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A house price index based on the SPAR method ☆

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A B S T R A C T

Within the European Union there has been a push to provide European governments and the European Central Bank with the statistics they need for monitoring the owner-occupied sector. This paper reports on the results of a project to develop a house price index for the Netherlands. From January 2008, *Kadaster*, the Dutch land registry office, and Statistics Netherlands began jointly publishing house price index numbers for the whole country and for some specific dwelling types and regions. A number of special institutional features of the situation in the Netherlands contributed to the choice of index construction method. The indexes are computed using the Sale Price Appraisal Ratio (SPAR) method, which utilizes the ratios of transaction prices and previous appraisal values. We describe the SPAR method, compare it with repeat sales methods and assess the reliability of the official Dutch appraisal values. Empirical results for January 1995–March 2009 are presented. The SPAR method performs well compared to repeat sales, and the results reported will be of interest to other countries that have, or could instigate, institutional arrangements similar to those in the Netherlands.

1. Introduction

In 2004, the Netherlands initiated a project to develop a house price index for the owner-occupied sector. The efforts were part of a broader, and urgent, push within the European Union to provide European governments and the European Central Bank with the statistics they need for monitoring the owner-occupied sector.[1] The current credit crunch has underlined the importance of having reliable house price indexes. The objectives of the Dutch project have recently been achieved and are being reported on in this paper. From January 2008, *Kadaster*, the Dutch land registry office, and Statistics Netherlands began jointly publishing house price index numbers for the whole country and for some specific dwelling types and regions. The indexes are computed using the so-called Sale Price Appraisal Ratio (SPAR) method. A number of special institutional features of the situation in the Netherlands contributed to the choice

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[1] Apart from house prices as such, the treatment of owner-occupied housing in the HICPs, the consumer price indexes produced in European Union Member States on the basis of harmonized standards, is also of interest. HICPs are needed in particular for the assessment of price convergence, for monitoring inflation and for conducting monetary policy in the euro zone. For an extensive discussion on alternative methods to incorporate owner-occupied housing into a consumer price index, see Diewert (2003).

of index construction method. The results reported may be of interest to other countries that have, or could institute, similar institutional arrangements.

Prior to the introduction of the SPAR indexes, *Kadaster* already started publishing house price index numbers for the owner-occupied sector in May 2005. A set of 55 monthly indexes was computed, consisting of a nation-wide index, four regional indexes and indexes based on combinations of region and dwelling type. These indexes, described extensively in Jansen et al. (2008), were estimated using a weighted version of the repeat sales approach (Case and Shiller, 1987; Abraham and Schauman, 1991; Calhoun, 1996). The repeat sales method was originally developed by Bailey et al. (1963). They argue that this method is more efficient than other methods as it utilizes information on prices from earlier periods and includes it in selling prices in later periods. However, there are a number of drawbacks, which make repeat sales indexes unsuitable for official statistics. One of the most serious drawbacks is revision, which means that past values of the index will be revised by present-day information (Baroni et al., 2004). In other words, additional sales reverberate on the index values because new pairs provide information on movements in the house prices which goes beyond the information obtained from the sample.

Bourassa et al. (2006), who also discuss the problem of revision and other drawbacks, present the SPAR index as an alternative to hedonic or repeat sales indexes. Like the repeat sales method, the SPAR method is based on matched pairs but, in contrast, uses (nearly) all price data that is available for the period under observation. Since the majority of the houses sold during the observation period were not sold during the index reference or base period, there is a general shortage of transaction prices for the base period. The base period prices are therefore estimated using appraisals of the houses. In the Netherlands official government appraisals are collected under the Real Estate Law [*Wet Waardering Onroerende Zaken*]. In contrast with a repeat sales index, the SPAR index is not revised when data for new periods is added. Bourassa et al. (2006) "maintain that the advantages and the relatively limited drawbacks of the SPAR model make it an ideal candidate for use by government agencies in developing house price indexes".

Price indexes can be either value weighted or equally weighted. A value-weighted price index explicitly or implicitly weights the indexes of individual dwellings by their base period prices (values). The literature stresses that the choice between a value weighted and an equally weighted index should depend on the aim of the index (see e.g., Wang and Zorn, 1997). Our focus is on an index that aims at measuring the price change of the owner-occupied housing stock, and the weighted (arithmetic) variant of the SPAR method seems a suitable choice. Some users, on the other hand, may wish to have a price index for a 'mean dwelling'.[2] An unweighted (geometric) mean index, which arises for example from a standard repeat approach, might be more appropriate in that case. The intention of *Kadaster* and Statistics Netherlands, however, was to produce house price index numbers according to a single method.

The paper is organized as follows: Section 2 contains a brief review of the literature on two 'traditional' methods, hedonic modelling and the repeat sales method, and gives background information on the SPAR method. Section 3 argues that in the Netherlands individual property appraisals can be used for constructing the SPAR index and presents some empirical evidence on their reliability. Section 4 compares repeat sales and SPAR index numbers. Section 5 concludes.

2. Three approaches to measuring house price indexes

Houses are sold infrequently and the composition, or 'quality mix', of the properties sold usually varies substantially from period to period. This introduces bias in simple price index measures such as the mean or median. For example, if in the current period a disproportionate number of high-priced houses were sold, then the mean or median price would rise, even if not a single house had increased in value (Case and Shiller, 1987). This drawback has led to the development of alternative methods, particularly to hedonic and repeat sales methods. An advantage of the hedonic approach over other methods is that, at least in principle, it can adjust for quality changes of the individual properties.

2.1. Hedonics

Hedonic regression models were initially used to separate price and quality changes in capital goods and for durable consumer goods such as cars to calculate quality-adjusted price indexes (see e.g., Griliches, 1971). Later, hedonic modeling came to be widely used in housing market research (Mason and Quigley, 1996). A hedonic model expresses the price P_{it} of house i in period t as a function of a set of physical (and possibly also other) characteristics, Q_i, and time t:

$$P_{it} = f(Q_i, t). \quad (1)$$

The hedonic coefficients can be interpreted as shadow prices which reflect the value of a characteristic.[3] For example, an extra room will push up the value of the property by a specific amount. Specifying the correct functional form and including the correct set of quality characteristics is an essential element of hedonic modeling. Mason and Quigley (1996) argue that the functional form assumption is particularly awkward in the housing context because the hedonic price function summarizes not only consumer preferences and production technologies but also various quantities which are historically determined, hard to measure,

[2] This most likely holds for the Dutch Central Bank that requires financial institutions to specify their risks by estimating the actual liquidation value for every single dwelling in their mortgage portfolio.

[3] The multi-period time dummy variable hedonic price index seems to have dominated the literature. There are other types of hedonic indexes that may be more suitable. Hill and Melser (2007) argue that 'double' hedonic imputation might be a better choice: the characteristics parameters are allowed to change over time, and this method seems to be less prone to omitted variables bias. However, just like repeat sales indexes (see Section 4), multi-period time dummy indexes are subject to revision – they violate 'temporal fixity'. Nevertheless, the advantage of the multi-period time dummy method is its efficiency since data across different time periods are pooled.

and inaccessible to economic theory (see also de Vries and Boelhouwer, 2005). They furthermore argue that the existence of sub-markets might go some way towards explaining why the standard hedonic specification may not work. Despite the drawbacks, researchers have examined numerous datasets and model specifications to determine the marginal effect of housing characteristics on house prices and to construct house price indexes. For a recent review, see Sirmans et al. (2005).

In the Netherlands, the prices of all houses sold are recorded by *Kadaster*, the land registry office. Unfortunately, dwelling characteristics other than built surface area and type of dwelling (detached house, corner house, terraced house, semi detached house) are not registered. This prevents the use of hedonic modeling for the construction of quality-adjusted house price indexes.

2.2. Repeat sales

The repeat sales model is extensively addressed in the literature (see Bailey et al., 1963; Case and Shiller, 1987, 1989; Goetzmann, 1992; Calhoun, 1996; Dreiman and Pennington-Cross, 2004), so a brief description will suffice here. Bailey et al. (1963) laid the foundations for the repeat sales method. As the name already suggests, the repeat sales approach models the price changes of houses that are repeatedly sold. Essentially, it uses a collection of prices paid for single properties at different points in time to estimate a vector of numbers that best explains the observed price changes over the sample period (Abraham and Schauman, 1991). Specifically, it expresses the logarithm of the ratio of the house price P_{is2} in the second sale period s_2 and the price P_{is1} in the initial or first period s_1 ($s_1 < s_2$) as

$$\ln(P_{is2}/P_{is1}) = f(D_{it}), \tag{2}$$

where D_{it} is a set of time dummy variables. For the first sale of a particular house the time dummy has the value -1, for the second sale it has the value +1. All other dummies have the value 0.

Case and Shiller (1987) proposed the weighted repeat sales method, an adapted version of the unweighted method described by Bailey et al. (1963). They argue that the longer the holding period becomes, the greater the variance in individual house price change will be. This type of heteroscedasticity may undermine the efficiency of the repeat sales index (Wang and Zorn, 1997). Calhoun (1996) distinguishes three stages in the estimation of the weighted repeat sales model. In the first stage the original model of Bailey et al. is calculated. The second and third stages aim to improve the efficiency of the first-stage parameter estimates, accounting for the possibility that the estimation error is positively related to the time interval between subsequent transactions.[4]

[4] Jansen et al. (2008) found that heteroscedasticity was of little importance in the Dutch data – the amount of explained variance was less than one percent. They also encountered a problem with the weights necessary to correct for heteroscedasticity. In conclusion, Jansen et al. (2008) argue that the original repeat sales method of Bailey et al. (1963) seems more appropriate for calculating a house price index in the Netherlands than its weighted counterpart.

2.3. SPAR

The Sale Price Appraisal Ratio (SPAR) method has been applied in New Zealand since the early 1960s. It is advocated by Bourassa et al. (2006) as an alternative approach to measuring house price indexes. Like repeat sales methods, the SPAR method is based on matched pairs but, in contrast, uses (nearly) all price data that is available for the period of observation. Since the vast majority of houses that are sold during the current period were not sold during the index reference or base period, there is a lack of transaction prices for the base period. The base period prices are therefore estimated using (official government) appraisals of the properties.

de Haan et al. (2008) indicate that there are various types of SPAR indexes; they can be either value weighted or equally weighted. If an equally weighted index is preferred, the geometric variant would be the best choice. For an index that tracks the changes in the value of the housing stock, in which we are particularly interested here, the weighted arithmetic variant seems a natural choice. The value-weighted arithmetic SPAR index can be written in the following three ways:

$$I_{\mathrm{SPAR},t} = \frac{\sum_{j=1}^{n_t} P_{jt} / \sum_{j=1}^{n_t} A_{j0}}{\sum_{i=1}^{n_0} P_{i0} / \sum_{i=1}^{n_0} A_{i0}} = \frac{\sum_{j=1}^{n_t} w_{j0}\left(\frac{P_{jt}}{A_{j0}}\right)}{\sum_{i=1}^{n_0} w_{i0}\left(\frac{P_{i0}}{A_{i0}}\right)} = \left[\frac{\sum_{i=1}^{n_0} A_{i0}/n_0}{\sum_{j=1}^{n_t} A_{j0}/n_t}\right] \frac{\sum_{j=1}^{n_t} P_{jt}/n_t}{\sum_{i=1}^{n_0} P_{i0}/n_0}, \tag{3}$$

where P_{jt} and P_{i0} denote the transaction prices for houses j and i in the current period t and the period 0 in which the houses were valued (the appraisal or base period); A_{j0} and A_{i0} are the respective appraisals; n_t and n_0 are the number of houses sold in period t and 0 (the sample sizes). The second expression on the right-hand side of Eq. (3) shows the basic idea behind the value-weighted SPAR index. In the numerator a price change is computed for each house sold in period t as the ratio of the actual transaction price and the appraisal. These house-specific price ratios are then weighted by their (base period) value share $w_{j0} = A_{j0}/\sum_{j=1}^{n_t} A_{j0}$, which explains the name 'value-weighted index'. Thus, more valuable houses have a greater impact on the index than less valuable houses. The denominator of (3) is a scaling factor, independent of time t, which is needed to make the index equal to 1 in the base period. It can alternatively be interpreted as a factor that corrects the numerator for possible over-estimation or under-estimation of the appraisals with respect to the transaction prices. Obviously, the denominator of (3) goes to 1 if in period 0 the appraisals would approach the transaction prices.[5]

The third expression on the right of (3) shows that the value-weighted SPAR index can also be viewed as the product of the simple ratio of mean transaction prices and a factor between square brackets. This bracketed factor

[5] The underlying assumption of the SPAR method is in fact that a linear relation through the origin exists in the base period between appraisal values and transaction prices for all houses sold in both the base period and the current period. See also Section 3, where we address the reliability of the Dutch appraisals.

is a ratio of mean appraisals and adjusts the ratio of mean sale prices for compositional change. In practice it may be desirable to apply the SPAR method to relatively homogeneous strata, since stratification by itself reduces the effect of compositional changes.

Though the SPAR method controls for changes in the quality mix of the sample, it does not control for quality changes of individual houses; the same goes for the repeat sales approach. It has been suggested that we adjust the valuations to take account of home improvements that require planning permission. Unfortunately, such adjustments are infeasible in the Netherlands because planning permission data are available only at aggregate (project) level and not for individual dwellings. Note that the SPAR method (as well as the repeat sales method) automatically controls for location as it is based on the matched pairs principle. This is an advantage compared to the hedonic method where it is often difficult to control for micro-location.

3. Representativity of the data

To estimate repeat sales and SPAR house price indexes, we exploited the dataset of *Kadaster*, the Dutch Land Registry Office. We call this dataset the 'transaction dataset'. For the SPAR method, in addition we used an 'appraisal dataset' with official appraisal values from the municipalities. An important question of course is whether the quality of the appraisals is satisfactory. Before explaining how the appraisals were determined and presenting evidence on their reliability, we first describe the transaction dataset.

3.1. Transaction dataset

Our (national) transaction dataset contains data on approximately 2.7 million individual transactions regarding second-hand, or resold, houses between January 1995 and March 2009.[6] A number of transactions were removed for reasons of validity. We applied price limits between 10,000 and 5 million euros. Dwellings that were sold more than twice in the same month were excluded. For the SPAR index, dwellings for which the corresponding appraisal values could not be found due to problems with merging the data files, could of course not be used. For the repeat sales index, dwellings with an extremely large surface area (over 1000 square meters) were excluded. Obviously, only dwellings sold twice or more could be used here, pertaining to about half of all transactions.

The literature suggests that repeated transactions with a short time interval might be 'unusual' in the sense that they may be distressed sales arising from, for example, divorce or job loss or that they may be speculative transactions (Englund et al., 1998; Steele and Goy, 1997; Clapp and Giacotto, 1999). In the Netherlands no conveyance tax needs to be paid on a house that is resold within 6 months. Jansen et al. (2008) have shown that a number of speculative sales took place during the boom between 1998 and 2001. Clapp and Giacotto (1999) and Steele and Goy (1997) suggest eliminating very short holds from the dataset. Jansen et al. (2008) explored the potential impact of such very short holds by calculating the monthly growth rate for each house sold. The mean growth rates were 8.2%, 5.2%, 1.2% and 0.9% for houses sold within 6 months, within 12 months, within all periods, and between 12 months and the end of the period, respectively. Thus, houses resold within 12 months typically realize a huge increase in value per month, which can potentially bias the index.

3.2. Appraisal dataset

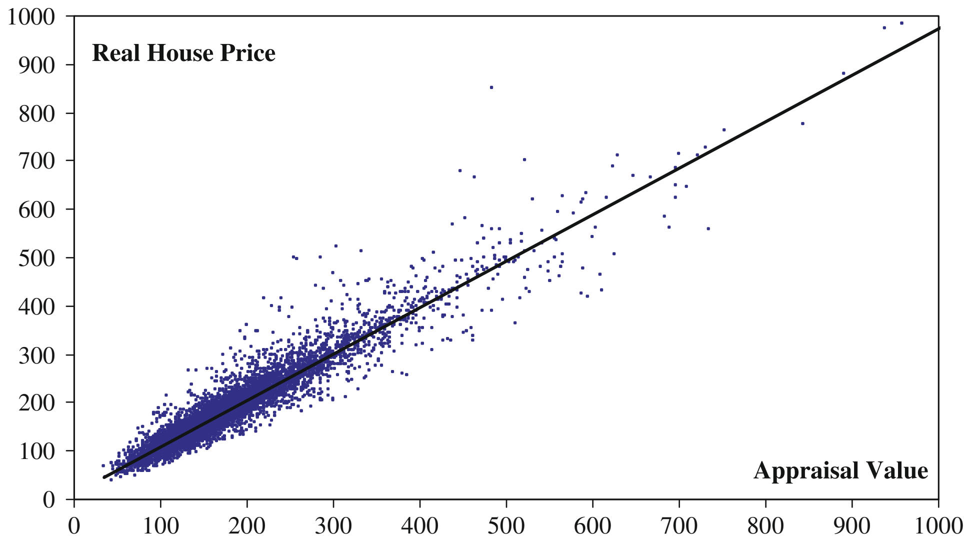
In the real estate literature there has been some discussion about appraisal values and their use in house price measurement (Geltner, 1991; Edelstein and Quan, 2006; Leventis, 2006). Most studies are based on appraisals of dwellings that are about to be re-financed. That is why, in general, the findings suggest that appraisals tend to be positively biased – they tend to over-predict the actual selling price of the property (Leventis, 2006). In the Netherlands official appraisals are collected under the Real Estate Law [*Wet Waardering Onroerende Zaken*] for tax purposes, not for re-financing. Dutch households pay local tax according to the value of their dwelling. Households who feel that the appraisal value is too high may lodge an appeal. Though legally appraisals should reflect the market values of the houses, we expected local authorities to underestimate them in order to avoid court procedures. So initially we assumed that the appraisal values would tend to under-predict the market values of the properties. However, an investigation into this issue proved us wrong (van der Wal et al., 2006; de Vries et al., 2006).

Dutch municipalities are legally obliged to have up-to-date estimates of the value of each real estate object in January 1995, 1999, 2003, 2005, and 2007. As of January 2007, houses are appraised on an annual basis. Appraisal values are determined ex post. For example, preliminary appraisals for January 2007 were determined at the beginning of 2008. The definitive values were available at the end of 2008 after taking into account any appeals lodged by home-owners.[7] At the time of this study, appraisals for 2008 were thus not yet available, so we distinguish five appraisal periods when computing SPAR index numbers (van der Wal, 2008). The records need continuous updating to be complete and 'correct'.

The entire process is monitored on the government's behalf by Council for Real Estate Assessment, the *Waarderingskamer*. There is no prescribed method of appraisal, but most municipalities appraise the objects using (hedonic-type) valuation models in combination with visual inspections and local market information. For privacy reasons we are not allowed to publish research findings based on appraisal data without explicit permission from the Dutch municipalities – it is they who own the appraisals. For this

[6] Transactions for newly built houses are not recorded by *Kadaster*. That is, houses have to be resold before they enter the transactions dataset.

[7] As the appraisals are determined ex post, they include home improvements carried out between the date of valuation (for example January 2007) and the date upon which the property was accorded an official value (here at the end of 2008).



Source: Kadaster Netherlands, computation OTB and Statistics Netherlands (10% sample)

Fig. 1. Real house prices and appraisal values in January 2003.

Table 1
Difference between real house prices and appraisal values.

Appraisal date	Mean A_j (€)	*Mean* rP_j (€)	Fraction rP_j/A_j (€)	Change in standard deviation (%)	R^2
January 1995	87,607	90,538	0.968	16.2	0.903
January 1999	133,901	130,532	1.026	11.4	0.940
January 2003	202,695	200,167	1.012	10.7	0.951

Source: Kadaster Netherlands, computation OTB and Statistics Netherlands.

study all municipalities in the province of Overijssel, except Hengelo and Dinkelland, granted us permission to publish the results, using definitive appraisal values for 1995, 1999, and 2003. Unpublished research has shown that our results are representative for the Netherlands as a whole.

A problem when comparing the current sale price P_{it} and the appraisal value A_{i0} is the difference in observation period. We therefore computed a 'real' house price, RP_{i0}, using the repeat sales House Price Index (*HPI*) which was published by *Kadaster* until January 2008[8]

$$RP_{i0} = (HPI_0/HPI_t)P_{it}. \tag{4}$$

The scatter plot in Fig. 1, which is based on data of January 2003 for the Province of Overijssel, shows the coherence between these values. For the SPAR approach to work well, the relation between appraisals and actual (real) house prices should be linear with a zero intercept term (apart from any random disturbances). The linear regression line is also shown in Fig. 1. The line almost crosses the origin, and the fit is satisfactory with an R^2 value of 0.91. For 1995 and 1999 the R^2 values are slightly lower: 0.86 and 0.88.

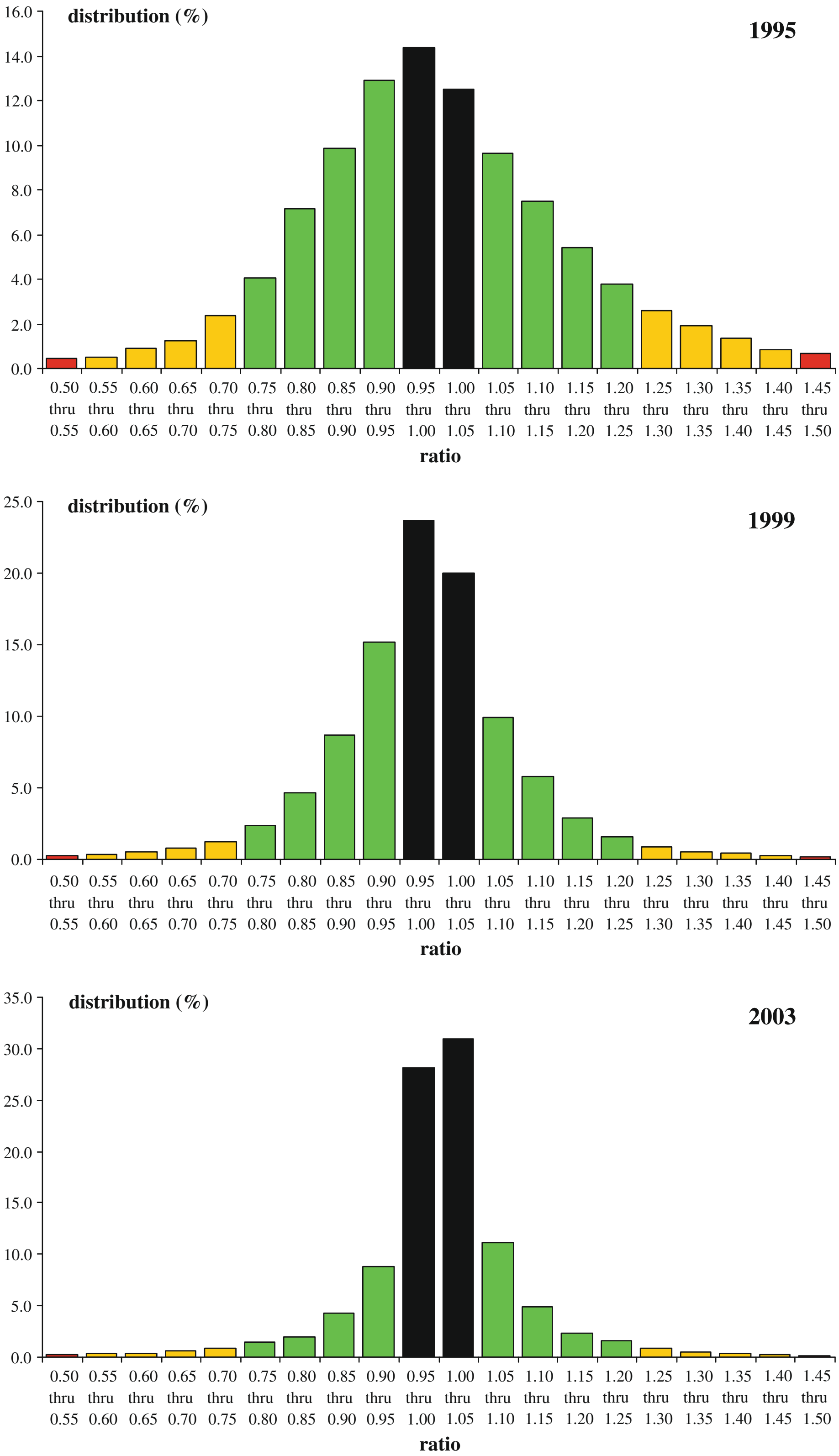
We conducted another simple but efficient comparison of the real house prices and the appraisals, again for January 1995, 1999, and 2003. The percentage differences between the mean appraisal and the mean real house price declined over time, indicating that the reliability of the appraisals has improved (Table 1). The decrease in the standard deviation endorses these findings. In the first period, the appraisal value underestimated the price by more than one percent on average. In the second period, starting in 1999, the appraisal values overestimated the sale prices, but the absolute difference between the transaction prices and the appraisals and the standard deviation decreased considerably. The same pattern is observable in the third period.

Finally, we analyzed the ratio F_{i0} of the real house price and the appraisal value:

$$F_{i0} = (RP_{i0}/A_{i0}). \tag{5}$$

In line with the principles of the Dutch Real Estate Law, we expect the ratio F_{i0} to be approximately equal to 1. Fig. 2 depicts the distribution of the ratios for each appraisal date using 20 classes of equal size on the *x* axis. The two middle classes (0.95–1.00 and 1.00–1.05) are in black to indicate the anticipated mid-point. The three graphs show that the distribution became increasingly steeper over time, indicating that more and more dwellings acquired a 'normal' fraction. In 1995 the ratio F_{i0} was between 0.90

[8] The repeat sales House Price Index, published by *Kadaster*, has been calculated by OTB Research Institute for Housing, Urban and Mobility Studies. For this study, we extended the time series to March 2009.

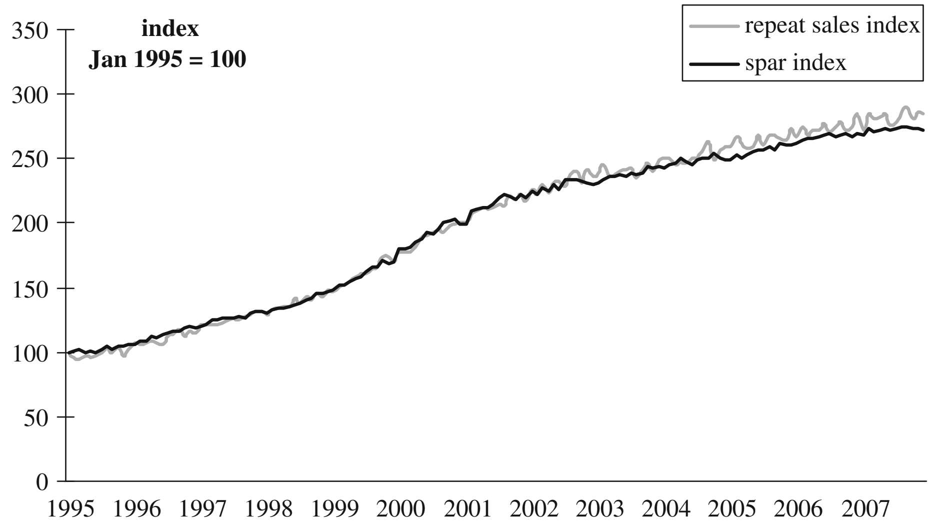


Source: Kadaster Netherlands; computation OTB and Statistics Netherlands

Fig. 2. Distribution of the ratio of real house price and appraisal value in the province of Overijssel (the Netherlands).

and 1.10 for only 56% of all properties while it rose to 79% in 2003. Thus, the (real) house price and the appraisal value have drawn closer together.

We believe that the quality of the official Dutch appraisals – certainly as of January 2003 – is sufficient for calculating a house price index based on the SPAR method. The



Source: Kadaster Netherlands; computation OTB and Statistics Netherlands

Fig. 3. House price indexes for the province of Overijssel (the Netherlands), January 1995–December 2007.

quality has undoubtedly improved over time, which should have a positive impact on the statistical accuracy of the resulting SPAR indexes. Note that we excluded unrealistic ratios between sale prices and appraisals, which might bias the SPAR index, by using a minimum value for the sale price of 10,000 euros and a maximum value of 5 million euros. This largely eliminates questionable transactions.

4. A comparison of SPAR and repeat sales index numbers

4.1. Trends and fluctuations

For the province of Overijssel we computed value weighted (arithmetic) SPAR indexes and (geometric) repeat sales indexes; the repeat sales method is comparable to that used for the OFHEO House Price Index (Calhoun, 1996). Unpublished research has confirmed that our findings are representative for the Netherlands as a whole. The two indexes are shown in Fig. 3 for January 1995 to March 2009. Like in most countries (and in other provinces in the Netherlands), house prices increased very rapidly. During the last couple of years house price appreciation slowed down and, probably influenced by the financial crises and the economic downturn, came to a stop in 2009. The SPAR and repeat sales index numbers exhibited quite similar trends until 2002. Since then, however, the SPAR method measures a much slower increase.

A striking feature of the SPAR index is that it is much less erratic than the repeat sales index. This becomes clearer from Fig. 4, which depicts the month-to-month index changes. A possible explanation is the 'waste of data' that has frequently been cited as a drawback of the repeat sales approach – only data of houses that were sold twice or more (after January 1995 in our case) can be used. To compute the repeat sales index for the province of Overijssel we had 43,386 pairs of repeat sales, whereas for the SPAR index we used the data of all 159,894 sales that took place between January 1995 and March 2009.

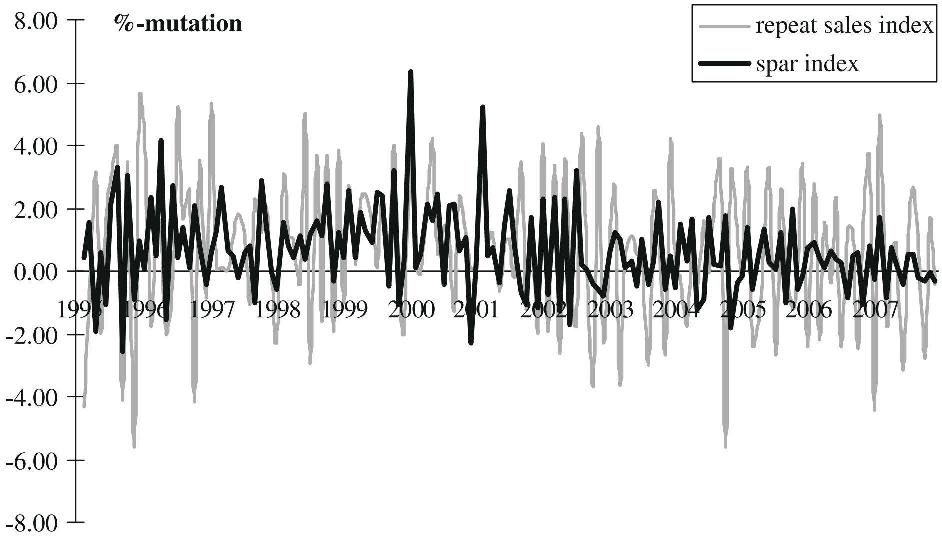
4.2. Precision

Fig. 4 indicates that the SPAR method provides a more accurate picture of the short run house price changes than the repeat sales method. It would be interesting to know the statistical accuracy of the index numbers. The mean square error of an estimator – the square root of the sum of the variance and the squared bias – is an inverse measure of its accuracy: it measures how far the estimator is expected to be from the population target it is aiming at. Here we focus on the variance component, or rather the square root thereof, the standard error (SE). This is an inverse measure of precision: the greater the standard error of an estimator, the lower its precision is. Using the standard errors we calculated 95%-confidence intervals around the estimated index values with bounds $I_{(.)t} \pm 1.96 \times \mathrm{SE}$. The width of the confidence interval gives an idea of the 'uncertainty' surrounding the estimates. Since the standard error depends on the sample size, a very wide interval may indicate that too few data were available to draw any definite conclusions about (changes in) the index values.

Standard errors and the corresponding 95%-confidence interval for the SPAR index were estimated using Taylor linearization techniques (see de Haan, 2007).[9] The estimation of the confidence interval for the geometric repeat sales (*RS*) index is less straightforward. The index number $I_{RS,t}$ is estimated by (Calhoun, 1996)

$$I_{RS,t} = \exp(\hat{\hat{\beta}}_t)(\times 100), \tag{6}$$

[9] It is assumed that the sets of houses sold in different periods are independently drawn random samples from the housing stock. Furthermore, we assume that the relative distribution of the sale prices in the base period and current period is equal to the distribution of the appraisals (in the base period).



Source: Kadaster Netherlands; computation OTB and Statistics Netherlands

Fig. 4. Monthly %-change of the house price indexes for the province of Overijssel (the Netherlands), January 1995–December 2007.

where $\hat{\hat{\beta}}_t$ denotes the estimated parameter from a generalized least squares regression. The corresponding standard error is

$$\sigma_{I_{RS,t}} = I_{RS,t}\sigma_{\hat{\beta}_t}, \tag{7}$$

where $\sigma_{\hat{\beta}_t}$ pertains to the standard error of the estimated coefficient from the third step of the generalized least squares regression.

Since the magnitude of the standard error depends on the level of the index, a relative measure of precision would be more appropriate. One such (inverse) measure, $PREC_t$, is obtained by dividing the width of the confidence interval, W_{C_t}, by the index number (and multiplying by 100):

$$PREC_t = (W_{C_t}/I_{(.),t}) \times 100. \tag{8}$$

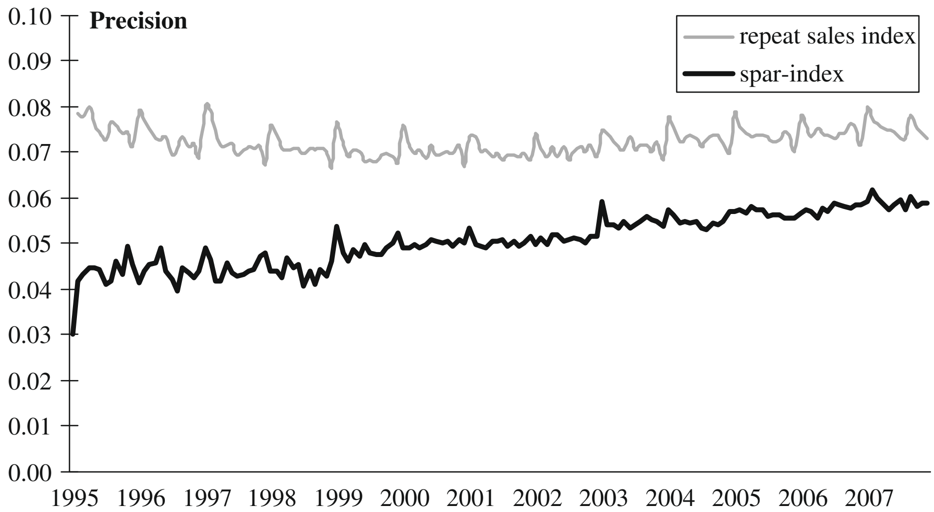
Fig. 5 displays the precision of both price indexes according to this relative measure. The SPAR index was more precise than the repeat sales index across the entire period. At first glance, this seems obvious given that the SPAR index utilizes all data. But there is a caveat. Each time houses were re-valued – in our case in January 1999, January 2003, January 2005, and January 2007 – a new short-term SPAR index series was compiled, based on the most recent appraisal values. The five short-term series were subsequently multiplied to obtain the long-run series that is shown in Fig. 3. This type of 'chaining' will in general raise the standard error of the long-run SPAR series because each time a new source of sampling error, and maybe also non-sampling error, is added (see also Shi, 2008, who describes something similar. This cumulative effect can be seen in Fig. 5: the precision clearly decreases in subsequent valuation periods.

If the 'uncertainty' of the chained SPAR index increases over time, why do we use the newly available appraisals in the first place? Why not stick to the old ones and compute a direct, unchained index? The reason is that newly built houses that are resold can only be incorporated through chaining as, by definition, they have not been valued in the past. A direct SPAR index would thus become less and less representative for the (changing) housing stock. Furthermore, it would have been strange not to benefit from the improved quality of the appraisals, the more so because many users are interested in short-term house price movements rather than in very long time series.

4.3. Cause and effect

There are three potential explanations for the difference in the trend of the two indexes. Firstly, the repeat sales approach leads to an index based on a geometric mean of the individual appreciation rates, whereas our SPAR index has an arithmetic structure. It is well known that a geometric index is smaller than its arithmetic counterpart unless all appreciation rates are the same (Wang and Zorn, 1997). To check this, we also estimated *arithmetic* repeat sales index numbers (Shiller, 1991). These indexes scarcely deviated from the usual geometric repeat sales index numbers. Conversely, geometric SPAR index numbers appeared to differ only marginally from the arithmetic SPAR numbers. Thus, in our dataset the effect of using geometric or arithmetic means was negligible.

Secondly, the two indexes are computed from different samples. The SPAR index uses all transaction data, whereas the repeat sales index only uses data of houses that have been repeatedly sold. The mean house price in the repeat sales dataset was approximately 8% lower than the mean house price in the SPAR dataset. Jansen et al. (2008) observed that Dutch properties resold within short time intervals appreciate at a higher rate than properties resold within longer time intervals (see also Clapp and Giacotto, 1999). In a repeat sales index, after additional sales come available, new matched pairs of houses provide additional information about price changes beyond that found with



Source: Kadaster Netherlands; computation OTB and Statistics Netherlands

Fig. 5. Precision of the house price indexes for the province of Overijssel (the Netherlands), January 1995–December 2007.

the previous data. Since these properties apparently appreciate at a lower rate, we would expect the revised repeat sales index numbers to be lower than the initially computed numbers. Put differently, we expect the repeat sales index to be revised downwards as time passes and to come closer to the SPAR index. In an earlier paper (van der Wal et al., 2006) it was shown that this revision effect is indeed important: a SPAR index re-calculated on the repeat sales dataset was much less different from the repeat sales index than the original SPAR index.

Thirdly, our SPAR index is value weighted, whereas the repeat sales index is unweighted. As long as cheaper houses undergo the same price change as more expensive houses, weighting does not matter. However, there is some evidence that more expensive houses appreciated less than cheaper ones, which has a downward effect on a value-weighted index (van der Wal et al., 2006).

5. Conclusion

This paper reports on a project to develop a house price index for the owner-occupied sector. Some special institutional features of the situation in the Netherlands contributed to the choice of index number method. The SPAR approach to constructing a house price index has been used in New Zealand since the early 1960s and is also applied in Sweden and Denmark. Recent experiences in Australia with the SPAR method are promising as well (Rossini and Kershaw, 2006). Like the repeat sales method, the SPAR method is an alternative to hedonic methods when insufficient data is available on the characteristics of dwellings. In their standard form, both methods have at least two things in common: they are based solely on price changes of matched pairs, and thus adjust for compositional change, but they make no adjustment for changes in the quality of individual dwellings. Sample selection bias is most likely to be smaller for the SPAR index than for a repeat sales index as the latter excludes houses that have been sold only once. Also, SPAR index numbers are not subject to revision. From a practitioner's point of view the simplicity and transparency of the SPAR method can be seen as an advantage.

Two main results emerge from our study.

- The quality of the official Dutch appraisal values, while subject to certain limitations, is sufficient enough for computing a SPAR index.
- For the Netherlands the difference in trend between the (geometric) repeat sales index and the (value-weighted arithmetic) SPAR index is not negligible in the long run. In the shorter run, the SPAR index is less volatile and more precise than the repeat sales index.

From May 2005 to January 2008 *Kadaster*, the Dutch land registry office, published house price indexes based on the repeat sales index method. Based on the results of this study, *Kadaster* decided to change over to the SPAR index, which is computed monthly by Statistics Netherlands. As of January 2008 the two organizations jointly publish SPAR house price index numbers for the whole country and for different types of dwellings and regions.

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