm,q}$  are the coefficients that indicate how observable characteristics affect the  $q$ th quantile of the conditional distribution of rents (see Cameron Trivedi, 2010, ch. 7, for a description of the estimation methods).

After estimating the quantile regression for tenants, the estimated coefficients should be applied to the dwelling characteristics of owners to compute the predicted implicit rent value associated to own-occupied dwellings. Recall that the estimation process produces as many estimated parameters ( $\hat{\alpha}_{0,q}$

and  $\hat{\beta}_{hm,q}$ ) as many quantiles have been defined on the conditional distribution of rents. In order to estimate the implicit rent for owners, researchers should first assign each home owner to a quantile, which is not straightforward. According which distribution should owners be ordered to? Gasparini and Escudero (2004) use income distribution, assuming that the monetary value of the demand for non-observable characteristics is related monotonically to the distribution of income, so that the conditional quantiles of the distribution of non-observables coincides with the quantiles of the distribution of income. In other words, individuals in the  $q$ th quantile with respect to the rent distribution are also found in the  $q$ th quantile of the income distribution. This might not be the case if, for instance, the quality of rented and owners-occupied dwellings differs.

### 2.1.6 Spatial Models

Since the most important determinant of a house value and its related rental value is location, house prices are most likely to be spatially dependent. Not only dwellings in the same location are likely to have similar characteristics because they were probably developed at the same time, but they also share the same neighborhood amenities (parks, school, hospitals), or suffer from the same unpleasant features, for instance pollution or crime. Although some neighborhood characteristics can be explicitly accounted for in the hedonic model (vector  $\mathbf{N}_h$  in equation 1), a location omitted variable bias might still persists (Hill, 2013). This can occur either because of true unobservable characteristics, or because of limitations in the set of variables in the questionnaire. The growing availability in surveys of geospatial coordinates for each dwelling may allow overcoming this problem.

Spatial dependence can be captured either in the regressors or the error term. The first approach, i.e., including location as an explanatory variable using geospatial data, is the most straightforward one. Spatial autoregressive (SAR) models allow for both spatially lagged dependent variables and spatially lagged disturbance terms. Although the SAR models are the most commonly applied, there is a wide range of alternatives, particularly semi-parametric and non-parametric spatial approaches, for example: *kriging* (Diggle and Ribeiro 2007, Montero and Larraz, 2010), *spatial smoothing* (Wood 2006; Wood et al. 2008), approaches based on *spatial penalization* (Fahrmeir et al. 2013), *geographically weighted least squares* (Fotheringham et al. 2002), and *spatial scaling factor models* (Brunauer et al., 2010). For an elaborate discussion and a review of the literature on spatial dependence, the use of geospatial data and also on nonparametric estimation, we refer the reader to Hill (2013). A more recent approach is the inclusion of explicit spatial (distance) variables obtained from *GIS data* (Lozano-Gracia and Anselin, 2012).

In general, the methods to introduce the spatial information in a hedonic model can be classified in the following three families: first-order autoregressive spatial models (SAM); first-order autoregressive errors models (SEM); and first-order spatial Durbin error models (SDM). In all the three cases, spatial dependence is modeled through a matrix  $\mathbf{\Lambda}_h$  of spatial weights (where each entry is represented by  $\lambda_{hk}$ ), with zeros on the diagonal (so that the distance between a dwelling and itself is zero).

In the case of SAM models, location is included as an explanatory variable by using the weighted independent variable (the rent  $R_h$ ) as regressor, where weights come from the space matrix (equation 6):

$$g(R_h) = \sum_k \lambda_{hk} f(R_h) + \alpha_0 + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \epsilon_h \quad (6)$$

Another way to capture spatial dependence is using the information in the error term, as in the SEM models (equation 7):

$$g(R_h) = \alpha_0 + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \eta_h \quad (7)$$

$$\eta_h = \sum_k \lambda_{hk} \eta_k$$

Finally, in the case of SDM, both the independent variable and the set of explanatory variables are included as regressors weighted by the spatial matrix (equation 8):

$$g(R_h) = \sum_k \lambda_{hk} f(R_h) + \alpha_0 + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \sum_{m=1}^M \sum_k \lambda_{hk} f_m(X_{hm})\beta_{hm} + \epsilon_h \quad (8)$$

In the context of house pricing, spatial dependency is usually verified (see Anselin et al, 1996; Anselin and Bera, 1998, Hill, 2013 and references therein, Can 1992). Kuminoff et al (2008) for instance find that adding spatial fixed effects to the hedonic price function influences performance in the presence of omitted variables. Brunauer et al (2010), in a semi-parametric setting, allow the price function to vary among districts in Vienna with spatial scaling factors, finding that the spatial scaling model leads to significant improvement of model quality and predictive power with respect to the benchmark model with district-specific intercepts or the single-district model. Lesage and Pace (2004) find that SAM on generated sample data with half missing values for the independent variable produces predictions as accurate as when the model is run on the full sample.

### 2.1.7 Heckman Selection models

Unobserved quality of shelter chosen by renters can be very different from that chosen by owners, as there may be systematic differences in characteristics between renter and non-renter households.<sup>14</sup> If the choices of tenure type and characteristics of the dwelling are not independent, as underlined by Arevalo and Ruiz-Castillo (2004), the OLS estimation in the market rental sector might be inconsistent. If, for instance, the owners are more likely to live in higher-quality dwellings, the rent predicted with the OLS would under-estimate their imputed rent.

Consequently, some authors (for instance, Norris and Pendakur, 2013, Arévalo and Javier Ruiz-Castillo, 2004, Deaton and Zaidi, 2002) suggest adopting the Heckman (1976) two-stage estimation method in hedonic models. Equation (9) determines the rent paid by tenants, and equations (10) and (11) are the selection equations which determine who is the tenant ( $t_h = 1$ ) and who is the home owner ( $t_h = 0$ ).  $X_{hj}$  is a vector of explanatory variables which is assumed to determine the tenure status and to be independent of the rent value. Error terms  $\epsilon_h$  and  $\eta_h$  are jointly distributed as a Normal.

$$g(R_h) = \alpha_0 + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \epsilon_h \quad \text{if } t_h = 1 \quad (9)$$

$$t_h = 1 \quad \text{if} \quad \sum_{m=1}^M f_m(X_{hm})\gamma_{hm} + \sum_{j=1}^J f_j(X_{hj})\delta_{hj} + \eta_h > 0 \quad (10)$$

$$t_h = 0 \quad \text{otherwise} \quad (11)$$

<sup>14</sup> Note that the selection bias could occur not only among tenant and owners, but among tenants between market and non-market tenant in subsidized market.

Norris and Pendakur (2013) apply the selection model to Canadian data, and find that making use of Heckman selection model increases the imputed rent of owners by almost 30% with respect to a standard OLS model.

### 2.1.8 Stratification (Imputation Cells)

The stratification method involves creating a number of homogeneous cells defined in terms of various characteristics, from the size of the dwelling, year of construction, quality of the building, to location or household composition. In a more sophisticated version of the approach, strata could also be defined by means of cluster or factor analysis (see, for instance, Olczyk and Lane, 2008). All households are then assigned to each strata, and the imputed rent for the home owners are then defined on the basis of rents paid by tenants in the same strata.

Statistics Finland defined 128 strata (Frick et al 2010). In a study on rent imputation in the UK, Mullan et al. (2007) define 12 strata, using as variables tenure type, council tax band, whether the property is in London or not, and the number of rooms in the property. Stratification is used in 12 out of 29 countries for estimating imputed rent in the EU Survey on Income and Living Conditions (Törmälehto and Sauli, 2013).

Typically, imputed rents are obtained by taking the mean (Crossley and Pendakur, 2006) or the median within each cell (Milligan, 2008). In case some cells are empty of renters, neighbor cells are used.

While creating the strata, the objective is to optimize the physical homogeneity of dwellings within each cluster, while ensuring a sufficient number of observations to produce a reliable rent estimate. Clearly, the more characteristics are used to define the strata, the more refined is the approach, as dwellings in the same strata will be of a more homogeneous quality. Nevertheless, increasing the number of strata reduces the average number of observations per stratum, and a very detailed stratification might raise the standard error of any rent imputation (see, for instance, Eurostat, 2013a). Moreover, seeking precision often clashes with the underlying data.

According to Malpezzi (2000), for instance, the minimum required number of observations for analysis in a given housing market is around 500, and any stratification that leads to cells with a number of observations smaller than 500 should not be considered adequate. According to the Eurostat guidelines (Eurostat, 2013b, p.210), it is not recommended to use any stratification or econometric methods for rent-imputation when the share of free-market tenants falls below 10 percent (see also Törmälehto and Sauli, 2010, p.157). According to the International Comparison Program Methodological Handbook (ICP, 2013, ch.10, p.4), instead, the standard approach (cell-stratification) should not be attempted when less than 25 percent of all dwellings in the country are rented.

## 2.2 The Capital Market Approach

In the *capital market* approach the implicit rent is understood as the rate of return that would have been obtained by owners if the home equity had been invested in an interest bearing account. Alternately, the owner's annual user cost of a dwelling could be understood as the difference between purchasing a house at the beginning of the period, using it, and selling it at the end of the year. Two methodologies may be followed under this approach: the *rent-to-value* and the *user-cost* method.

### 2.2.1 The Rent- to-Value Approach

The rent-to-value approach<sup>15</sup> formulates the hypothesis that, in equilibrium, the asset price of a dwelling  $V_h$  should equal the current market rent  $R_h$  capitalized at a rate  $c$  (see also Phillips, 1988, Garner and Kogan, 2007, Heston and Nakamura, 2009):

$$V_h = \frac{R_h}{c} \quad (12)$$

From equation (12), the capitalization rate  $c$  can be defined as the rent-to-value ratio:

$$c = \frac{R_h}{V_h} \quad (12')$$

As suggested by Diewert (2009),  $c$  may be regarded as an estimate of the real interest rate plus the depreciation rate applicable to the dwelling's value to transform it in the flow of services from housing. As underlined in Phillips (1988), the relationship between house values and residential rents should behave in predictable ways. For example, if the real financing cost of owning a dwelling is low because of favorable fiscal treatment, we should expect a low capitalization cost. The capitalization rate  $c$  could be estimated using a hedonic model:

$$\ln(P_h) = \alpha + \sum_{m=1}^M f_m(X_{hm})\beta_{hm} + \gamma_h \text{owner} + \epsilon_h \quad (13)$$

where  $P_h$  is the market value for owner-occupied dwellings and the annual rent for tenants; *owner* is a binary variable that equals 1 if the individual owns the dwelling and 0 otherwise. The capitalization rate  $c$  (or rent-to-value) is:

$$c = \frac{R_h}{V_h} = e^{-\hat{\gamma}_h} \quad (14)$$

Another method to estimate the capitalization rate is used by Yates (1994) and Sounders and Siminski (2005) on income distribution in Australia. In these examples, the rent-to-value rate is calculated as the value of gross imputed owner-occupied rent derived from the National Accounts<sup>16</sup> divided by an estimate of the gross value of the owner-occupied housing stock derived from the Household Expenditure Survey (HES). Imputed rents are then obtained by applying the capitalization rate to the value of the property reported in the HES.

Two problems related to this approach have been underlined in the literature (see Phillips, 1988, ILO, 2004, Garner and Kogan, 2007). The first consists in using the same capitalization ratio for tenants and owners within the same area. This might be misleading when dwellings' characteristics differ significantly between these two population groups. The second problem arises from the omitted-variable bias embedded in the *owner* variable, which summarizes underlined differences in the quality of the dwellings for owners and tenant.

Regardless of previous caveats, the rent-to-value approach has been used, for instance, in the United States National Accounts imputation for the services of owner-occupied housing (see Lebow and Rudd,

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<sup>15</sup> In Malpezzi and Mayo (1987) the rent-to-value ratio is also defined *amortization ratio*.

<sup>16</sup> This is based on the market rents received for dwellings that have similar characteristics to those that are owner-occupied.

2003) as well as in South Africa's 1993 LSMS (see Deaton and Zaidi, 2002). In the latter, instead of running a hedonic model, the local median of rent-to-property values in the same location was used to impute rent for home-owners.<sup>17</sup>

### 2.2.2 The User-Cost Approach

While the rent-to-value approach endogenously defines the return rate that transforms a dwelling's value into the flow of services, the user-cost approach needs an exogenous estimate of the capitalization cost. To implement this method, two sets of information are needed: (i) the rate of return for housing and (ii) information on operating costs related to home ownership such as maintenance, repairs, rates, insurance, mortgage interests payments, and expected appreciation of the property.

The user cost related to the dwelling type  $h$  at time  $t$  ( $UC_{h,t}$ ) is then defined in equation (15):

$$UC_{h,t} = V_{h,t}(i_t + \gamma - E\pi_{h,t}) \quad (15)$$

where  $i_t$  is the nominal interest rate or the real mortgage interest rate or the opportunity cost of having invested in buying a home instead of investing in other financial activities;  $\gamma$  is the sum of depreciation, maintenance and repair, and insurance; and  $E\pi_{h,t}$  is the expected appreciation of the property (or inflation). As Diewert (2009) points out,  $(i_t - E\pi_{h,t})$  may be interpreted as the real interest rate at time  $t$ .

Yates (1994) applies this approach to the 1988/89 Australian Household Expenditure Survey (AHES), using subjective assessment of dwelling value and operating cost from the AHES and computing the return rate for housing by comparing the individual estimates with the imputed rent found in the Australian National Accounts. Other examples of countries adopting the user cost approach are Estonia, Czech Republic, Island, Slovak Republic and Sweden for the European Community Survey on Income and Living Conditions (see Törmälehto and Sauli, 2013). Unfortunately, there are no details available about the rent imputation process implemented in these countries.

Frequently, a simplified version of the user-cost approach is used by fixing an arbitrary implicit rate of return on housing equity. This equals a safe private market (long-run) rate of return. Smeeding et al. (1993) use a return rate of 2 percent and add it to each country's inflation level. The resulting rate is multiplied by home equity  $V_{h,t}$  to estimate imputed rent. This is also the method followed by Frick and Grabka (2003), who adopted a 6 percent nominal interest rate and a 2 percent real interest rate. Deaton and Zaidi (2002) apply the user-cost approach in Vietnam. The value of housing consumption is 3 percent of the current value of the house which comes from a regression of housing value on various housing characteristics.

Lastly, Verbrugge (2008) and Garner and Verbrugge (2009) highlight the notable divergence between actual rents and user costs for the case of the United States, concluding that the rental equivalence method should be the preferred choice for official price statistics. Other difficulties in applying the user cost method entails making reasonable assumptions on the proper interest rate, depreciation rate, inflation rate, as well as having precise information on the purchase prices for the dwellings (see ILO, 2004 for an exhaustive review).

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<sup>17</sup> In cases where the property value was also missing, it was replaced by the number of rooms of the dwelling times the median property value per room in each locality Deaton and Zaidi (2002).

## 2.3 Payment Approach

Under the payment approach, the cost of housing corresponds to the out-of-pocket expenditures faced by households. Therefore, rent and utilities are part of tenants' welfare aggregate while mortgage interest payments,<sup>18</sup> taxes, insurance, maintenance and repairs are included in owners' welfare. This approach could be misleading when measuring poverty (Garner and Short, 2001).<sup>19</sup> For instance, Sierminska et al. (2008) show that in most of the nine developed countries of the study,<sup>20</sup> the median wealth-holdings by age of the household's head exhibit a hump-shaped pattern. Younger heads have less than older ones. Simultaneously, elderly-headed household have virtually zero median debts which means that these are more likely to have already cancelled their mortgages. Therefore, expenditures on housing for homeowners with very low or no mortgages are not precise proxies of the flow of services received by owners (see also Crossley and Curtis, 2006 and Frick and Grabka, 2003). As a result, the payment approach may understate poverty estimates for elderly-headed households.

Moreover, differences in mortgage payments may reflect differences in interest rates or loan parameters which may not be related to the quantity and quality of housing services. Therefore, there is a risk of overestimating poverty for homeowners with very low or no mortgage and underestimating it for households with high mortgages levels or tenants.

The US Interagency Technical Working Group on Developing a Supplemental Poverty Measure Census (2010) acknowledges the need to adjust poverty thresholds by housing status. Citro and Michael (1995, p.148) state that the shelter component of the poverty line "*would include actual outlays for mortgage payments, taxes, insurance, and maintenance and repairs, together with an imputed amount for the estimated rental value of the home net of such outlays. Such a definition would treat homeowners with low or no mortgage payments in a comparable manner with other homeowners and renters.*" However, Crossley and Curtis (2006) question that property taxes are related to the consumption of housing services. Additionally, Garner and Short (2001) argue that taxes, insurance, maintenance and repairs associated to home ownership should not be included but only the part of those expenditures associated to being a potential renter of their own apartment should be considered.

## 2.4 Self-assessment

This approach is based on data collected in some household surveys about owners' estimates of a fictitious market rent of their dwellings.<sup>21</sup> For instance, homeowners are asked to estimate how much they would pay if they were renting their home Frick et.al. (2010). This method relies on the expectation that owners *can* estimate rental equivalences even when there is no comparable rental dwelling in the area if they know of rents in other areas (Gaerner and Kogan, 2007). This should be less problematic in regions where rental market is active and well developed (Lanjouw, 2009). Thus, owner-occupiers are likely to be informed about the value of their dwelling and the amount they would have to pay to rent a home with similar quality and location attributes. Arévalo and Ruiz-Castillo (2004) find self-assessed values to be very similar to the results of a hedonic model on the same dwellings in Spain. Additionally,

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<sup>18</sup> Generally, these include only interests while the main payment is considered as investment.

<sup>19</sup> Garner and Short refer to the definition of the poverty threshold for the United States.

<sup>20</sup> Canada, Cyprus, Finland, Germany, Italy, Norway, Sweden, United Kingdom and United States.

<sup>21</sup> See Gillingham (1983) for a discussion on the importance of using this approach in "user-cost" method. To list few papers about other methods such as the rental equivalence approach see: Goodman and Ittner (1992); Garner and Rozaklis (2001); Garner and Short (2001); Garner et al. (2003); Garner et al. (2006); Gaerner and Kogan (2007); Lanjouw (2009); Arévalo and Javier Ruiz-Castillo (2004); Lebow and Rudd (2003); Heston and Nakamura (2009) and Frick et.al. (2010).

Garner and Kogan (2007) suggest that home-owners, with the help of interviewers, might be able to give a very good estimate of the true rent by reporting what they would pay to live in their own dwelling.

However, owner-occupiers may over-estimate the true rental value of their dwelling compared to rented homes with similar characteristics given the affinity to their property or neighborhood and should be treated with caution (Frick et al., 2010). Garner and Rozaklis (2001) find in the United States that housing costs with self-reported rental equivalence resulted in higher estimates (almost 15 percent) than those based on a hedonic model.<sup>22</sup> A more recent study by Garner et.al (2006) state that median reported rental equivalence in the US Consumer Expenditure Survey is higher not only than the estimates from a hedonic model on tenants but also from the rent-to-value model and the payment (out-of-pocket expenditure) approach based on the same data. A similar result is found in Goodman and Ittner (1992) who explored the accuracy of owners' estimates of house values *vis-à-vis* the sales prices of the same properties, using a national United States sample. The authors find that the median homeowner in the mid-1980s overvalued her house by about 6%.

Several authors compare the approach to home-owned dwellings' adopted by the US Bureau of Labor Statistics (BLS) for the CPI with the one adopted by the Bureau of Economic Analysis (BEA) for personal consumption expenditures. While the CPI relies on home owners' self-reported estimates, the BEA uses the rent-to-value ratios. Lebow and Rudd (2003), for instance, suggest that home-owners may give quite inaccurate estimates of what their homes would rent, and this could create large biases in the computation of the CPI, given the large weight attached to the imputed rent category. Garner et al. (2003) found that in 1992, the estimate of dwelling services of renters and owners was about 9 percent higher in the BEA than the BLS. In addition, they find that the two series have consistently grown apart from 1992 to 2000.

As underlined by Garner and Short (2001, p.15), the reason of this mismatch could be both that respondents has a mistaken and biased idea on the market value of their dwelling, or that *the reported rental equivalence values are likely to be capturing variations in housing and neighborhood quality that hedonic approaches do not*. Moreover, owners might have above-market evaluation of their dwellings because of some special attachment for specific features of their homes, especially if they designed or made those themselves, what Heston and Nakamura (2009) define *owner pride* factor. Although there is consensus about the existence of this bias and a recommendation about testing it when market rents are developed (Lanjouw, 2009); so far, there is no systematic way or methodological procedure identified in the literature which deals with this problem.

## 2.5 Information from External Sources

The estimated rent assigned to individuals depends on the imputation method and the quality of the data underpinning the exercise. So far, we have described different estimation methods based on data collected in one household survey. However, this type of dataset may occasionally have limited information on housing that would compromise the quality of results. One possible solution is using other data sources such as: (i) other households surveys; (ii) administrative register; (iii) newspaper or internet offer notices; (v) multiple listing datasets; (vi) mortgage transactions; and (iv) key informant evaluations.

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<sup>22</sup> In 1997, the authors found an estimated expenditure of 18,761\$ for the self-reported expenditure as opposed to 16,351\$ with hedonic estimate.

Among the group of studies which combine different household surveys to estimate the flow of the service, Marquier (2003) merges the French housing survey (*enquête logement*) with the survey on income and living condition (SILC) and Ceriani et al (2013) match two household budget surveys produced for Italy (one by the Statistical Office, the other by the Bank of Italy) to maximize information about households' real estate properties. Garner et al. (2006) suggest using the rental equivalence reported in the United States' Consumer Expenditure Survey published by the Bureau of Labor Statistics, and apply the coefficient of a hedonic regression on housing unit characteristics of the American Housing Survey. It is relevant to mention, most studies found in the literature are focused on developed countries. This is a consequence of the existence and easily availability of alternative datasets which are atypical in developing countries. Another possible source of information could be the rental surveys conducted by the different Statistical Offices for constructing the 2011 PPPs (ICP, 2013).

As mentioned, a second option would be using administrative registers such as cadasters, or transaction and assessment data. These type of data sources may be the most comprehensive about dwellings' characteristics in a country. However, there are several drawbacks of using these datasets. Usually, municipalities collect this type of information and it is not generally centralized. In other words, a huge effort might be done in gathering it for the whole country. Additionally, dwellings' values reported in cadasters may be outdated. On the other hand, transaction data have information only on houses which have been exchanged on the market, which may be a small share of the total stock. In countries where the value of the dwelling is taxed, fiscal records may represent a good option for the analysis (see Pollakiwsky 1995).

Kholodilin (2012) analyzes the level of flats' prices in 48 large European cities, by collecting data from internet websites. Similar approach is implemented by the Bank of Albania for calculating the House Price Index and the Rent Price Index for Tirana (Kristo and Bollano, 2012). The dataset is obtained from sale and rent announcements published in a newspaper.<sup>23</sup> One limitation of this approach is that newspaper announcements may not be a good approximation of the stock of housing in a country. For instance previous examples only consider the capital and large cities in their samples. Moreover, even if we could virtually find sale or rent announcements of dwellings in all locations in one country, the sample of dwellings may likely suffer from selection bias. Similarly, data collected from multiple listing agencies and mortgages transactions suffer from lack of representativeness. As suggested in Pollakowsky (1995), this type of information may be more appropriated for studies concentrated in a specific location or metropolitan area.

Finally, key informants could be asked to assess the value of the dwellings.<sup>24</sup> These could be for instance enumerators while conducting the households' survey, as in the case of Zimbabwe (Zimbabwe National Statistical Agency, 2013, p.127). Someone knowledgeable about a specific location might have some insights on non-observable characteristics of the dwelling, and can be more objective in her evaluation than home-owners. When no other information for rents or home values is available, using external sources could provide a good approximation of the value of housing services.

### **3 Importance of rent imputation in other economic disciplines**

Other economic disciplines have also acknowledged the importance of the imputed rent. This section provides an overview of how practitioners in the fields of National Accounts, Consumer Price Index,

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<sup>23</sup> The sample includes 90 apartments in each quarter (Kristo and Bollano, 2012).

<sup>24</sup> This is similar to the problem faced when collecting food prices (see Gibson 2007)

Purchasing Power Parities and Income Taxation have been dealing with difficulties associated to rent imputation. The Canberra Group's report states that micro level estimates could benefit from drawing on the methodologies and data sources used in the macro-contest (Canberra Group, 2001, p.64). Yet, not all methods adopted in other contexts might be appropriate in the case of welfare measurement; like conflating GDP with measures of economic well-being which might lead misleading conclusions on people's welfare and entail wrong policy decisions (Stiglitz, Sen and Fitussi, 2009).

### 3.1 National Accounts

The importance of imputed rents in National Accounts is well summarized in Figure 1 more than half of the total housing consumption is imputed rent in many countries in Europe (see also Tormalehto and Sauli, 2010). The value of these housing services is estimated to be *equal to the rentals that would be paid on the market for accommodation of the same size, quality and type* (SNA, 2008, §9.65), *taking into account factors such as location, neighborhood amenities, etc., as well as the size and quality of the dwelling itself* (ESA, 2010, §3.75). This estimation might be difficult to define *in a situation where there is either no rental market in such properties or only a very limited one* (SNA, 2008, § 20.64). The European System of Accounts (ESA, 2010) suggests that rents for owner-occupiers should be imputed using the stratification method covered in Section 2.1.8.<sup>25</sup>

The System of National Accounts<sup>26</sup> recommends including the imputed values of the housing services of owner-occupied dwellings in three chapters: the production account, the use of income accounts and the price and volume measures (SNA, 2008). In the first one, the production of services by household's members for their own consumption has traditionally been excluded because of limited repercussions on the rest of the economy. However, the only exception is the production of housing services for own consumption by owners. This would guarantee international and inter-temporal comparability since the share of home owners varies significantly between countries, regions and over time. The imputed values of the housing services are also included in owners' final consumption expenditures in the *use of income accounts*.<sup>27</sup> The housing service is treated as one of the consumption items acquired by households and used to satisfy their needs. Individuals living in their own dwellings are treated as unincorporated enterprises selling dwelling services to themselves. Finally, in the chapter devoted to *price and volume measures*, the SNA briefly mentions the problem of building the correct deflator for rental services of owner-occupied dwellings, making reference to the Consumer Price Index manual (ILO, 2004).

Deaton (2005) notices that imputed rents for homeowners are among those items of the consumption aggregate which consumption ratios between survey-to-National Accounts are typically less than unity.<sup>28</sup> The reason is that imputed rents are usually included in National Accounts' consumption but rarely in household surveys' consumption. Moreover, there has been a divergence between national accounts and households' surveys over time and one of many possible reasons could be the increase in the share of the SNA's consumption attributable to owner-occupiers' rents.

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<sup>25</sup> The stock of dwellings is stratified by location, nature of dwelling and other factors that affect the rental, and then, the average actual rental per stratum is applied to all dwellings in that particular stratum.

<sup>26</sup> The System of National Accounts (SNA) is the internationally agreed standard set of recommendations on how to compile measures of economic activity in accordance with strict accounting conventions based on economic principles, elaborated jointly by the European Commission, the International Monetary Fund, the Organization for Economic Cooperation and Development, the United Nations and the World Bank.

<sup>27</sup> This approach records how different economic sectors such as households, government units and non-profit institutions serving households; allocate their disposable income between final consumption and saving.

<sup>28</sup> As well as financial services indirectly imputed and consumption by nonprofit institutions serving households.

## 3.2 Price Indexes

The treatment of owner-occupied housing is recognized as the most difficult, complex and important (ILO, 2003, §17, 2004) sector in the compilation of consumer price indices (CPI).<sup>29</sup> Several methods could be used for measuring the value of own-occupied dwellings in a CPI. These are: the acquisition approach, the use approach (user and rental equivalence approaches), the payment approach, and the exclusion from the price index. The usefulness of the index depends mainly on how informative the index is to policy makers than on defining which one of previous methods is right.

Generally, the entire monetary expenditure paid for the acquisitions of new dwellings is optimal when the primary purpose of the CPI is monitoring macroeconomic indicators such as inflation (ILO, 2003, §131).<sup>30</sup> Inflation is in fact perceived as a monetary phenomenon in market transactions made between households and other institutional sectors. In the acquisition approach, therefore, prices are recorded at full market prices and entirely allocated to the time of purchase, in a fashion identical to the treatment of non-durables and services.

When the primary purpose of the index is to adjust compensation or income, the *Payment Approach* could be the most appropriate (Goodhart, 2001 and ILO, 2003).<sup>31</sup> In this kind of *cash flow approach* the consumption expenditure of owner-occupied dwelling is measured by using the out-of-pocket expenditures, e.g. initial cash outlay for the purchase of the house, mortgage repayment and interest payment, insurance, maintenance and repairs. The Payment Approach, although conceptually and computationally simple, *ignores the opportunity costs of holding the equity in the owner occupied dwelling, it ignores depreciation and it uses nominal interest rates without any offset for inflation* (Diewert, 2013, p.49). Despite the criticisms, the Payment Approach is currently used in Austria, Chile, Ireland and the Slovak Republic (Table 1).

The *use cost* of the services for owner-occupied dwelling during certain period is correct when taking the standard-of-living approach to the CPI (Diewert, 2013, ILO, 2004, ch 23).<sup>32</sup> The *Use Approach* comprises the rental equivalence and the capital market approach. The *Rental Equivalence Approach* evaluates the owner-occupied dwellings with the actual rents paid for similar properties by tenants when the rental market exists. There are different ways to implement this approach; for instance by asking owners about the potential rent of their dwellings;<sup>33</sup> or housing experts (ILO, 2003); or by applying statistical or econometric techniques.

According to the *Capital Market Approach*, the value of an owner occupied dwelling is based on the current market value of the dwelling adjusted for the opportunity cost of the equity, the depreciation rate, property taxes and insurance, and the cost of maintenance and repairs (ILO, 2003, 2004, Diewert, 2013). There are two options: the rent-to-value approach (US Bureau of Economic Analysis) and the user-cost approach (see ILO, 2004; Diewert, 2013; Guðnason and Jónsdóttir, 2009 for the Iceland example).

Exclusion of the price of housing from the CPI is justified on the basis that house ownership is assimilated to a capital asset (see ILO, 2004). The Euro-Area Harmonized Index of Consumer Prices, for instance, excludes to date any treatment of owner-occupied housing, although Eurostat admits that this

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<sup>29</sup> Indices that reflect the change in prices paid by a representative household for a representative basket of goods and services.

<sup>30</sup> Even within the framework of measuring inflation, there is some debate on the appropriateness of including housing for monetary policy purposes, mainly for the risk of including volatile assets which would in turn lead to unstable price indices (see Goodhart, 2001).

<sup>31</sup> Originally, this was the CPI's purpose.

<sup>32</sup> The aim of the index is to measure changes in the cost of living.

<sup>33</sup> This is the case of the US Bureau of Labor Statistics.

issue is the *major shortcoming* in the coverage of its inflation indicator, and pilot studies have been put in place to developing a system of own-occupied housing price indices (Eurostat, 2012). As summarized in Table 1, there is no homogeneity in the way different statistical offices handle owner-occupied housing.

### 3.3 Purchasing Power Parities

Household dwelling service expenditures are also included in the computation of Purchasing Power Parities (PPP) and their treatment is a major concern particularly when PPPs are used in international poverty comparisons (see Deaton, 2010). PPPs are indicators of price level differences across countries in a given reference period and are produced by the International Comparison Program<sup>34</sup> (ICP, 2013) and by Eurostat-OECD (2012).

The standard procedure recommended for the computation of PPPs is the same as in National Accounts: owner-occupied dwelling are evaluated at the same rents actually paid for identical, or very similar, dwellings in the country. The method used for the imputation is the *stratification* approach: the housing stock is divided into strata by type, size, quality and location, and each dwelling is evaluated at the average rent in its stratum.

This standard procedure works well in countries where two conditions are met: first, rented dwellings are representative of the stock of dwellings as a whole and second, statistical agencies collect information on rents for different kinds of dwellings in most parts of the country. However, many countries cannot supply information on rents that can be used to calculate PPPs by the standard procedure. This is the problem faced by the ICP for many developing countries with respect to traditional dwellings<sup>35</sup>; ignored when the share of traditional dwellings is lower than 5% (ICP, 2008); or the problem faced by Eurostat-OECD for transition country and new Member States where the rental market is not well developed.

The alternative method for estimating dwelling costs is the *user cost* approach. It entails estimating imputed rents by summing all the costs that owners incur. These costs are: (i) intermediate consumption; (ii) other taxes on production; (iii) consumption of fixed capital; and (v) real net operating surplus.

Figure 2 shows few rules based on country's rent market for deciding between standard methods: (i) *development*: share of rented dwellings in the country (25 percent); (ii) *type*: rented dwellings are mainly (i.e. more than half) occupied by foreigners or by government or other employees; or (iii) *spatial distribution*: rented dwellings are not evenly distributed over all parts of the country (see ICP 2011 Guidelines for the User Cost Method to calculate rents for owner occupied housing).

### 3.4 Taxation

Imputed rents are also relevant in the contest of taxation. There are many arguments in favor of including imputed rent as part of the personal income tax base on equity and efficiency grounds (Andrews et al., 2011, Figari et al., 2012, IMF, 2009, Poterba, 1992 and references therein). These

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<sup>34</sup> The International Comparison Program (ICP) is a worldwide statistical partnership to collect comparative price data and compile detailed expenditure values of countries' gross domestic products (GDP), and to estimate purchasing power parities (PPPs) of the world's economies. Using PPPs instead of market exchange rates to convert currencies makes it possible to compare the output of economies and the welfare of their inhabitants in real terms (that is, controlling for differences in price levels).

<sup>35</sup> Traditional dwellings are generally built by family members. The walls are made of less durable materials such as dried clay, sun dried bricks, bamboo or latticework, and the roofs are made from reeds, straw or palm fronds. Traditional dwellings are generally located in rural areas and the families that occupy them are most likely to be engaged in agriculture. (ICP, 2008)

discussions share the same distributional concerns as those found in the welfare analysis and opposed to National Accounts, Price Indices and Purchasing Power Parities whose aim is to create an aggregate housing estimate.

Theoretically, net imputed rents<sup>36</sup> should be included in a comprehensive income tax base in order to obtain fully neutral taxation of owner-occupation (IMF, 2009; Pellegrino et al., 2012). This would be similar to the equilibrium where renting-costs equal owning-costs (Ceriani et al., 2011, Poterba, 1992). However, home ownership benefits of particularly favorable treatments in reality. Imputed rental income on the principal home is almost never included in the income tax base<sup>37</sup>; and mortgage interests cost, as well as major renovation expenses, are usually deductible (Bourassa et al., 2013).

This advantageous fiscal treatment of home ownership determines higher returns for investing in real estates than in other forms of savings (Dougherty VanOrder, 1982). Consequently, this could produce excess investments in housing with respect to alternative assets, like stock and bonds (Sierminska et al., 2008, Arnold et al., 2011). This over-investing in real-estate may generate efficiency distortions such as potential co-factors in triggering the housing bubble as well as significant budgetary costs (see Ceriani et al., 2011 for the case of the United States, and Pellegrino et al., 2012 for the case of Italy).

Even in the few cases where imputed rental income is subject to income tax, the corresponding value is either drawn from outdated administrative records or calculated as a flat percentage of the capital value of housing after operating and interest costs deduction (Yates, 1994). As a result, imputed rent is much lower than free market rents (Andrews et al., 2011, Pellegrino et al., 2012).

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<sup>36</sup> Calculated as the difference between imputed rents and the sum of mortgage interest payments, maintenance costs and depreciation cost.

<sup>37</sup> Few exceptions are found in Poland, the Netherlands and Switzerland.

## 4 Distributional Impacts of rent imputation

So far we have covered not only the relevance this topic has on welfare measures in developed and developing countries but also the measurement methodological challenges that practitioners faced in the welfare space as well as in other economic spaces like price indices, national accounts, among others. However, we are not knowledgeable about how different imputation methods affect the welfare distribution. In order to do this, we divide this section into two parts: the first one presents the theoretical foundations to analyze how different hypothetical rents' distributions would impact inequality and poverty measures as well as poverty profiles and other measures of the welfare distribution. The second subsection gathers and classifies a comprehensive list of results from the literature.

### 4.1 A theoretical framework

Consider a population  $P$  made of  $i = 1, 2, \dots, n$  individuals,  $n \in \mathbb{N}$ . Each  $i$ -th individual is endowed with a consumption level (net of rent) of  $x_i$ , such that  $x = [x_1, x_2, \dots, x_n]$  represents the distribution of net consumption in population  $P$ . Without loss of generality, let us assume that expenditure levels are ordered, such that  $x_1 \leq x_2 \leq \dots \leq x_n$ .

Let  $r_i$  be the rent level associated to individual  $i$ -th, and  $r = [r_1, r_2, \dots, r_n]$  is the distribution of rents in population  $P$ . Note that  $r_i$  would either be the level of market rent if individual  $i$  is a tenant, or the imputed rent if  $i$  is a home-owner. The latter is the result of some imputation method discussed in Section 2. Independently of the generation process underpinning the rent's distribution, consider three hypothetical settings: Scenario  $A$ , rents are the same for all individuals in the society; scenario  $B$ , rent is a fixed proportion of each individual's expenditures; and scenario  $C$ , rent is a different share of each individual's expenditure. Formally:

$$\begin{aligned} A. \quad r_i^A &= r \quad \forall i \in P, \quad r > 0 \\ B. \quad r_i^B &= \rho x_i \quad \forall i \in P, \quad \rho \in (0,1) \\ C. \quad r_i^C &= \rho_i x_i \quad \forall i \in P, \quad \rho_i \in (0,1) \end{aligned}$$

How would the distribution of consumption  $x$  be affected by adding to each individual the rent defined in scenarios  $A$ ,  $B$  and  $C$ ? Before answering this question, define  $y^j = x + r^j$  the new consumption distribution after including rents. Thus,

$$y^j = [y_1^j, y_2^j, \dots, y_n^j] \equiv x + r^j = [x_1 + r_1^j, x_2 + r_2^j, \dots, x_n + r_n^j]$$

Since  $r_i^j$  is positive for all individuals, the initial consumption distribution ( $x$ ) will be shifted to the right. Therefore, the first moment of  $y^j$  will be bigger than the first moment of distribution  $x$ . Formally, let  $\mu(x)$  and  $\mu(y^j)$  the respective averages of distributions  $x$  and  $y^j$  then:

$$\mu(y^j) > \mu(x).$$

We can assess the effect of including rent into the consumption distribution by defining the *rent-incidence-curve*. Let us define first  $g_q$  as the percentage increase in consumption for quantile  $q$  when adding rents to the consumption aggregate.<sup>38</sup> Strictly:

<sup>38</sup> Consumption at the  $q$ th quantile is the consumption below which the consumption of  $q$  percent of the population fall (Foster, J et.al. 2013)

$$(\#) \quad g_q = \frac{y_q^j - x_q}{x_q} = \frac{(x + r^j)_q - x_q}{x_q}$$

The *rent-incidence-curve* plots  $g_q$  at each quantile of per capita consumption. As  $r^j$  is positive for each individual, the curve is positive defined. In other words, each point of the curve is placed above zero. Adding rents reduces inequality if the  $g_q$ 's rent-incidence curve are higher for the poorest quantiles than the richest quantiles of the distribution (see Figure 4, panel A). Likewise, the rent-incidence curve presents a positive slope. On the other hand, inequality increases if the rent-incidence-curve shows a negative slope. Finally, if consumption of all individuals in the society is increased by the same proportion, the curve is flat and there is no change in inequality (see Figure 4, panel B). Note that by definition these curves are anonymous but if the movement in the distribution preserves the ranking of individuals (i.e. rank-preserving transformation), the rent-incidence-curve becomes non-anonymous.

Generally, inequality decreases under scenario A.<sup>39</sup> Since the consumption of everybody is increased by a fixed amount  $r$ , the consumption of the poorest grows in relative terms faster than the consumption of the richest individuals, and therefore the slope rent-incidence-curve is negative. For example<sup>40</sup>, the Gini index,  $G(\cdot)$ , on the new distribution  $x + r^A$  will be lower than the Gini index computed on the original distribution:  $G(x) > G(x + r^A)$ , as  $\mu(x) < \mu(x + r^A)$ .

$$G(x) = \frac{1}{2n^2\mu(x)} \sum_{i=1}^n \sum_{j=1}^n |x_i - x_j| > \frac{1}{2n^2\mu(x + r^A)} \sum_{i=1}^n \sum_{j=1}^n |x_i + r - x_j - r| = G(x + r^A)$$

Inequality remains constant under scenario B: as consumption level of all individuals is increased by the same share, the rent-incidence-curve is flat and the Gini index does not change:

$$\begin{aligned} G(x + r^B) &= \frac{1}{2n^2\mu(x + r^B)} \sum_{i=1}^n \sum_{j=1}^n |x_i + r_i^B - x_j - r_j^B| \\ &= \frac{1}{2n^2\mu(x + \rho x)} \sum_{i=1}^n \sum_{j=1}^n |x_i + \rho x_i - x_j - \rho x_j| \\ &= \frac{1}{2n^2\mu(x)(1 + \rho)} (1 + \rho) \sum_{i=1}^n \sum_{j=1}^n |x_i - x_j| = G(x) \end{aligned}$$

Nothing can be stated a priori with respect to inequality under scenario C. If rent is a growing share of consumption expenditure ( $\rho_i > \rho_j$  for each  $i > j$ ), then the rent-incidence-curve will be increasing, as well as inequality. On the other hand, if there is no linear relation between the original consumption distribution and how the shares behave, we cannot easily infer the distributional impact of imputed rents. For example, if rents are higher for some specific segment  $k$  of the population such as urban dwellings, individuals belonging to that segment  $k$  may also present higher rent shares than other subgroups  $h$ :  $\rho_i^k > \rho_i^h$ . The effect of adding rents on inequality is not straightforward in this case.

The second aspect we want to analyze is how poverty is affected after introducing rent to the original welfare distribution. In particular, we are interested both in changes in poverty levels, and in changes in the profiles of poor individuals.

<sup>39</sup> Only when the original distribution has perfect equality, inequality does not change.

<sup>40</sup> The same results can be obtained considering other inequality measures, for instance the Generalized Entropy family (proofs available upon request).

Define  $z_x$  as the poverty line associated to the consumption distribution  $x$ , and  $z_j$  is the poverty line related to the  $y^j$  consumption distribution.  $P(k, z_h)$  is defined as the poverty level associated to distribution  $k$ , which can be either  $x, y^A, y^B$  or  $y^C$  and poverty line  $z_h$ , where  $h$  may denote either  $x$ , or  $A, B, C$ . Finally, let  $Q(k, z_h)$  be the set of poor individuals when consumption is  $k$  and the poverty line  $z_h$ , defined as:  $Q(k, z_h) = \{i: k_i < z_h\}$ .

In the following, we consider first the effects of imputing rents on poverty by keeping fixed the poverty line to  $z_x$ . Therefore, we will address changes in poverty levels by comparing the initial poverty  $P(x, z_x)$  with  $P(y^j, z_x)$ ,  $j = A, B, C$ ; and changes in poverty profiles by comparing the initial set of poor individuals  $Q(x, z_x)$  with the new sets  $Q(y^j, z_x)$ . Then, we will give some intuitions about what happens to poverty when we change the poverty lines to account for the changes in the consumption distribution after rent imputation.

Given poverty indices satisfy monotonicity, poverty cannot increase if we add to each individual's consumption a positive fixed amount ( $r > 0$ ), keeping the initial poverty line  $z_x$ :  $P(y^j, z_x) \leq P(x, z_x)$  for  $j = A, B, C$ . Therefore, we will surely observe a decline in the number of poor individuals after rents are imputed.

The first two scenarios, moreover, are rank-preserving, and this guarantees that the poorest individual after including rents in the consumption aggregate will be the same as the baseline scenario (see Figure 3). Therefore, the new set of poor individuals will be a subset of the original:  $Q(y^j, z_x) \subseteq Q(x, z_x)$ . Note that this does not guarantee the poverty profiles before and after imputing rents to be the same. This would only happen if each observed characteristic of poor individuals would be either uniformly distributed or completely random. If, on the other hand, some characteristics are indeed linked to the severity of individuals' deprivations, we will observe a change in the poverty profiles moving from  $Q(x, z_x)$  to  $Q(y^j, z_x)$ . For example, if the very poor live in a specific region,  $Q(y^j, z_x)$  will have a higher share of individuals living in that specific region than  $Q(x, z_x)$ . Or if the very poor in the society belong to a specific minority group or have very low level of education, the new set of poor individuals after rent imputation will over represent that minority group or low level of education with respect to the baseline.

Under hypothesis  $C$ , rank is not necessarily preserved, and therefore there could be reshuffling in the distribution: some very poor individuals could end-up non-poor, while some poor individual very close to the poverty line could remain poor. Therefore it is no longer always true that the new set of poor individuals is a subset of the original set. For instance, if urban dwellings are of higher quality than rural dwellings, we can reasonably expect that rents in rural areas would be lower than rents in urban areas. In this case, two poor individuals, identical under each respect, but one living in urban and the other living in rural settlement may end up after rent imputation at different side of the poverty line.

All the above discussion about poverty is based on a fixed poverty line  $z_x$ , computed on the original consumption aggregate  $x$ . If the consumption distribution changes, however, it should be good practice, whenever possible, to change the poverty line accordingly, and compare  $P(y^j, z_j)$  and  $Q(y^j, z_j)$  with the baseline scenario  $P(x, z_x)$  and  $Q(x, z_x)$ . The poverty line should in fact be a measure of the expenditures needed to reach the minimum level of living needed to escape poverty: if a new item, rents, is added to the set of expenditures, the poverty line should account for it.

The poverty line can be defined in different ways. We concentrate here on two cases: an absolute poverty line and a relative poverty line. In the case of an absolute poverty line, we consider here the cost of basic needs approach. Recall that the poverty line  $z$  is generally computed by adding a food

poverty line  $z^F$  and a non-food poverty line  $z^{NF}$ :  $z = z^F + z^{NF}$ . Seeking simplicity, we can think of the non-food component as determined residually by inflating the food poverty line with the ratio of non-food consumption to food consumption for the reference population.<sup>41</sup> Let us define  $\bar{x}^F$ ,  $\bar{x}^{NF}$  and  $\bar{x}$  as the average food consumption, the average non-food consumption and the average total consumption for those individuals close to the food poverty line, such that  $\bar{x} = \bar{x}^F + \bar{x}^{NF}$ , then:

$$z_x^{NF} = z^F \frac{\bar{x}^{NF}}{\bar{x}^F}$$

Including rents to the distribution affects the non-food part of the consumption distribution, while the food part remains the same:  $y^j = x^F + (x^{NF} + r) = x^F + y^{j,NF}$ . Accordingly, only the non-food component of the poverty line changes, while the food component remains the same ( $z_x^F = z_j^F = z^F$ ). Adding rent to the original distribution decreases the share of food to total consumption, hence increasing the non-food poverty line:

$$z_j^{NF} = z^F \frac{\bar{y}^{j,NF}}{\bar{x}^F} = z^F \frac{\overline{x^{NF} + r^j}}{\bar{x}^F} \geq z^F \frac{\bar{x}^{NF}}{\bar{x}^F} = z_x^{NF}$$

As a result, the total poverty line  $z_j$  is higher than the original poverty line  $z_x$ . The magnitude of the difference between  $z_j$  and  $z_x$ ,  $\Delta_j^z$ , is defined as:

$$\Delta_j^z = z_j - z_x = z^F + z_j^{NF} - z^F - z_x^{NF} = z_j^{NF} - z_x^{NF} = z^F \frac{\overline{x^{NF} + r^j}}{\bar{x}^F} - z^F \frac{\bar{x}^{NF}}{\bar{x}^F}$$

Notice that, if the distribution of rents is such that there are not sensible changes in the definition of the reference population for defining the total poverty line,  $\Delta_j^z$  can be further simplified to:

$$\Delta_j^z = \frac{z^F \bar{r}^j}{\bar{x}^F}$$

where  $\bar{r}^j$  defines the average rents for the reference households.

Under hypothesis A,  $\Delta_A^z = \frac{z^F r}{\bar{x}^F}$ ; under hypothesis B,  $\Delta_B^z = \frac{z^F \rho \bar{x}}{\bar{x}^F}$ ; under hypothesis C,  $\Delta_C^z = \frac{z^F \bar{\rho} \bar{x}}{\bar{x}^F}$ , where  $\bar{\rho}$  stands for the share of total consumption defining rents for the reference group of poor individuals. Notice that the change in poverty line would be bigger the smallest the share of food consumption over total consumption. In other words, as the non-food component of total consumption gains importance, we should expect the impact of imputed rent on the poverty line to be more relevant.

A relative poverty line is usually defined as a function of the mean or the median of the welfare distribution,  $z = f(m(x))$ .<sup>42</sup> In this relative case, we can assert that  $z_x = f(m(x)) \leq f(m(y^j)) = z_j$ . The magnitude of the change in poverty lines,  $\Delta_j^z$ , is in this case defined as:

<sup>41</sup> Specifically, the lower level of the total poverty line is defined based on those households whose total consumption is close to the food poverty line. On the other hand, the upper level of the poverty line happens when households whose total *food* consumption is close to the food poverty line (see Ravallion (1994)). In the following we assume that the reference population for the estimation of the food poverty line does not vary under different definitions of the consumption aggregate namely including or not the housing component.

<sup>42</sup> For example, Eurostat, the European Statistical Agency, sets the poverty line at 60 % of the national median equivalized disposable income after social transfers.

$$\Delta_j^z = z_j - z_x = f(m(y^j)) - f(m(x))$$

and can be assessed a-priori if  $f(\cdot)$  is a linear function,  $m(\cdot)$  a linear operator, and  $y^j$  is obtained from  $x$  by a rank-preserving transformation. In particular, considering  $f(x) = \alpha x$ :

$$\Delta_j^z = \alpha(m(x + r)) - \alpha m(x) = \alpha m(x) + \alpha r - \alpha m(x) = \alpha r$$

Since both the poverty line and the original welfare distribution increase as a consequence of including rents in the welfare aggregate, the effect on poverty is unclear. If welfare of those immediately below the original poverty line increase more than  $\Delta_j^z$  poverty might decrease. If, on the other hand,  $\Delta_j^z$  is higher than the increase in welfare of those around the initial poverty line, poverty might increase. The effect on the profile of poor individuals is also unclear, as it depends on whether the distribution of the original characteristics are independent of the severity of poverty and of the distribution of imputed rents, as explained above.

Working with real data, we often observe that the distribution of characteristics of the poor is linked to the poverty status of individuals, and imputed rents follow a non-linear pattern with respect to the original welfare distribution, as in our hypothesis C. Hence, the distributional impact of rent imputation is unpredictable. In particular, it is hard to find common rule on the effect that the exercise might have on the profiling of poor individuals. Moreover, the baseline scenario could be a distribution of income or consumption already including (some) rents: for instance, there could be rents paid by tenant, but no evaluation of the value of services from housing for home owners; or rent for owners could be the self-assessed values that we may questioned and try to substitute with some imputed values. In this last case, if it is true that owners tend to overestimate the value of their dwellings, it is possible that the consumption aggregate defined using imputed rents is lower than the original consumption aggregate obtained by adding the self-assessed rent for some individuals. Therefore, the composition of poor individuals might change as a result of the different definition of consumption aggregate (in this case, there might be more poor home-owners).

## 4.2 Evidence from the literature

The impacts of including imputed rent in the welfare measure are not easily predicted from a theoretical viewpoint as previously discussed. However, results from the literature are conclusive towards a reduction effect on both inequality and poverty measures (see Table 2). A few points are worth mentioning before presenting results from the literature: first, most analysis has been performed in developed countries; second, income has been the main welfare aggregate measure; and third, most studies do not adjust poverty lines.

In developed countries such Australia, Yates (1994) and Sounders and Siminski (2005) find an unambiguously equalizing but modest impact on the income distribution in different periods: 1988-89 and two rounds of Household Expenditure Survey: 1993-94 and 1998-99 respectively. Both studies also underline that the aggregate picture masks much of the redistribution which has taken place. Sounders and Siminski (2005) find a substantial re-ranking within the income distribution, as 9 percent of the population moves by more than one quintile with respect to the benchmark case.

Frick and Grabka (2003) find the same equalizing effect of imputed rent on the income distribution for West-Germany and partly for the USA. The overall effect is a combination of an increase in income inequality between home-owners and renters, overcompensated by a decrease in income inequality within groups. Frick et al. (2010) obtain the same results in five European countries: Belgium, Germany,

Greece, Italy and the UK. Additionally, the authors find that the main beneficiaries are outright owners and households in rent-free or subsidized dwellings, which generally coincides with the elderly.

Moreover, Mullan et al. (2007) investigate the distributional impact after accounting for imputed rents in the household disposable income measure in the UK. The authors compare the effects obtained by applying two imputation techniques, a hedonic model and stratification. Although the overall effect is a reduction in inequality, the authors underline the sensitivity of results depending on the particular approach adopted and dataset used.

Törmälehto and Sauli (2010, 2013) analyze the distributional implication of imputed rents from 2007 to 2010 for the 29 countries included in the EU Survey of Income and Living Conditions. Again, the data confirm the main results found in the literature: imputed rents decrease relative income inequality. In particular, reduction in inequality is the combined effect of the equalizing gap-effect and dis-equalizing re-ranking effect.

Considering consumption as the welfare measure, Crossley and Curtis (2006) find a significant equalizing effect of rent imputation in a study of child poverty in Canada, between 1986 and 2000. The authors argue that this effect may be due to the low variability of the imputed rent which reduces the dispersion of consumption (on this see also Brzozowski and Crossley, 2011).

In the case of developing countries, Gasparini and Escudero (2004) obtain an equalizing effect of imputed rent in the income distribution of Greater Buenos Aires. This results as a combined effect of a relatively large proportion of house-owners in the lower strata of the income distribution and low income elasticity in housing expenditure. In Madagascar and Côte d'Ivoire, Guenard and Mesple-Soms (2010) report the impact on inequality of not taking imputed rent for home-owners into account. Inequality, measured by the Gini index, increases by over 6 percentage points in Madagascar and by 1 percentage point in Côte d'Ivoire. Hence, including imputed rent for home owners would have an equalizing effect on both consumption distributions.

In an isolated study on a socialist country, Buckely and Gurenko (1997) shed light on the housing-based income transfer mechanism of the Soviet regime in Russia. When income is adjusted for housing, inequality decreases significantly.

Few studies focus on the impact on poverty and most of them consider a fixed poverty line. Crossley and Curtis (2006) find a reduction in poverty when including imputed rent in a study of child poverty in Canada, from 1986 to 2000. For instance, the headcount index decreases from 8.85 to 4.44 in 2000. Based on the same dataset but during a different timespan 1997-2009, Norris and Pendakur (2013) study the impact on poverty of different rent-imputation approaches, finding that Heckman selection bias correction reduces the measured level of poverty obtained from OLS imputations. This is due to the fact that although low-consumption owners have only slightly better observed characteristics than their renter counterparts, they have better unobserved dwelling characteristics. Therefore, using OLS imputation would underestimate owners' consumption and consequently overstate their poverty.

Imputed rents have also a poverty-reduction effect for the elderly. This result is consistent independently of considering a fixed poverty line (as in Frick and Grabka, 2003) or an adjusted poverty line based on the distribution of income when imputed rent is added (as in Frick et al., 2010, D'Ambrosio and Gagliarano, 2007 or Törmälehto and Sauli, 2010, 2013). Törmälehto and Sauli (2010, 2013) also

confirm the decrease in elderly poverty when considering rent in 29 countries included in the EU Survey of Income and Living Conditions from 2007 to 2010 (see also Marquier, 2003 for France).

In developing countries, Guenard and S. Mesple-Soms (2010) show an increase of 9 and 3 percentage points in Madagascar and Côte d'Ivoire respectively headcount indices. This growth results as a consequence of not including imputed rent in the consumption aggregate.

## 5 Concluding Remarks

This paper provides an extensive description of the different methodological approaches implemented to impute rent over the last decades. In particular, we focus on methods applied for welfare measurement. The literature is inconclusive about the most appropriate method to be used to impute rent for owners (and nonmarket tenants). Each method presents advantages as well as disadvantages also depending on the type of data available.

Within the hedonic price modeling framework, the parametric semi-logarithmic model has several advantages that make it a very common approach in the empirical literature. However, the lack of a specific functional form to be preferred over others and the risk of misspecification has generated a stream of applications using semi-parametric and non-parametric models. Yet, results are not unanimous when testing the superiority of semi-parametric and non-parametric approaches with respect to parametric ones. Additionally, when choices of tenure type and characteristics of the dwelling are not independent, OLS estimations might be inconsistent. Thus, correction for selection bias should be used. Implementing the stratification method involves creating a number of homogeneous cells defined in terms of various characteristics. Considering a large set of characteristics to define the strata increases the estimates precision, but also the magnitude of the standard error of imputed rents, as the number of observations per cell decreases with the number of strata.

The capital market approach faces similar difficulties as the hedonic model. The rent-to-value approach has two main problems highlighted in the literature: using the same capitalization ratio for tenants and owners within the same area might be misleading when dwellings' characteristics differ significantly between these two population groups; and the second problem arises when underlined differences in the quality of the dwellings for owners and tenants are omitted in the estimation. The user-cost method entails complications like making reasonable assumptions on the proper interest rate, depreciation rate, inflation rate, as well as having precise information on the purchase prices of the dwellings.

The self-assessment relies on the expectation that owners *can* estimate rental equivalences even when there is no comparable rental dwelling in the area in case they know of rents in other areas. This is supposedly less problematic in regions where the rental market is active and well developed. However, owner-occupiers may over-estimate the true rental value of their dwelling compared to rented homes with similar characteristics given the affinity to their property or neighborhood and should be treated with caution. Some studies calculate the magnitude and sign of this bias but there is not enough analysis or advice on how to solve or deal with this estimation problem.

Using data from external sources may contribute to solve the imputation problem when data are comprehensive enough about dwellings' characteristics like in the case of administrative registers. However, several drawbacks arise when using this type of data such as the huge efforts necessary to gather such data for a whole country, outdated dwellings values reported in cadasters, and registers of exchanged houses that may not be representative of the total stock.

Although we focus on the welfare measure, we also inspect how other economic disciplines such as National Accounts, Price Indices, Purchasing Power Parity and Taxation tackle difficulties on this topic. All disciplines acknowledge the importance of including rent as part of their measurement. However, as in the welfare analysis, they propose different imputation methods without choosing one over another.

The second objective of this paper is presenting the distributional impacts of rent imputation in the literature. The impacts of the inclusion of imputed rent in the welfare aggregate cannot be easily predicted from a theoretical viewpoint. Changes in inequality depend on the distribution of rents and imputed rents across the population. If rents are uniformly distributed (in the extreme scenario, if everybody has the same rent level), then we should expect a reduction in inequality. If rents are a fixed proportion of the households' welfare aggregate, we would not detect any change in inequality. Finally, if there is no clear pattern in the distribution of rents, no conclusive prediction can be drawn about the effect of rent imputation on inequality. With respect to poverty, the theory can only trivially predict a reduction in the level of poverty when the poverty line is kept fixed relative to the case of no imputed rent. When the poverty line is adjusted to take into account the changes in the non-food allowance due to imputation of rent, the effect on poverty levels would depend on the relative magnitude of the increase in the poverty line and in the welfare aggregate of those around the original poverty line. Even in the simple case of a fixed poverty line, nothing can be said *a priori* on changes in the profile of the poor, unless both rents and each characteristic of the poor are uniformly distributed, which is unlikely. However, results from the literature indicate a reducing effect both on inequality and poverty measures.<sup>43</sup>

Lastly, we would like to stress that to the best of our knowledge there is no study that systematically analyzes the distributional impacts of including rents using all the different imputation techniques. There are only a few studies where results from different imputation methods are analyzed. Crossley and Curtis (2006) compare the hedonic model and the payment approach. Norris and Pendakur (2013) show results from hedonic models with and without Heckman correction. Mullan et al. (2007) compare the hedonic model and stratification. Moreover, we did not find any analysis of the distributional impacts obtained by adjusting absolute poverty lines which are commonly used in developing countries. Only systematic comparative studies may allow evaluating techniques and produce recommendations.

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<sup>43</sup> Notice that most of the results are based on a fixed poverty line.

## References

- Andrews, D., A. Caldera Sánchez and Å. Johansson (2011), "Housing Markets and Structural Policies in OECD Countries", OECD Economics Department Working Papers, No. 836, OECD Publishing.
- Anglin, P.M., and Gençay, R. (1996), Semiparametric Estimation of a Hedonic Price Function, *Journal of Applied Econometrics*, 11(6), 633-648.
- Anselin, L., A. K. Bera, R. Florax and M.J. Yoon (1996), "Simple diagnostic tests for spatial dependence", *Regional Science and Urban Economics*, 26(1), 77-104.
- Anselin, L. and A. Bera (1998). Spatial dependence in linear regression models with an introduction to spatial econometrics, In A. Ullah and D. Giles (eds.), *Handbook of Applied Economic Statistics*, 237-289, Marcel Dekker, New York.
- Arévalo, R. and J. Ruiz-Castillo (2004), "The Rental Equivalence Approach To Nonrental Housing In The Consumer Price Index. Evidence From Spain," *Economics Working Papers we041704*, Universidad Carlos III, Departamento de Economía.
- Arnold, J.M., B. Brys, C. Heady, A. Johansson, C. Schweltnus and L. Vartia (2011), "Tax policy for economic recovery and growth," *The Economic Journal*, 121, F59-F80.
- Bin, Okmyung (2004) "A Prediction Comparison of Housing Sales Prices by Parametric versus Semi-Parametric Regressions," *Journal of Housing Economics*, 13(1), 68-84.
- Bin, Okmyung (2005) "A semiparametric hedonic model for valuing wetlands," *Applied Economics Letters*, 12(10), 597-601
- Blades, Derek (2009), "Housing in ICP 2011: Issues to be Resolved," ICP Technical Advisory Group Meeting.
- Bourassa, S. C., Haurin, D. R., Hendershott, P. H., & Hoesli, M. (2013), "Mortgage Interest Deductions and Homeownership: An International Survey," *Journal of Real Estate Literature*, 21(2), 181-203.
- Brunauer, W.A., S. Lang, P. Wechselberger and S. Bienert (2010), "Additive Hedonic Regression Models with Spatial Scaling factors: An Application for Rents in Vienna," *Journal of Real Estate Financial Economics*, 41, 390-411.
- Brzozowski, M. and T.F. Crossley (2011), "Viewpoint: Measuring the well-being of the poor with income or consumption: a Canadian perspective," *Canadian Journal of Economics / Revue canadienne d'Economie*, 44(1), 88-106.
- Buckley, Robert M. and Eugene N. Gurenko (1997) "Housing and Income Distribution in Russia: Zhivago's Legacy," *The World Bank Research Observer*, 12(1), 19-32.
- Cameron, A.C. and P.K Trivedi (2010), *Microeconometrics Using Stata*, Stata Press.
- Can, Ayse (1992), "Specification and estimation of hedonic housing price models," *Regional Science and Urban Economics*, 22, 453-474.
- Canberra Group (2001), *Expert Group on Household Income Statistics: Final Report and Recommendations*, Ottawa.
- Ceriani L., C. Fiorio and C. Gigliarano (2013), "The importance of choosing the data set for tax-benefit analysis," *International Journal of Microsimulation*, 6(1) 86-121.
- Ceriani V., S. Manestra, G. Ricotti, A. Sanelli and E. Zangari (2011), "The tax system and the financial crisis", *Bank of Italy Occasional Papers*, 85.
- Citro, C. and R. Michael (1995), *Measuring Poverty: A New Approach*, National Academies Press.
- Clapp, J. M., Kim, H.-J., Gelfand, A. E. (2002): "Predicting Spatial Patterns of House Prices Using LPR and Bayesian Smoothing," *Real Estate Economics*, 30 (4), 505-532.
- Cropper, M.L, L.B. Deck and K.E. McConnel (1988), "On the Choice of Functional Form for Hedonic Price Functions," *Review of Economics and Statistics*, 70(4), 668-675.
- Crossley and Curtis (2006) "Child Poverty in Canada," *Canadian Journal of Economics/ Revue canadienne d'Economie*, 52(2), 237-260.
- Crossley, Thomas F. and Krishna Pendakur (2006) "The Social Cost-of-Living: Welfare Foundations and Estimation," *Quantitative Studies in Economics and Population Research Reports 407*, McMaster University.
- Cruces, G., A. Ham and M. Tetaz (2008) "Quality of Life in Buenos Aires Neighborhoods: Hedonic Price Regressions and the Life Satisfaction Approach,"
- D'Ambrosio, C and C. Gigliarano (2007), "The distributional impact of imputed rent in Italy", Project no: 028412, AIM-AP, *Accurate Income Measurement for the Assessment of Public Policies, Specific Targeted Research or Innovation Project*.

- Deaton, A. (2005); "Measuring poverty in a growing world" (or "Measuring growth in a poor world"), *Review of Economics and Statistics*, 87, 1-19.
- Deaton, A. (2010), "Price Indexes, Inequality, and the Measurement of World Poverty", *The American Economic Review*, 100(1), 3-34.
- Deaton, A. and M. Grosh (2000), Consumption, in M. Grosh and P. Glewwe (eds.), *Designing Household Survey Questionnaires for Developing Countries: Lessons from Ten Years of LSMS Experience*, ch.17, pp. 91-133, Washington, DC: World Bank.
- Deaton, A and S. Zaidi (2002), "Guidelines for Constructing Consumption Aggregates For Welfare Analysis", The World Bank.
- Diewert, Erwin (2003), Hedonic Regressions: A Review of Some Unresolved Issues, mimeo.
- Diewert, Erwin (2009), Durables and Owner-Occupied Housing in a Consumer Price Index, in *Price Index Concepts and Measurement*, W. Erwin Diewert, John S. Greenlees and Charles R. Hulten (Eds.), 445-500, University of Chicago Press.
- Diewert, W.E. (2013), The treatment of owner occupied housing and other durables in a Consumer Price Index, in *Index number theory and measurement economics*, W.E. Diewert (Ed.).
- Diggle, P. and P.J. Ribeiro (2007), *Model-based Geostatistics*, Springer Series in Statistics.
- Dougherty, Ann and Van Order, Robert (1982) "Inflation, Housing Costs, and the Consumer Price Index," *American Economic Review*, American Economic Association, vol. 72(1), pages 154-64,
- Ebru, Ç. and A. Eban (2011), Determinants of house prices in Istanbul: a quantile regression approach, *Quality & Quantity*, 45(2), 305-317.
- Ekeland, Ivar, James J. Heckman, and Lars Nesheim (2004) Identification and Estimation of Hedonic Models, *Journal of Political Economy*, 112(S1), *Papers in Honor of Sherwin Rosen: A Supplement to Volume 112*, S60-S109.
- ESA (2010), "European System of Accounts", Eurostat, Publications Office of the European Union.
- EC No. 1980/2003 European Commission, Commission Regulation (EC) No 1980/2003 of 21 October 2003, Implementing Regulation (EC) No 1177/2003 of the European Parliament and of the Council concerning Community statistics on income and living conditions (EU-SILC) as regards definitions and updated definitions
- Eurostat (2013a), *Handbook on Residential Property Prices Indices (RPPIs)*.
- Eurostat (2013b), *Methodological guidelines and description of EU-SILC target variables, 2014 operation (version December 2013)*, DocSILC065(2014 operation).
- Eurostat-OECD (2012), *Eurostat-OECD Methodological Manual on Purchasing Power Parities*, Publications Office of the European Union.
- Fahrländer, S.S. (2006) "Semiparametric Construction of Spatial Generalized Hedonic Models for Private Properties," *Swiss Journal of Economics and Statistics*, Swiss Society of Economics and Statistics, 142(4), 501-528.
- Fahrmeir, L., Kneib, Th., Lang, S., Marx, B. (2013), *Models, Methods and Applications*, Springer.
- Figari, F, A. Paulus, H. Sutherland, P. Tsakloglou, F. Zantomio (2012), "Taxing Home Ownership: Distributional Effects of Including Net Imputed Rent in Taxable Income," IZA discussion paper series, IZA DP No. 6493.
- Fotheringham, A. S., C. Brunsdon and M. E. Charlton (2002) *Geographically Weighted Regression: The Analysis of Spatially Varying Relationships*, Wiley, Chichester.
- Foster, J., Seth, S., Lokshin, M. and Sajaia, Z. (2013), "A Unified Approach to Measuring Poverty and Inequality: Theory and Practice", The World Bank, Washington, D.C.
- Freeman, A. M. 1993. *The Measurement of Environmental and Resource Values: Theory and Methods*, Washington, DC: Resources for the Future.
- Frick, J. and M.M. Grabka (2003), "Imputed rent and income inequality: a decomposition analysis for Great Britain," *Review of Income and Wealth*, 49(4), 513-537.
- Frick, Joachim R., Markus M. Grabka, Timothy M. Smeeding and Panos Tsakloglou (2010), "Distributional effects of imputed rents in five European countries", *Journal of Housing Economics*, Volume 19, Issue 3, September 2010, Pages 167-179.
- Garner T. and D. Betson (2010) "Setting and Updating Modern Poverty Thresholds," BLS Working Papers, 435.

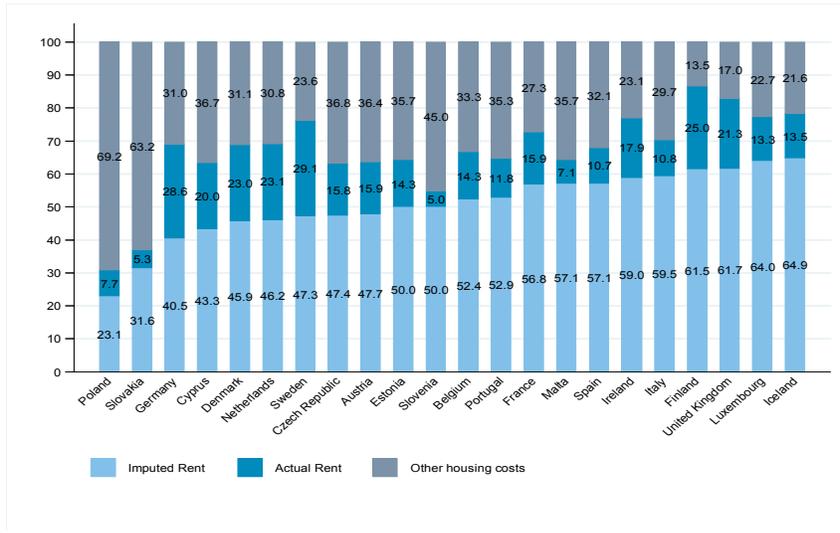
- Garner T. and U. Kogan (2007) "Comparing Approaches to Value Owner-Occupied Housing Using U.S. Consumer Expenditure Survey Data", paper prepared for the Annual Meetings of the Allied Social Sciences Associations Society of Government Economist, Chicago, Illinois, January 7, 2007
- Garner, T. and K. Short (2001) "Owner-Occupied Shelter in Experimental Poverty Measures," Poverty Measurement Working Paper.
- Garner, T. and K. Short (2001), "Owner-Occupied Shelter in Experimental Poverty Measures," paper prepared for the Annual Meeting of the Southern Economic Association Tampa, Florida, November 1, 2001.
- Garner, T. and K. Short (2009), "Accounting for Owner-Occupied Dwelling Services: Aggregates and Distributions," *Journal of Housing Economics*, 18(3), 233-248.
- Garner, T. and P. Rozaklis (2001), "Owner-Occupied Housing: An Input for Experimental Poverty Thresholds," paper presented at session organized by the Society of Government Economists at the annual meeting of the Allied Social Sciences Associations, January 6, 2001.
- Garner, T. and R. Verbrugge (2009) "The Puzzling Divergence of Rents and User Costs, 1980-2004: Summary and Extensions." in *Price and Productivity Measurement, Volume 1-Housing*, W. Erwin Diewert, Bert M. Balk, Dennis Fixler, Kevin J. Fox and Alice O. Nakamura (editors), chapter 8, 125-146.
- Garner, T., Kathleen S. Short, and Uri Kogan (2006) "What Do We Knows About the Value of Owner-Occupied Housing Services? Rental Equivalence and Other Approaches," Southern Economics Association Annual Meeting, Charleston, South Carolina, November 18, 2006.
- Garner, T., Janini, G., Passero, W., Paszkiewicz, L. and Vendemia, M. (2003), *The Consumer Expenditure Survey in Comparison: Focus on Personal Consumption Expenditures*, Washington, DC: US Department of Labor - Bureau of Labor Statistics.
- Gasparini, L., Escudero, W.S., (2004) "Implicit Rents from Own-housing and income distributions: Econometric estimates from Greater Buenos Aires" *Journal of Income Distribution* 12(1-2), 32-55.
- Gencay, R. and X. Yang (1996) "Source Forecast Comparisons of Residential Housing Prices by Parametric and Semiparametric Regression", *The Canadian Journal of Economics / Revue canadienne d'Economie*, 29(S12), pp. S515-S519.
- Gibson, J. (2007) "A Guide to Using Prices in Poverty Analysis", World Bank, Washington, D.C.
- Gillingham, Robert (1983), "Measuring the Cost of Shelter for Homeowners: Theoretical and Empirical Considerations", *The Review of Economics and Statistics*, 65(2), 254-265.
- Goldberger, A. (1968), "The Interpretation and Estimation of Cobb-Douglas Functions," *Econometrica*, 36(3-4), 464-472
- Goodhart, C. (2001), "What Weight Should be Given to Asset Prices in the Measurement of Inflation?," *The Economic Journal*, 111 (June), F335-F356.
- Goodman, J.L. and J.B. Ittner (1979), "The Accuracy of Home Owners' Estimates of House Value," *Journal of Housing Economics*, 2, 339-357.
- Guðnason, R. and G.R. Jónsdóttir (2009), "Owner Occupied Housing in the Icelandic CPI," chapter 9, 147-150 in *Price and Productivity Measurement, Vol.1, Housing*, Diewert, W.E., B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (Eds.), Trafford Press.
- Guenard, C. and S. Mesple´-Soms (2010), "Measuring inequalities: do household surveys paint a realistic picture?," *Review of Income and Wealth*, 56(3), 519-538.
- Halvorsen, R. and H.O. Pollakowski (1981), "Choice of functional form for hedonic price equations", *Journal of Urban Economics*, 10(1), 37-49.
- Haput, H., J. Schnurbus and R. Tschernig (2010), "On nonparametric estimation of a hedonic price function," *Journal of Applied Econometrics*, 25(5), 894-901.
- Heckman, J.J. (1976), The common structure of statistical models of truncation, sample selection and limited dependent variables, NBER Chapters, in: *Annals of Economic and Social Measurement*, 5(4), pages 475-492, National Bureau of Economic Research, Inc.
- Heckman, J.J., R. L. Matzkin and L. Nesheim (2010), "Nonparametric identification and estimation of nonadditive hedonic models," *Econometrica*, 78(5), 1569-1591.
- Heston, A. and A.O. Nakamura (2009), "Questions about the equivalence of market rents and user costs for owner occupied housing," *Journal of Housing Economics*, 18, 273-279.
- Hill, R. J. (2013), Hedonic price indexes for residential housing: a survey, evaluation and taxonomy," *Journal of Economic Surveys*, 27, 879-914.

- ICP (2008), ICP 2003-2006 Handbook  
<http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/ICPEXT/0,,contentMDK:20126612~pagePK:60002244~piPK:62002388~theSitePK:270065,00.html>
- ICP (2013), Measuring the real size of the World economy. The Framework, Methodology, and Results of the International Comparison Program (ICP), The World Bank.
- ILO (2003), Resolution concerning consumer price indices, Adopted by the Seventeenth International Conference of Labour Statisticians (November-December 2003).
- ILO (2004) Consumer Price Index manual: theory and practice.
- IMF (2009) Debt bias and other distortions: crisis-related issues in tax policy, Prepared by the Fiscal Affairs Department, June 12th.
- Kang, H.B. and A. K. Reichert (1987), "An Evaluation of Alternative Estimation Techniques and Functional Forms in Developing Statistical Appraisal Models," *The Journal of Real Estate Research*, 2(1), 1-27
- Kholodilin, K.A. (2012), "Internet Offer Prices for Flats and Their Determinants: A Cross Section of Large European Cities," Discussion Papers of DIW, German Institute for Economic Research, Berlin.
- Kristo, E. and E. Bollano (2012) "House Price Index – Methodology and Use", *Bulletin of Bank of Albania*, 2012 H1, 113-130.
- Kuminoff, N.V., Parmeter, C.F. and Pope, J.C. (2008), Hedonic Price Functions: Guidance on Empirical Specification, American Agricultural Economics Association, 2008 Annual Meeting, Orlando, Florida, July 27-29, number 6555.
- Lancaster, K.J. (1966), "A new approach to Consumer Theory," *The Journal of Political Economy*, 74(2). 132-157.
- Lanjouw (2009) "Constructing a Consumption Aggregate for the Purpose of Welfare Analysis: Principles, Issues and Recommendations Arising from the Case of Brazil," paper prepared for the OECD/University of Maryland Conference entitled "Measuring Poverty, Income Inequality and Social Exclusion: Lessons from Europe", Paris, March 16/17, 2009
- Laurice and Bhattacharya (2005) "Prediction Performance of a Hedonic Pricing Model for Housing," *The Appraisal Journal*, Spring 2005.
- Lebow, D.E. and J.B. Rudd (2003), "Measurement Error in the Consumer Price Index: Where Do We Stand?" *Journal of Economic Literature*, 41, 159-201.
- Lesage, J.P. and R.K. Pace (2004) "Models for spatially dependent missing data," *Journal of Real Estate Finance and Economics*, 29(2), 233-254.
- Lisi, G. (2013), "On the functional form of the hedonic price function: a matching-theoretic model and empirical evidence," *International Real Estate Review*, 16(2), 189-207.
- Lonzano-Garcia N. Nad L. Anselin (2011), "Is the price right? Assessing estimates of cadastral values for Bogota, Colombia," Geoda Center for geospatial analysis and computation, Arizona State University, Working Paper n.3.
- Malpezzi, S. (2000), "Housing," in M. Grosh and P. Glewwe (Eds.), *Designing household survey questionnaires for developing countries: lessons from the 15 years of the living standards measurement study*, ch.12, 293-314, Washington, DC: World Bank.
- Malpezzi S. (2002) "Hedonic Pricing Models: A Selective and Applied Review," in *Housing Economics and Public Policy: Essays in Honour of Duncan Maclennan, T. O. Sullivan and K. Gibbs* (Eds.), Blackwell Science Ltd.
- Malpezzi, S., L. Ozanne and T. Thibodeau (1980) *Characteristic Prices of Housing in 59 Metropolitan Areas*, The Urban Institute.
- Marquier, R. (2003), "Imputation de loyers fictifs aux propriétaires occupants: quel impact sur les contours de la population pauvre?," Insee document de travail, F0309.
- Martins-Filho, C. and O. Bin (2005), "Estimation of hedonic price functions via additive nonparametric regression," 30, 94-114.
- Meese, R. and Wallace, N. (1991) "Nonparametric estimation of dynamic hedonic price models and the construction of residential housing price indices," *Journal of the American Real Estate and Urban Economics Association*, 19, 308-332.
- Milligan, K. (2008), *The Evolution of Elderly Poverty in Canada*, Canadian Public Policy, University of Toronto Press, vol. 34(s1), 79-94.
- Montero, J.M. and B. Larraz (2010), "Estimating Housing Prices: A Proposal with Spatially Correlated Data," *International Advances in Economic Research*, 16(1), 39-51

- Mullan, K., Sutherland, H., and Zantomio, F. (2007). The Distributional Impact of Imputed Rents in the United Kingdom. Paper prepared for the AIM-AP Project, Institute for Social and Economic Research. University of Essex. United Kingdom.
- Norris, Sam and Krishna Pendakur (2013), "Imputing rent in consumption measures, with an application to consumption poverty in Canada, 1997–2009," *Canadian Journal of Economics/ Revue canadienne d'Economie*, 46(4), 1537–1570.
- OECD (2013), *OECD Framework for Statistics on the Distribution of Household Income, Consumption and Wealth*, OECD Publishing, <http://dx.doi.org/10.1787/9789264194830-en>.
- OECD (2014), *OECD.Stat (database), National Accounts at a Glance*, DOI: 10.1787/data-00285-en.
- Olczyk, A. and S. Lane (2008), "Refining the Stratification for the Established House Price Index," Australian Bureau of Statistics Research Paper.
- Pace K. (1993), "Nonparametric Methods With Applications to Hedonic Models," *Journal of Real Estate Finance and Economics*, 7, 185-204.
- Parmeter, C.F., D.J. Henderson and S.C. Kumbhakar (2007) "Nonparametric Estimation of a Hedonic Price Function," *Journal of Applied Econometrics*, 22(3), 695-699.
- Pellegrino, S., M. Piacenza, G. Turati (2012), Assessing the distributional effects of housing taxation in Italy: from the actual Tax Code to imputed rent, *CEifo Economic Studies*, vol. 58, n. 3, 495-524.
- Phillips, R.S. (1988), "Residential capitalization rates: Explaining intermetropolitan variation, 1974–1979," *Journal of Urban Economics*, 23(3), 278-290
- Pollakowski, H.O. (1995) "Data sources for measuring house price changes," *Journal of Housing Research*, 6(3), 377-387.
- Poterba, J.M. (1992), "Taxation and Housing: old questions, new answer," *The American Economic Review*, 82(2), 237-242.
- Rosen, S. (1974), "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *The Journal of Political Economy*, 82(1), 34-55.
- Sierminska E., A. Brandolini and T. M. Smeeding (2008), *Comparing Wealth Distribution Across Rich Countries: First Results From the Luxembourg Wealth Study*, in *Household Wealth in Italy*, Rome: Bank of Italy
- Sirmans, G., D. Macpherson and E. Zietz (2005), "The composition of hedonic pricing models," *Journal of Real Estate Literature*, 13(1), 3-43.
- Smeeding, T., P. Saunders, J. Coder, S. Jenkins, J. Fritzell, A.J.M. Haganaars, R. Hauser, M. Wolfson (1993), "Poverty, inequality, and family living standards impacts across seven nations: the effect of non-cash subsidies for health, education, and housing," *The Review of Income and Wealth*, 39(3), 229–256.
- SNA (2008), "System of National Accounts 2008", European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations and World Bank, New York.
- Sounders, P. and P. Siminski (2005), "Home ownership and inequality: imputed rent and income distribution in Australia," *Economic Papers Vol. 24 No. 4*, 346-367.
- Stiglitz J.E., A. Sen and J. Fitussi (2009), Report by the Commission on the Measurement of Economic Performance and Social Progress.
- Törmälehto, Veli-Matti and Hannele Sauli (2010), "The distributional impact of imputed rent in EU-SILC", EUROSTAT: Methodologies and working papers.
- Törmälehto, Veli-Matti and Hannele Sauli (2013), "The distributional impact of imputed rent in EU-SILC 2007-2010", EUROSTAT: Methodologies and working papers.
- UN (1977), *Provisional Guidelines on Statistics of the Distribution of Income, Consumption and Accumulation of Households*, department of Economic and Social Affairs, Statistical Office, United Nations Publications.
- US Interagency Technical Working Group on Developing a Supplemental Poverty Measure Census (2010), [https://www.census.gov/hhes/www/poverty/SPM\\_TWGObservations.pdf](https://www.census.gov/hhes/www/poverty/SPM_TWGObservations.pdf).
- Verbrugge, R. (2008) "The puzzling divergence of rents and user costs 1980-2004," *Review of Income and Wealth*, 54(4), 671-699.
- Wood, S. (2006) "Low-Rank scale-invariant tensor product smooths for generalized additive mixed models," *Biometrics*, 62(4), 1025–1036.
- Wood, S. N., Bravington, M. V., & Hedley, S. L. (2008) "Soap film smoothing," *Journal of the Royal Statistical Society B*, 70(5), 931–955.

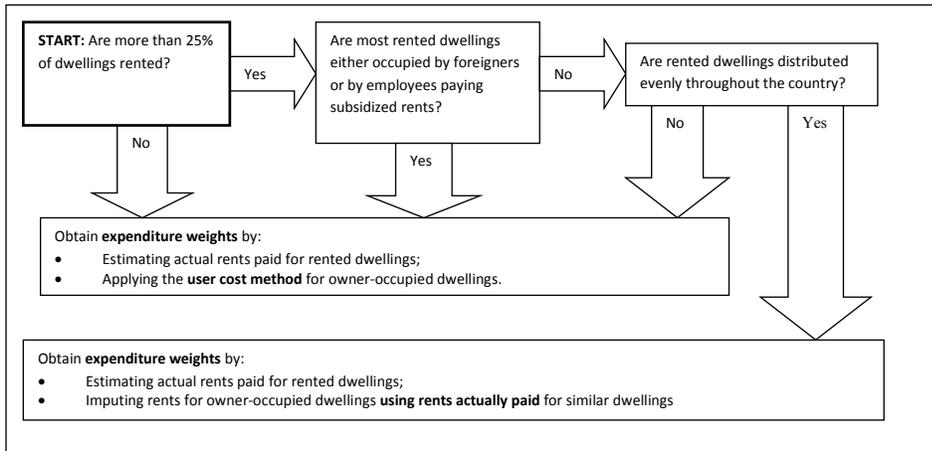
- Wooldrige, J.M. (1992) "Alternatives to the Box-Cox Regression Model," *International Economic Review*, 33(4), 935-955.
- Yates, J. (1994) "Imputed rent and income distribution," *Review of Income and Wealth*, 40(1), 43-66.
- Zietz, Joachim, Emily Norman Zietz and G. Stacy Sirmans (2007) "Determinants of House Prices: A Quantile Regression Approach," *The Journal of Real Estate Finance and Economics*, 37(4), 317-333.
- Zimbabwe National Statistical Agency (2013) "Poverty and Poverty Datum Line Analysis in Zimbabwe 2011/12," [http://www.zw.undp.org/content/dam/zimbabwe/docs/Governance/UNDP\\_ZW\\_PR\\_Zimbabwe%20Poverty%20Report%202011.pdf](http://www.zw.undp.org/content/dam/zimbabwe/docs/Governance/UNDP_ZW_PR_Zimbabwe%20Poverty%20Report%202011.pdf)

Figure 1: Structure of housing consumption – COICOP 4 Housing, 2012



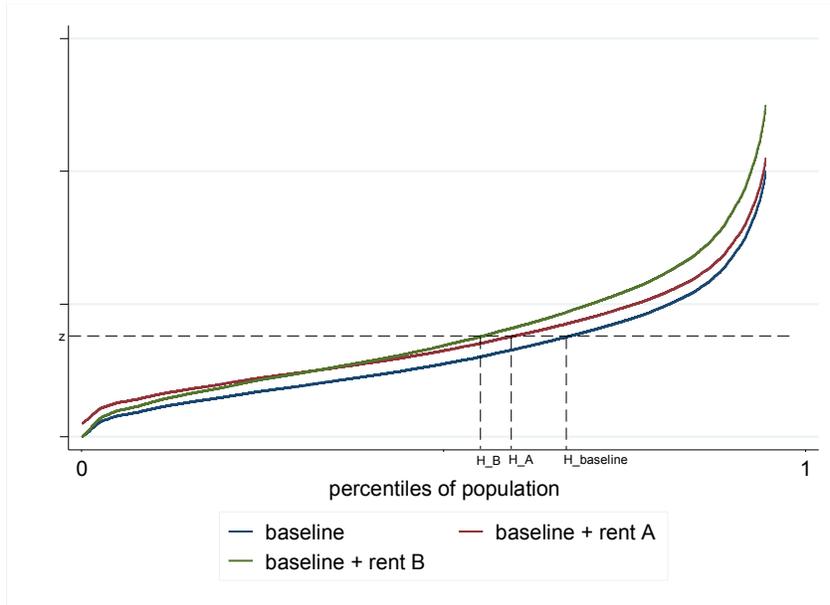
Source: Our elaboration on Eurostat data.

Figure 2: ICP 2005 decision chart for rent-imputation method of modern dwellings



Source: Our elaboration from ICP (2010), p.6

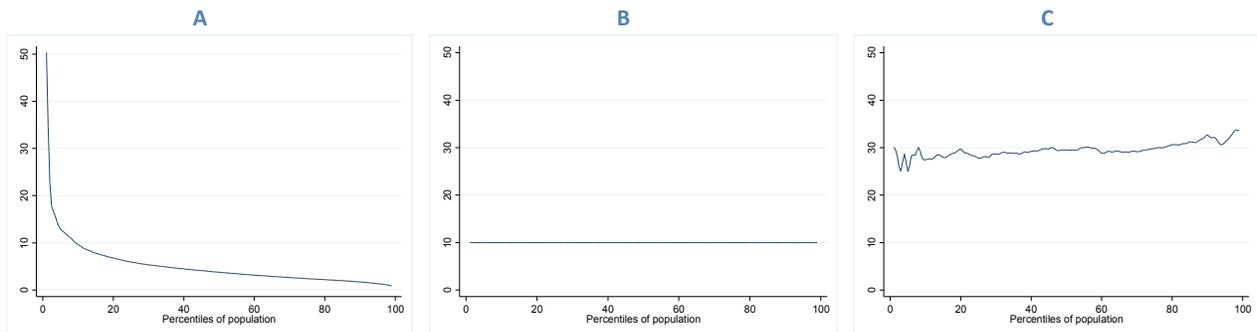
**Figure 3: Effect of imputed rent on poverty, hypothesis A and B**



*Note:* rent A are computed as a fixed amount for each individual; rent B rent are computed as fixed share of total household consumption. Z is the poverty line, and  $H_i$  stands for the headcount poverty index for, respectively, the baseline, and hypothesis A and B.

*Source:* Our elaboration on simulated data.

**Figure 4: Rent-incidence-curve under hypothesis A, B and C**



*Note:* Panel A is obtained by comparing the baseline with a new distribution where rents are included as a fixed amount for each individual; Panel B compares the baseline with a new distribution where rent are included as a fixed share of total household consumption; Panel C shows the changes between the baseline and a new distribution where rents are a random share of households' consumption.

*Source:* Our elaboration on simulated data.

**Table 1: Treatment of Owner-occupied housing in the CPI, OECD countries**

Treatment of Owner-Occupied Housing	OECD countries
Excluded	Belgium, Estonia, France, Greece, Indonesia, Italy, Korea, Luxemburg, Poland, Portugal, Slovenia, Spain, Turkey, United Kingdom
Acquisition Approach	Australia, Finland
Payment (cash-flow) Approach	Austria (regular payments), Chile (mortgage interest repayments), Ireland (mortgage interest repayments), Slovak Republic (repairs and maintenance)
Use Approach	Rental Equivalence Czech Republic, Denmark, Germany, Israel, Japan, Mexico, Norway, South Africa, Switzerland, United States, The Netherlands
	Capital Market Canada, Iceland, New Zealand, Sweden

Source: OECD, Main Economic Indicator. Sources and Definitions, <http://stats.oecd.org/mei/>, wired 23<sup>rd</sup> April 2014.

**Table 2: Distributional effects of including imputed rent in the welfare aggregate, selected references**

Reference	Country (survey, year)	Welfare Aggregate	Method for rent imputation	Effect on Inequality	Effect on Poverty
Buckley and Gurenko (1997)	Russia (Russian Longitudinal Monitoring Household Survey, 1992)	Income	Rent-to-income ratio inferred from countries with GDP per capita similar to Russia and User Cost	Reduction	Not discussed
Guenardand and Mesple-Soms (2010)	Madagascar (EPM93, 1993) and Cote D'Ivoire (ENV98, 1998)	Income and Consumption Expenditure	Not discussed	Reduction	Reduction
Yates (1994)	Australia (Household Expenditure Surveys, 1988-1989)	Income	Rent-to-value Approach <sup>1</sup>	Not significant at aggregate level. But re-ranking from households in the middle income deciles to those at the lower and the highest deciles	Not discussed
Sounders and Siminski (2005)	Australia (Household Expenditure Surveys, 1993-1994, 1998-1999)	Income	Rent-to-value Approach <sup>1</sup>	Reduction	Not discussed (instead of poverty, the authors discuss the share of each tenure-type falling in the first quintile of the income distribution)
Crossley and Curtis (2006)	Canada (Family Expenditure Survey - FAMEX, 1986–1996 and Survey of Household Spending - SHS, 1997–2000)	Consumption Expenditure	Hedonic Model and Payment Approach	Reduction	Reduction
Norris and Pendakur (2013)	Canada (Survey of Household Spending - SHS, 1997–1999)	Expenditure	Hedonic Model with Heckman correction	Not discussed	Reduction (of the Heckman correction models as opposed to a simple OLS approach)
Gasparini and Escudero (2004)	Argentina, Greater Buenos Aires (National Household Expenditures Survey, 1996-1997)	Income	Hedonic Model, quantile approach	Reduction	Not discussed
Frick and Grabka (2003)	Great Britain (BHPS 1993-1998), West Germany (SOEP 1993-1998) and USA (PSID 1994-1999)	Income	Capital Market Approach	Reduction in West Germany and USA. Minor increase in Great Britain (no standard errors provided)	Reduction (positively correlated with age of the household head)
Mullan et al. (2007)	United Kingdom (Family Resources Survey 2003/04) and Family Expenditure Survey	Income	Hedonic Model and Stratification	Reduction	Reduction (positively correlated with age of the household head)

Reference	Country (survey, year)	Welfare Aggregate	Method for rent imputation	Effect on Inequality	Effect on Poverty
Frick et al. (2010)	2000/01 FES) Belgium (EUSILC, 2004), Germany (SOEP, 2002), Greece (HBS, 2004/05), Italy (EUSILC, 2004), and the UK (FRS 2003/04)	Income	Hedonic Model (Heckman selection for Belgium, Germany and Greece)	Reduction	Reduction
D'Ambrosio and Gigliarano (2007)	Italy (EUSILC and SHIW, 2004)	Income	Hedonic Model	Reduction (with the exception of the ratio p10/p50)	Reduction
Törmälehto and Sauli (2010, 2013)	European Countries (EU-SILC, 2007-2010)	Income	Hedonic Model (with and without Heckman Selection)	Reduction	Reduction for elderly poverty

<sup>1</sup>Rents are estimated as a fixed annual percentage of the value of the property. This percentage was calculated as the value of gross imputed owner-occupier rent derived from the National Accounts (which is based on the market rents received for dwellings that have similar characteristics to those that are owner-occupied) divided by an estimate of the gross value of the owner-occupied housing stock derived from estimates reported in the Household Expenditure Survey (HES)

Source: Our elaboration