A countrywide house price index for 152 years.

By Jens Lunde, Anders Helding Madsen and Maria Lundbæk Laursen.

Abstract

The presented house price index for Denmark from 1860 to 2012 has been constructed by analysing already published data from Statistics Denmark. Houses are heterogeneous assets, and nowadays they differ in many aspects from houses in 1860. Due to improved building quality, urbanization and the revolution of the transportation, they are now situated in much larger cities and fewer houses are found in the countryside. Furthermore the houses are more and better equipped. Obviously, conceptual and practical difficulties exist in separating the value and the price of the houses when the development in house prices is depicted.

The Danish house price index covering all the 152 years is in reality a simple average sale price index for houses. From 1920 on it was possible to construct another and a “pure” house price index, based on the Sales Price Appraisal Ratio (SPAR) method. Several challenges for creating the house price index arose, especially in converting the previous registered house prices in the statistics into current market prices.

In real terms, the average sale price index increased more than the SPAR index for the years where the two indices were compared, and the difference express the qualitative improvement of the sold house through the years. The SPAR index contains long house price cycles, and the unique recent bubble is observed. The development in real prices holds no arguments for the SPAR index will increase in the long run. Already published long house price indices exist for Herengracht (the Netherlands), Norway, USA, France, and recently also Australia. Until now, the here presented house price index for Denmark is the longest countrywide house price index ever been published, based on official data, and qualitatively probably the best long house price index.'

Key-words : Housing price inflation and indices. Housing market cycles, demand and supply.
1. Introduction

The changes over time in the price of goods must per definition be estimated for goods of the same quality and size. A price index for a bundle of goods must form a constant quality index. Otherwise the index depicts a combined development in the goods quantities, qualities and prices, i.e. in the goods’ values. If possible, this challenge has to be met at constructing the Danish house price index for the 152 years from 1860 and until today. The modern one-family house with all the technical facilities did not exist in 1860. At that time most of the houses were rural houses connected to farming and only few of them exist today and then totally renovated. The index begins shortly before, the Danish soldiers February 1864, at the start of the Second Schleswig-Holstein war, left the historical trench system Dannevirke, by foot and drawing the guns after them. This historical digression focus on that 152 years ago houses were without technical and sanitary facilities and only horses could facilitate transportation of people among the houses.

Nevertheless, in this paper is presented a house price index for Denmark from 1860 to 2012, which until now, is the longest nationwide house price index in the world. Even, the index relies on originally collected data on sale prices, which were published by the same official, independent and public financed statistical institution: Statistic Denmark. For the first six decades the house price index has been constructed by the simplest method, the average sale price. From 1920 on the sale price appraisal ratio (SPAR) method is used for constructing the house price indices. Recently this method has been recommended as plain, efficient and possibly the best housing price index method.

The aim with the paper is to describe the house price development in the best possible way. It is highly demanded to identify and analyze the long housing cycles over centuries. As Reinhart & Rogoff remark: “central to the analysis are historical housing price data, which can be difficult to obtain and are critical for assessing the recent episode.” (2009, p. 226).

However, already some very long house price indices have been constructed and published. The authors were inspired by these and especially by the much media citation of the U.S. house price index back to 1890 at Shiller’s publishing of “Irrational Exuberance. Second Edition,” (2005, chap. 2). The deciding challenge to construct a long Danish house price index was the remark at Statistic Denmark’s homepage on the Danish property price data: “The oldest publication referred to is Statistiske Meddelelser 1845-1849.” The aim is not to contribute to a methodological improvement of the housing price statistic. But owing to former years careful public servants the presented house price index provide arguments for using the Sale Price Appraisal Ratio (SPAR) method.1

The paper proceeds as follows. The next section considers the conceptual difference between a housing value and a housing price index. In the following section a long house price index is seen as a part of the 152 years Danish history. Then the used methods as determined by the existing data are presented and afterwards the previously published long house price indices. Section 6 contains the practical problems at collecting the data, the chosen house property types, the frequency of the data and the sources. Then we explain the correction from registered house prices to market prices. At that point the constructed indices are introduced, first the average sale price index 1860-2012 and then the SPAR-method and -index 1920-2012. In the next section a comparison from 1920 to 2012 of the two indices render it possible to see the differences in their growth rates as an estimate of the quality improvements of the sold houses. In the following section the combined real house price index for 1860-2012 is presented, and after compared with the U.S. and the Norwegian indices. In the preceding sections the upturns and downturns and three special cycles: the “Great Depression” in the 1930s, the economic growth in the 1960s, and the recent “rocket” are followed. In Section 18 is discussed if real house prices will increase in the long run. The last section contains the constructed real house price index for the Copenhagen area 1920-2012.

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1 Originally, the practical efforts at finding the data and at constructing the Danish house price index was presented in Madsen’s and Laursen’s master thesis as tutored by Lunde, (Madsen & Laursen, 2009).
2. Housing value versus housing price indices

A house can be seen as a bundle of attributes. Obviously houses are heterogeneous goods, which differ in many ways for just to mention some of the possible attributes: location, size of plot, size of house, age, floors, cellar, roof, number of bathrooms, and … Moreover, the house buyers’ appraisal of these attributes changes over time. Since 1860 many new facilities and improvements of the houses have been introduced and are common now.

The challenge for house price indices in general and for the Danish house price index from 1860 to 2012 in particular, is to separate changes in prices and quality improvements. Over the one and a half century, the houses’ architectural performance, technical facilities, sizes, equipment, transportation system, and urbanization has changed enormously in Denmark as in all countries.

Some fundamental differences are known. By linking housing stock data and the building statistic was found that nearly all residential properties existed 80 years after the construction. The age composition of the building stock follows the building activity, which has varied a lot over the years. Through the index period two technological breakthroughs appeared: 1) around the year 1900 the modern toilet and electric light, and 2) from the end of the 1920s central heating, bath rooms, balconies, and open spaces with green areas were introduced in new buildings and, over time, at modernisations, (Boligministeriet, 1990, chap. 4).

Denmark experienced a building boom in the 1950s and especially in the 1960s and 1970s. Around 425,000 dwellings – app. 1/6 of the housing stock – were built in the 1970s, the “record decade”, (Boligministeriet, 1990, p. 35). The one-family house was the most common and a popular tenure and property type in these decades, where the consumers gave high priority to own a house and a car.

The challenge at constructing a house price index is to expand the development in the house prices instead of in the house values. In reality an index for the average sale prices or m2 prices is a house value index. Many existing indices are housing value indices, also many of the indices published by OECD and BIS. Moreover for some countries, the index only covers larger cities or a special type of property. (André, 2010, p. 51). Below the Danish house price index is presented, which is a house value index for the first 60 years and a pure house price index for the last 92 years. The index covers one-family houses but of changing definitions and limitations.

3. A house price index through 152 years Danish history.

The aim with the presented house price index is to give the most precise description of the house price development and thereby of an integrated part of the housing market cycles through the one and a half century. The house price and housing market changes mirrors the progress and the changes in the Danish macro economy.

In this period Denmark has changed from a poor farming country, over an industrialized and to a modern “high tech” and relatively efficient society in a globalized competition with now frequent and strong technological and transportation progress. Similar to several other European countries Denmark is highly involved in the world trade and have had efficiency advantages of the removal of trade restrictions internationally and by the European currency cooperation as Danish kroner “shadows” the euro. Denmark has a high tax level and a large public sector, a high degree of equalizing over the public budget, and the inhabitants see the country as a "welfare state". Denmark has a relatively well organized labor market and a negotiated wage formation. Both the Danish welfare and labor market model is under attack from the European and internationally cooperating and liberalization.

The Danish housing market has been influenced by progress in the economic welfare over the many years behind the constructed house price index. Especially in the 1960s and 1970s the nation experienced a
sustained economic growth, which significantly improved the population’s housing standard. In average each Dane dispose over more than 50 m² floor area today. In Denmark the owner-occupation sector makes up to approximately 53 % of the housing stock, private cooperative housing with 7 %, private rental housing with 18 % and social housing with 20 % covers the rest.

Obviously the economic cycles are seen in the house price development. As a farming country Denmark was seriously affected by the crisis in the 1930s, where real house prices were nearly halved. All significant fluctuations since 1920 are presented below in Table 3. The largest upturn has been seen from 1993 to 2007 with a real house price increase at 168 %. Since 1973 Denmark has experienced three downturns, each with real house price decreases around one-third; still the recent housing and financial crisis is ongoing.

In 1860, Denmark had 1.608.362 inhabitants, and at the end of 2012, there were 5.602.628 inhabitants. In the period, the country was directly involved in two wars. Denmark lost the second Schleswig-Holstein war in 1864 to Prussia and Austria. Afterwards the Danish boarders were narrowed as a larger part of Southern Jutland became a part of Germany. In 1920 at the peace treaty after the First World War, a referendum was arranged and a part of Southern Jutland with 163.622 inhabitants became part of Denmark again.

The changes in the Danish society through the 152 years and the change in properties, whose price data are used at constructing the indices, fit into a certain degree. For the first decades small farm houses and cottages are included and as late as from 1965 on, one-family and terrace houses are the only properties behind the index; these houses cover around half of the housing stock today. It is close to an anachronism to construct a house price index, as the one-family house nearly not existed in 1860. Up to the 1940s many families and single persons had their existence at working on the neighborhood farms on a daily basis, and the farm houses had often some gardening and some farm animals adjusted; many houses had – as an integrated part of the house – a group of farm animals, possibly some pigs and cows, or only a pig and some hens. From the family story the senior author (Lunde) tells that his grandparents had a farming house close at a small village ("Lunde") in the 1920s, where the great-grandmother had a room beside a one-pig piggery, both of similar size, at the end of the house.

In the late 1930s the modern one-family house began to be popular. The government subsidized construction of small houses and did set out certain limitations on these houses’ size (max110 m²), standard and price. The lack of building materials through the 1940s made building of these “state loan houses” attractive. Few of these government subsidized houses stands today as they were originally built.

After World War II the housing need had increased and the population had a feeling of a housing shortage, partly due to increased housing demand because of reduced imputed rent taxation and an introduced rent regulation. Also the access to building materials at the market was restored and the access to state loans meant that more families could afford to buy more unique houses designed by an architect. The government experienced increasing costs at the state loans and they were replaced with traditional mortgages through 1958 on. Through the long upturn after 1956, in the 1960s and 1970s, the number of one-family and terrace houses had a pronounced increase, further stimulated of the low and over long periods negative real interest rates after tax (high inflation, relatively low interest rates, deduction of nominal interest payments in high taxed marginal income).

Property taxation in some form has been used in Denmark since the beginning of the 1100 century and covered then a large part of the total tax proceeds. In 1903 the income and property taxation was reorganized and modernized, a new law on property taxation was set through, and besides the imputed rent taxation for owner-occupiers was introduced. This taxation created the background for establishment of a public property assessments in 1901 as followed by ordinary property assessments each 4th year from 1904 on. The Danish tax authorities started to make public property assessments for the Danish houses and properties in general, which made sale statistics available.
Therefore the property taxation in Denmark rendered it possible to use the Sales Price Appraisal Ratio-
method (SPAR method) to estimate a “pure” house price index for Denmark. From 1920 on the SPA ratio:
the sale price/public assessed property value, can be withdrawn from published statistics. These SPA ratios
have been used to make an in principle constant quality house price index since 1920. As a bonus the quality
improvement can be estimated for the years after 1920 at comparing the average sale price and the SPAR
indices.

4. Housing price index methods
A large economic literature exists on housing price indices. Methodologically, the used property price
indices fall in four groups: 1) a simple index on a quantitative unit, for example assessed property values,
sale prices for the houses, or sale prices for a quantity unit as m² or …. 2) hedonic housing price indices, 3) 
repeat sales housing price indices, and 4) Sale Price Appraisal Ratio (SPAR) housing price indices.

The aim of this paper is to identify and present the house price development over the 152 years long time
span and not to find and discuss optimal methods to construct house price indices. Furthermore the aim is to
describe the house price development and the original registrations and housing price index methods had to
be used. Applying to the Danish indices, the available data has determined the method to be used. Thus
below is presented:

a. An index over average sale prices (buying prices or transaction prices) for houses from 1860 to
2012.
b. A house price index constructed by use of the SPAR method from 1920 to 2012.
c. The two indices are combined in one Danish house price index, where the average sale price method
is used from 1860 to 1920 and the SPAR index method 1920 to 2012.

An average sale price index is an intuitively obvious and simple method to measure house price changes by.
Such price indices exist in several countries. The sale prices at the transaction are seen as the correct measure
for the houses’ market values.

In principle, the public assessed property values render it possible to find and follow the changes in the
average property value for all houses in the housing stock and not only for the sold units. The disadvantage is
that even though the assessments are done in market values by law, these are difficult to hit precisely. Also
the public assessments in Denmark have only been done with 2-4 years intervals mostly. – The public
assessed property values are essential for the SPA ratios.

Obviously the average sale price method can be criticized. Houses and other properties are heterogeneous
assets, and the sold houses’ size, location, depreciation, addition of new build or renovated houses etc. vary
over time, which influence the average sale prices. Also through the housing cycles a sale price index will
have higher volatility than constant quality indices. In periods with economic growth and increasing house
prices, modernization and renovation will accelerate the house price increases, even though this influence
represents a quality improvement. Contrary, when falling house prices and low economic growth make
improvements unprofitable, lack of maintenance and aging of facilities etc. will accelerate the house price
fall, even though this part express a quality deterioration. Thus, an average sale price index has more
similarities with a house value index than with a house price index. Also the official Danish expression in the
statistics: ”gennemsnitlige købesum” could be understood as average housing value, why these data form a
sort of house value index.

Traditionally the aim has been to construct property price indices as constant quality indices. Therefore in
public Danish statistics, property price indices are constructed by use of the ratio: the property sale price-to-
public assessed property value ratios were calculated for each sold unit, and then at fixing the public
assessments to a certain year, the changes over time in the ratios for the sold properties were calculated. Thus
the house or property price index was created. (The method will be further outlined in section 9 below.)
Originally the public property assessments were done manually by some introspection from experienced appraisers, appointed by the municipality. Over the last couple of decades hedonic regression technic has been used for the most common property type: one-family houses. This is a robust standard procedure for public assessments of properties at market values. In average the public assessed property value for houses lay about 10 % below the market prices for houses at the time for assessment but possibly the not published variance in the ratio is high.

Both Statistic Denmark and SKAT mention in their methodological papers at their web pages, why they use the SPAR method at the property price index construction. With a standard text from Statistic Denmark’s articles in Statistiske Efterretninger and Statistiske Meddelelser, the purpose is: “the relation between the buying price [= sale price] and the public assessed property value should result in a “cleaner” expression for price differences and changes, i.e. more independent to the sold properties average size, age, quality, location etc., which influence the average sales amount.” Before the registered prices of sold properties were calculated as “cash” market prices, one more sentence was added to the text: “However still changes in the financial conditions influence the prices.”

Fortunately, this SPAR method is rather useful – and possibly qualitatively the best housing price index method. Boursassa et al. (2006) point out that the SPAR method fares well with respect to the constant quality criterion. The method is easy to construct and does not require detailed databases of property attributes. The method is easy to administrate and cost efficient, because property tax on houses and other properties and imputed rent taxation for owner-occupiers has existed in Denmark since 1903.

Boursassa et al. (2006) compared the alternative house price index methods: hedonic regression, repeat sales, and sale price appraisal ratios according to four criteria: constant quality, no sample selection bias, absence of revision and easy to administer, and found that the SPAR method had the most advantages. They did not include median or mean house price indices given their obvious limitations. (Boursassa et al., 2006). We might add that the Danish SPAR house price index satisfies all four criteria.

The SPAR method seems to be relatively unknown, but has been presented in a couple of articles recently. Boursassa et al. (2006) presented The Sale Price Appraisal Ratio (SPAR) under the title: “A simple alternative house price index method” and mentioned that this method had been applied since the early 1960s in the official New Zealand indices. Even they maintain that the method “should be considered by government agencies elsewhere when developing house price indexes.” (2006, p. 80). An additional argument is that both hedonic and hybrid methods need data with many quality attributes and in large numbers to produce a constant quality index.

Since the 1960s the SPAR method is used in New Zealand and is also used in official house price indices in Denmark and Sweden but not in other countries, (Boursassa et al., 2006; Shi, 2009). In Denmark the SPAR method has been seen as the housing and property price index method and as documented below in this paper the method can be used back to 1920. Contrary, for example, the method is not used in the U.S. or in UK. Possibly therefore the method was not mentioned in the AUREUEA primer on housing markets and policy, (Green and Malpezzi, 2003) and in a methodological paper on the UK residential house price indices, (Wood, 2005).

Some further interest in using the SPAR technique has been spurred. Shi, Young and Hargeaves have analyzed the possibility to construct a monthly house price index in New Zealand and found it reasonable to apply for larger cities in the country (2009). De Vries, de Haan, Van der Wal and Mariën have developed a house price index for the owner-occupied sector in the Netherlands and used the SPAR method for the purpose, (2009). Statistic Denmark has published monthly house price data from January 2006 on by use of the SPAR method.

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2 For example seems the SPAR-method not to have been mentioned in the proceedings from a recent BIS-IMF conference on real estate indicators and financial stability, (BIS, 2005).
5. Already existing long house price indices.
The five published long house price indices have been met by a considerable high economic historical and economic policy interest. They are presented shortly.

Eichholtz published in 1997 the Herengracht house price index from 1628 to 1973, the longest house price index until now. The transaction data were found in a register over each building at the Herengracht channel in Amsterdam and were used to construct a hedonic repeat sales price index. Originally 614 houses were included in the index but after building and area changes (demolitions, uniting, and new building) and changes between occupational and residential status, the housing stock in the area include 487 housing units. An uncertainty at the index is the few annual sales. (Eichholtz, 1997).

The longest housing index for an international metro pole has been constructed for Paris from 1840 on and was from 1936 on extended as a housing price index for France, (Friggit, 2002). The index uses tax data from the French national land archives and has been constructed by the repeat sales method.

The nearly 200 years long house price index for Norway is even well known by Norwegian newspaper readers. Originally the index was constructed by Eithreim et al. (2004) and relies on price per square meter for the four largest cities, from 1819 Bergen and then gradually Oslo, Kristiansand and Trondheim were included. Until 1986 the data are taken from the historical tables for detached houses, semi-detached houses and flats and aggregated to city indices using information about relative shares of houses; methodologically weighted repeat sales were used. Data from 1986 and onwards are based on a hedonic house price method and are updated annually (see Norges banks homepage). Housing prices are often more volatile for a metropolis than for the country, (see for Denmark section 19). Therefore the housing price index for the four largest Norwegian cities is not necessarily representative for all Norwegian houses.

Shiller’s index of U.S. home prices from 1890 on became “world famous” with the second edition of “Irrational Exuberance” (2005). He constructed the index by linking index and data from different sources. For 1890-1934 he used a published house price index. For the years 1934 to 1953, he collected median values of approximately 30 asking home prices for each year and for each of five cities as advertised in newspapers; of these data from five cities he made simple averages. As house prices for 1953–75, the home purchase component of the U.S. Consumer Price Index was utilized. And then for 1975–87 the U.S. home price index published by OFHEO and this index was from 1987 on substituted with the repeat sales U.S. home price index as originally produced by Case, Shiller and Weiss. (Shiller, 2005, notes to Chapter Two). – Shiller’s index has inspired many economists but of the different published long run house price indices this index has the most of an ad hoc character. It is difficult to disagree with Shiller, when he finds the index is “imperfect” and open for improvement.

The most recent published long house price index covers Australia’s major capital cities of Sydney and Melbourne for the period 1880-2010. The index is based on recently collected asking prices for 1880 to 1950 and for 1950 to 1970 actual selling prices were found in weekly property market reports with a sample size in a range from 200-500. These data were “spliced with existing series post-1970” to form the whole index. The Australian real median house prices did only rose marginally from 1880 to the mid-1950s for then to start at a persistent and significant rise up to the peak in 2008. (Stabledon, 2010).

Recently the long run housing price indices have been accompanied by a nominal and real housing rent index for Amsterdam for over 300 years, as Eichholtz, Straetmans and Thjeebe have constructed a constant-quality housing rent index from 1550 to 1850 by use of repeated-measure regressions analysis. The Amsterdam housing rents were free of any rent control during the whole sample period. Both nominal and real rents fluctuate and form cycles, which seem to be less volatile than real housing prices in the different long-run indices. The export-oriented character of the Amsterdam economy and its relation to the economic and demographic environment is depicted in a narrative ways, and also formally is shown that the fluctuations in
housing rent co-move with the fluctuations in domestic business cycle and international indicators. (Eichholtz et al., 2012).

6. Data used to create the long house price index for Denmark
Across the world, the published house price indices have been based on different price concepts and type of properties, (Ball, 2009). Perhaps most national indices rely on sale prices (or buying or transaction prices) but with different time-lag from sale and until the prices are recorded in a public or semi-public register. For other indices asking prices or mortgage data are collected. Many house price indices cover one-family houses, with or without terrace houses, but other indices have more wide definitions with flats and/or other residential properties included. Also some price indices only cover the capital or the larger towns.

Therefore, the data used at the construction of the long Danish house price index are presented in details in this section. Possibly these data are the most precise and complete historical data for a country’s house prices. However two rather important challenges must be overcome at the construction of the index: the definition and limitation of the included one-family houses, (in this section) and the correction of the registered prices to market prices at buying without loans, (see next section).

The indices are calculated by use of official data from Statistic Denmark, an independent public authority for statistics, whose independence is safeguarded by law, and who has existed since 1850. Also official data from SKAT (the tax authorities), which has existed in some form since the origin of the kingdom, are used. Both institutions have carried different names through the years.

Data were collected from Statistic Denmark’s official annual publications: Statistical Yearbook (since 1896) and Statistiske Meddelelser (since 1850), as available at Statistics Denmark’s library and at Rigsarkivet.3

For the first many years the property statistics was made manually. At Rigsarkivet we have seen statistical registrations, handwritten with ink. At the original registration and production of the house price statistics, most of the data were handled, calculated, hand-written and printed at manual processes, which contained special risk for errors in writing, calculations and reproductions. Some few obvious errors in the published statistics have been corrected by the authors; other errors might remain. And errors at our recording of data from printed sources might have appeared. However, we did our best to control the quality. – From 1992 on the statistics are found electronically (www.Statistikbanken.dk).

As mentioned some statistical property data exist from 1840 on according to Statistic Denmark’s homepage. However the data quality and character had such a form as we decided not to include the period 1840-1860 in the house price index. For the period 1870-1884 only data for five years periods existed, why the total nominal increases have been equally divided over the 5 years at interpolation.

The official Danish house price statistics include only the registered prices at ordinary free trade, why prices set at intra-family sales and at forced sales (foreclosures included) has been sorted out where possible. The Danish practice is to publish house price statistical data as average values, as total values and as index. Median house price indices are not published in official Danish statistics.

Since 1932 all property transactions as well as the registered buying/sale prices were fully and perfectly entered in the land registry and therefrom transmitted to the statistic. It was decided by law in 1932 that the property buyer should fill a special sale reporting scheme to the municipality’s property tax office – and after to Statistics Denmark – as a condition for the land registration of the new owner, (see Ministerialtidende,

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3 In principle, Rigsarkivet has stored SKAT’s historical data, but the data on the public assessed property values for the years in the period 1920 to 1965 were not found; these data should have been used for the correction of property values from a registered price level to market prices, see next section.
1932). The duty to register has guaranteed that all property sales are included in the property sale statistic as a base for the public property assessments and taxation. Buyers, sellers and their agents have never had any tax avoidance or other incitement to avoid precise registrations of sales and prices.

Hardly any other national house price statistics rely on a similar fully and precise coverage. On 8 September 2009 the electronic land registry was started, why the property price registration for the statistic cannot be more exact.

Before 1932 only around half of the property transactions were registered in the land registry. Officially was stated in Statistical Yearbook (in our translation): “With reference to the Ministry of Justice circular of 28. January 1932 the reports contain all sales from 1932 on and after, while the earlier years reports included around half of the sales.”

The reported annual numbers of sale are seen in Table 1. Unfortunately the change was set through in the worst year, 1932, through the “Great Depression” in Denmark and adds extra uncertainty to the calculated fall in nominal house prices at 17.8 %, (see also section 15).

Table 1. Number of sales, annually, Denmark. 1928-1940.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of sales</th>
<th>Per cent change y/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1928</td>
<td>4375</td>
<td></td>
</tr>
<tr>
<td>1929</td>
<td>4610</td>
<td>5.4 %</td>
</tr>
<tr>
<td>1930</td>
<td>4598</td>
<td>-0.3 %</td>
</tr>
<tr>
<td>1931</td>
<td>4252</td>
<td>-7.5 %</td>
</tr>
<tr>
<td>1932</td>
<td>7908</td>
<td>86.0 %</td>
</tr>
<tr>
<td>1933</td>
<td>9261</td>
<td>17.1 %</td>
</tr>
<tr>
<td>1934</td>
<td>11336</td>
<td>22.4 %</td>
</tr>
<tr>
<td>1935</td>
<td>12046</td>
<td>6.3 %</td>
</tr>
<tr>
<td>1936</td>
<td>12444</td>
<td>3.3 %</td>
</tr>
<tr>
<td>1937</td>
<td>12769</td>
<td>2.6 %</td>
</tr>
<tr>
<td>1938</td>
<td>12410</td>
<td>-2.8 %</td>
</tr>
<tr>
<td>1939</td>
<td>13072</td>
<td>5.3 %</td>
</tr>
<tr>
<td>1940</td>
<td>13994</td>
<td>7.1 %</td>
</tr>
</tbody>
</table>

Source: Statistic Denmark, Statistical Yearbook. Different years.

"Outliers” have been removed from the property price statistics and the used methods might have varied somehow over the years. It might be desirable to remove wrong registrations and mysterious transactions, for example due to unknown conditions. On the other side the idiosyncratic volatility in the data is also a part of the normal market.

For the years 1860-1920 only indirect published average sale prices can be used to construct the house price index as seen for all the years up to 2012 in Figure 1 below.

For the years 1920-1965 SPA ratios have been calculated by use of house sale prices in the numerator and of the public assessed property values in the denominator. From 1965 on, price indices already constructed by the SPAR method have been used. The periods are combined in the SPAR house price index in Figure 2 below. However it was impossible to get data from the public property assessments before 1920 through Statistic Denmark.

Since the start of last century the appraisals were made by individual and manual estimates in the local community by appraisers. From 1970 on computer generated appraisal proposals were made by a simple hedonic model for one-family houses. And from 1. January 1986, the appraisals of the houses have been

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4 Statistic Denmark: Statistical Yearbook, 1934. Table 39, p. 33.
done by a hedonic housing value model based on several attributes at the house, (Statsskattedirektoratet, 1985). Also New Zealand uses hedonic methods for their appraisals and thus for their SPAR index, (Bourassa et al., 2006, p.84).

The data contain all sold houses in Denmark. The Duchy of Schleswig-Holstein is not included for 1860-1864. The changes of the Danish border in 1864 and 1920 influenced the size of the country and then the property sale statistics. Bornholm is not included between 1860 and 1894. The Faroe Islands and Greenland are not included.

The definition of the housing type: houses and more precise one-family houses has been one of the largest challenges at the construction of the house price index. The modern one-family house did not exist before the 1930s, and until 1920 data for farm houses – small farm and cottages – instead of town houses had to be used through longer periods at the construction of the indices. Through the whole period the property types with highest similarity to the one-family house have been chosen.

The precise limitation of the used property type is mentioned for each period in Table 2:
- For 1860 to 1920 small houses and small farms – and then the smallest farms – have been chosen as no data on other houses were available.
- For 1920 to 1965 the group “residential properties”.
  o In the period 1920-1958 with 1, 2, 3 or 4 flats. This statistic did only contain the total sale values and the number of sold properties, why it has been impossible to focus on residential properties with only one dwelling.\(^5\)
  o 1958-1965 residential properties with only 1 flat, in reality one-family houses.
- From 1965 on only one-family houses are included in the index.
- The two constructed house price indices use the same property type and the same sources.

The inclusion of farm houses in the house price index construction might also be seen in light of that earlier as well as nowadays the price changes for houses and farms might have a relatively high correlation.

The larger geographic units and the less frequent publishing, the more the portfolio effect is utilized to smooth out the house price development. At the construction of the house price indices we have followed the original publishing frequency in the used data:
- For the average house sale price index:
  - For 1860-2005 annual data.
  - For 2006-2012 quarterly data.
- And for the SPAR house price index:
  - For 1920-1965 annual data.
  - For 1965-1992 semi-annual data.
  - For 1992-2012 quarterly data.
- And for the Copenhagen area:
  - For 1920-1972 annual data
  - For 1973-2005 semi-annual data.
  - For 2006-2012 quarterly data.

The recent monthly statistic from Statistic Denmark has not been utilized for the presented long run house price index as this seems unnecessary in indices over mostly annual data. On monthly house prices for 1994-2004 for New Zealand, Shi et al. found that “a SPAR index at monthly time interval is possible for large cities within New Zealand, but is difficult to apply for medium and small cities on account of insufficient sales.” (2009, p. 348). This result confirms that monthly index should not be included in the indices here.

\(^5\) The parliament did first accept owner-occupied flats as a legal tenure in 1966, why these are not included in the indices at any time.
At the construction the house price indices were calculated nominally. At the presentation real house prices have been selected, also for practical reasons as the nominal house price index with $1860 = 100$ reached the value of 63461 at the peak in the 1. quarter of 2007. Statistic Denmark’s consumer price index, found in different sources, has been used for the whole range of years to deflate the nominal house price index.

Table 2. View over type of property, sources and periods.

<table>
<thead>
<tr>
<th>Period</th>
<th>Property type</th>
<th>Explanation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860-1869</td>
<td>Small farms, 1-2 tdr. hartkorn 6</td>
<td>Sold “freehold farms” in the Kingdom (except Bornholm), measured in Rigsdaler 2</td>
<td>DST Stat. Med. 2. række, bind 10, 3. kap., s. 72-73</td>
</tr>
<tr>
<td>1870-1884</td>
<td>Farms from 1-2 tdr. hartkorn on</td>
<td>Sold “freehold farms” and “copyhold farms” 1870-84</td>
<td>DST Stat. Med. 3. række, bind 10, kap. 1, s. 6-7, 12-13, 18-19</td>
</tr>
<tr>
<td>1885-1894</td>
<td>Farms from 1-2 tdr. hartkorn on</td>
<td>Sold “freehold farms” and “copyhold farms” exclusive foreclosures and Bornholm, after classes, regions and years in the ten years 1885-1894</td>
<td>DST Stat. Med. 3. række, bind 16, kap. 1, s. 149-151</td>
</tr>
<tr>
<td>1895-1899</td>
<td>Farms from 1-2 tdr. hartkorn on</td>
<td>Sale in free trade of regular farms with at least ¼ tdr. hartkorn, distributed after size, in each county and for each of the years 1895-99.</td>
<td>DST Stat. Med. 4. række, bind 9, kap. 5, s. 53.</td>
</tr>
<tr>
<td>1895-1899</td>
<td>Houses with 1/4-1 tld. hartkorn</td>
<td>Sale in free trade of regular farms with at least ¼ tdr. hartkorn, distributed after size in the years 1895-99.</td>
<td>DST Stat. Med. 4. række, bind 9, kap. 5 s. 50</td>
</tr>
<tr>
<td>1900-1904</td>
<td>Houses with 1/4-1 tld. hartkorn</td>
<td>Sale in free trade of regular farms with at least ¼ tdr. hartkorn, distributed after size, in each county and for each of the years 1900-1904.</td>
<td>DST Stat. Med. 4. række, bind 20, kap. 1, s. 4.</td>
</tr>
<tr>
<td>1905-1909</td>
<td>Houses with 1/4-1 tld. hartkorn</td>
<td>Sale in free trade of regular farms with at least ¼ tdr. hartkorn, distributed after size, in each county and for each of the years 1905-1909.</td>
<td>DST Stat. Med. 4. række, bind 36, kap. 1, s. 7.</td>
</tr>
<tr>
<td>1910-1917</td>
<td>Houses with 1/4-1 tld. hartkorn</td>
<td>Sale in free trade of already built farms with at least ¼ tdr. hartkorn, distributed after size, in each county and for each of the years 1910-1917.</td>
<td>DST Stat. Med. 4. række, bind 58, kap. 6, s. 52.</td>
</tr>
<tr>
<td>1918-1922</td>
<td>Houses with 1/4-1 tld. hartkorn</td>
<td>Sale in free trade of already built farms with at least ¼ tdr. hartkorn.</td>
<td>DST Stat. Med. 4. række, bind 69, kap. 1, s. 65.</td>
</tr>
<tr>
<td>1920-1958</td>
<td>Properties with residential character</td>
<td>Table over number of annual sales, purchase values, and assessed property values. The purchase values in the period 1920-29 are calculated in market prices.</td>
<td>DST Stat. Ar. from 1923 on in the section Industry and later property sales.</td>
</tr>
<tr>
<td>1965-1992</td>
<td>One-family houses</td>
<td>SKAT’s ”cash price” (market price) index from 1965 on. Can be used up to today and is updated each half year.</td>
<td>Property sales from 1974 and on, published first by Statens ligningsdirektorat, later Skattedirektoratet, Told og Skat; today SKAT.</td>
</tr>
<tr>
<td>1965-2006</td>
<td>One-family houses</td>
<td>Sold in ordinary free trade</td>
<td>Statistic Denmark: Statistical Yearbook from1967 and on, Property sales.</td>
</tr>
<tr>
<td>2006- today</td>
<td>One-family houses</td>
<td>Sold in ordinary free trade</td>
<td>DST Statistikbanken.dk EJEN77 Sold properties after region/ part of the country, property category (quarterly)</td>
</tr>
</tbody>
</table>

Note: The sources mentioned are DST = Statistic Denmark followed by the Danish name of the publications.

7. The necessary correction of registered prices to market prices.
At the production of the original statistics, the prices for the sold houses were registered precisely through all the years in the constructed house price indices. However the price concept: registered house prices instead

6 Basis for soil appraisal until 1903:1 barrel "hartkorn" = the value of one barrel rye or barley or two barrels of oats.
7 At the introduction of the krone as the currency in 1875, 1 rigsdaler was converted to 2 kroner (Olsen, 1962, p. 260).
of market prices, was dubious. Unfortunately in all the years up to the 1980s, the registered prices were determined for fully financed properties, as the loans were included in the sale agreement. The buyer’s and thereby the borrower’s debt was calculated by the printed values at the claims and not by their market values. Thus the property price was calculated as the sum of the different claims’ printed values and the down payment.

This registered house price is not the ”pure” market price, which is equal to the price the house would have been sold at without any loans raised and included, i.e. if the trade was carried through by cash, and the buyer had to finance the purchase afterwards. Therefore the registered Danish house prices varied between the houses and over time – in addition to ”pure” price changes – with changes in the interest level, the loan-to-value, the raised loan type, the type of lender and other loan conditions such as term and printed interest rate.

This unique Danish feature at the buying of houses and flats was an aspect of the mortgage system’s long history but has also been difficult to perceive for non-professional buyers at the property market and has been abolished now. Today, no Dane would propose to return to this trade practice.

Therefore the development in the registered – financed – sale prices do not reflect the house price changes correctly and seems rather useless for a house price index. The registered house prices must be corrected to ”market prices”, which are not influenced by financial conditions.

Back in time the correction can only be managed by use of average statistical information as individual data for the mortgage loans in the single property or individual data for the single owner’s or borrower’s debt do not exist. In the last part of this section further information on the re-calculation from ”registered prices” to ”market prices” is given.

The tradition behind the old practice for house buying and selling originates from the Danish mortgage system, as established in 1797: houses and other properties were sold with the seller’s mortgage loans included. The buyer continued as debtor at (some of) the seller’s old mortgage loans, and/or the seller raised new mortgages, which were taken over by the buyer as debtor for to repay the mortgages over the term. Obviously there were commercial interests behind this practice. Traditionally all Danish mortgages carried fixed interest rates over the whole term. These terms were up to 60 years at the highest but has been 30 years for the last 20 years.

These fixed interest mortgage loans and the corresponding mortgage bonds are issued with a face value at par and a fixed coupon interest rate. The bonds are sold in the market at a certain price and the sale proceed is equal to the amount the borrower receives. In the Danish mortgage system the fixed interest mortgage loan contain the call option that they can be prepaid at par (price 100). Alternatively, the loan can be prepaid by bonds, bought in the market, which is profitable for the borrower, if the market interest rate for the bond has increased up above the printed rate. Therefore the true value of the borrower’s debt is equal to the market value of the bonds behind the loan, i.e. the market price of the loan. Also due to tradition and regulation, mortgage loans and bonds are issued with lower coupon interest rates than the internal rate of return for the debt services, why fixed interest mortgage loans are raised and matching bonds sold at prices below par (price 100).

Unfortunately in the sale contracts the price of the sold property was originally written as a “sum” of the down payment and the face value of the different loans (old mortgage loans transferred to the buyer, new raised mortgage loans, private mortgage loans, bank loans), even though the bonds were sold/bought to prices (market values) somehow below par (100). The difference between the printed value and the bond sale proceed was called the ”priority attachment”. This difference is equal to the difference in net present values of the future debt services as calculated with the printed interest rates and as calculated with the internal rates of return on the bonds behind the mortgage loans.
First from 1993 on, it was determined by law that all sales of flats and houses should be carried through at the “market price”, in Danish: “kontantpris” [cash price], the property could be sold at without loans.

Historically the public assessed property values should be appraised as the registered sale prices by law, where the public assessed property value should be assessed as (our translation) “the property’s value at the market at normal financial conditions”. This was changed at the ordinary assessment in 1981 and from then on the public assessed property values should be appraised in “market prices”. Still at that year the valuation was done in “registered prices” and the transformation to “market prices” was done by use of some generally fixed factors, (Statsskattedirektoratet, april 1982). These factors are equal to bond prices for the “normal” bonds behind the owners’ mortgages. After the 1981 public assessment, the tax authorities started to publish property price indices based on “market prices” in parallel with indices, based on the traditional “registered prices”, (Statsskattedirektoratet, maj 1982).

These systemic changes of the public property assessments, the property price statistics and at last the rules for professional sales of houses and flats were all set through as a change from registered prices to market prices. This was supported by some research papers in the 1970s, where each author made his own house price index in market prices, but only for shorter periods compared to the here presented long house prices indices. In 1983 SKAT re-calculated all their property price indices to market prices back to 1965, also by use of generally fixed “normal” factors similar to bond prices for the “normal” mortgage financing at the specific time, (Statsskattedirektoratet, 1983).

The re-calculated house price data are utilized in the here presented house price indices. Still in the actual house price statistics SKAT make some re-calculations by use of standard prices for raised loans, if the registration in the land registry does not contain this information.

In order to re-calculate from registered prices to market prices the size of the loans and the prices at the single loan must be known. At the transaction the single property is financed with a combination of down payment, the continued mortgages from the seller, one or more new mortgages, private mortgage loans, and/or bank loans. Each of these claims must be included by its price at the time for the purchase.

No historical data exists for the individual loans with security in the single property. Even SKAT had to use imperfect statistical data at its re-calculation of their house price indices back to 1965. Quite a similar procedure was followed here at the correction of registered house prices to market prices for the years before 1965. This has been done by a close inspection of Statistic Denmark’s and SKAT’s publications. In some of these, data were found from 1913 and up to 1984 for the financing of the one-family houses (or similar properties) at the transaction. The compositions of the different claims at the transactions have changed a lot over the years, which contain a clear justification of that the re-calculation is necessary.

At the construction of the SPAR index the used SPA ratios contain both registered house price in the numerator and in the denominator, where the public assessed property value were appraised at the registered house price level. However, the re-calculation does not influence the numerator and the denominator into the same degree, because the same appraisal values are used over some years. Besides we find the problem with “overlapping years” as mentioned below.

In one of Statistic Denmark’s early publication was – by a coincidence – found data for 1920-1929, where the sale price was calculated ”after a reduction to the average market values of the raised mortgages”, i.e. a correction to market prices. However the public assessed property values were not re-calculated to market values for these years. A similar correction to market prices was not found for other years before 1965.

After the composition of the single claims at the transaction in all the years were found, the prices for the claims have to be identified. The average prices for mortgage bonds was published for each year in a special investigation: ”Kreditmarkedsstatistikken”, (Statistic Denmark, 1969).
Further assumptions at the calculations of the market prices were that the average price for private mortgage loans was 90% and for down payment 100%.

The re-calculations to market prices for the years 1860-1912 contained some special challenges, as no data for financing of the transactions were found, especially for the loans the buyers took over from the sellers. Only average prices for mortgage bonds existed back to 1860 (see above). As a simple average of the composition of the overtaken mortgage loans for the years 1913-1922, it was assumed that 40% of the registered house price was financed with mortgage loans for all the years 1860-1912, when the market prices were calculated.

For the years 1966 to 1984 the re-calculation to market prices of the registered sale prices after the same method as for the years 1930-1965.

The correction to market prices at the construction of the house prices has been done carefully and has been rather time consuming. Nevertheless these corrections still add some not negligible insecurity to the presented house price indices.

8. The Danish average sale price index for houses
The constructed index for the development in the real average sale prices for Danish houses from 1860 and until the 4. quarter 2012 is presented in Figure 1. As the index shows the changes in the average house values at the transactions, the index is influenced by changes over the many years in both the real house prices and in the quality of the houses.

The index is influenced by the variation over time in the composition of the sold houses, for example after a high part of "expensive" houses or a high part of "cheap" houses are sold. The variation in this composition will influence the measured price changes in the short run and through the single cycle. In the long run, this variation will disappear as by necessity all houses must be owned, used and sold.

The average price for sold houses does not necessarily represent the average house in the housing stock used as the average family’s home. The average house in the housing stock and the average sold house are not necessary the same, as the quality of the sold houses might vary. Contrary might be expected that this difference varies over the cycle, while in the long run the difference will be smoothened away.

The average sale prices are not stated in the historical statistics but are calculated from this statistics out of the number of sold houses in the year and on the total transaction value for the sold houses. Overlapping years have been used at the shift from one property type to another, why the index has not been influenced by the differences in the price levels among the different property types. Besides the price index was somehow smoothened over the first 20 years, because of the interpolation in between the observations each 5th year. Also the correction from registered prices to market prices is more uncertain in the years 1860-1920 than later.
Figure 1. Real average sale price index for houses, Denmark, 1860-2012 Q4 (1920 = 100).

Sources: See Table 2.

The Sale Price Appraisal Ratio (SPAR) or more precisely: the sale price-to-public assessed property value ratio is used to construct a constant quality house price index. The advantage at the method is that it automatic controls for differences in attributes as for example the building’s size, age, number of bathrooms, garage, the plots area, the geographical location. These attributes must influence both sale prices and public assessed property values, i.e. both the ratio’s numerator and denominator. Moreover the appraisal authorities – SKAT – have an incitement to make the best appraisals, as property taxes are written upon the public assessed property values.

The method is shortly described. The so called value-weighted SPAR is used and expressed by the following equation:

\[ I_v = \left[ \frac{\sum_{j=1}^{n} S_j}{\sum_{j=1}^{n} A_{j0}} \right] / \left[ \frac{\sum_{j=1}^{n} S_{j0}}{\sum_{j=1}^{n} A_{j0}} \right] \]

which can also be written as

\[ I_v = \frac{SPAR_t}{SPAR_{Bastadr}} \]

where \( I_v \) is the value-weighted SPAR index value for the period 0 to t. \( S_j \) is the sale price for the property \( j \) and \( A_{j0} \) is the public assessed property value the property \( j \) in a certain assessment year, below the basic year. The basic year must be the same for both SPA ratios, as otherwise it would be impossible to keep constant quality.

The equation shows in the numerator the ratio: the total sale amount for the sold houses in a certain period \( t \), divided with the total amount of the public assessed property values at the time for the assessment for the same houses. In the denominator the same ratio has been calculated for the houses sold in the basic year. At dividing the two SPA ratios the price change has been measured. The value-weighted SPAR is used by
Statistic Denmark for their house price indices, (Joensen, 2006). The value-weighted SPAR method is sometimes named a Dutot-average.

Also the other method, the so called *equally-weighted SPAR*, is used and is expressed by the following equation:

\[
I_{Lt} = \left[ \frac{\sum_{j=1}^{n_j} S_{j} A_{j0}}{n_j} \right] \left[ \frac{\sum_{j=1}^{n_j} S_{j-1} A_{j0}}{n_{j-1}} \right]
\]

which can also be written as

\[
I_{Lt} = \frac{\sum_{j=1}^{n_j} SPAR_j}{\sum_{j=1}^{n_{BasicYear}} SPAR_{jBasicYear}}
\]

The variables are the same as above. At this method the sale price and the public assessed property value has to be matched for each sold house in the period. SKAT uses this method, receive the special sale reporting schemes and calculate the individual SPA ratios for each sold house in year \(j\). After the average SPA ratio for the basic year is calculated. At dividing the two SPA ratios, the price change is measured. SKAT finds the advantage at the equally-weighted SPAR is that an error in an appraisal value or in an sale price would influence the total SPA ratio into less extend than if the value-weighted SPAR method had been used. Sometimes the equally-weighted SPAR method is named a Carli-average.

At the construction of the SPAR house price index both methods have been used due to the different data sources. For 1920 to 1965 the value-weighted SPAR in data from Statistic Denmark is used. From 1965 to 1992.Q1 the equally-weighted SPAR from SKAT (the tax authorities) is used. Again from 1992.Q1 the value-weighted SPAR at data from Statistic Denmark is used.

The constructed SPAR real house price index for 1920 to 2012.Q4 is presented in Figure 2.

*Figure 2. Real house price, Denmark, by the SPAR method, 1920-2012.Q4. (1920 = 100).*

Sources: see Table 2.
It is only possible to calculate useable SPA ratios for consecutive years, if the same year is used for the public assessed property values in the ratios’ denominators. The best solution is that the years for assessments are changed with shorter intervals in between, as the quality is frequent updated and remain constant. Thus it is necessary to have “overlapping years” to collect the short indices in a long combined index. The content of an “overlapping year” is that for the same period two SPA ratios based on two different assessment years exists. Thus the numerator is the same in these two ratios, while the denominator has been calculated for two different assessment years for the same houses to render the linking possible.

At the construction of the SPAR index we met the challenge for eight so-called “overlapping years” in the period 1920 to 1965, where the ”overlapping” ratios could not be made as the historical data did not contain data for the total public assessment property values for both the actual and the former assessment year. When such an “overlap year” is missing, it becomes impossible to link the two indices and to adjust for the changes in the quality of the houses in a correct way. In practice the SPAR house price index must follow the changes in the average sale price in the eight “overlapping years” and misses the quality correction for these years. The problem reduces the quality of the SPAR index but does not destroy its advantages for the remaining years.

10. An estimate of the quality improvement of the owner-occupied houses: the difference between the average sale price and the SPAR indices.
A comparison over the 92 years from 1920 to 2012 of the two house price indices, constructed by use of different methods but containing exactly the same house transaction, open for an unique opportunity to give the SPAR price index theoretical advantage an empirical content. None of the other mentioned long house price indices contain a similar opportunity.

As the simple index for the average sale prices must be expected to be influenced by increasing size of the houses and by other qualitative housing improvements over the years and therefore increase more than the SPAR house price index. From 1920 and up to the peak in 2007,Q2 did the real SPAR house price index increase 210.1 % for the whole period or 1.31 % p.a., while the real average sale price index for houses did have a peak an year later in 2008,Q2 and had then increased 362.1 % in total since 1920 or 1.76 % p.a. – Thus the average annual difference between the increase in the two real house price indices was 0.45 %.

If instead the growth in the real house price is measured from 1920 and until 2012,Q4, the average sale price index for houses had increased 297.7 % in total or 1.51 % p.a., while the SPAR house price index had increased 120.2 % in total or 0.86 % p.a. – Thus the average annual difference between the increase in the two real house price indices was 0.65 %.

An additional real house price increase in the range between ½ and ¾ % annually can be seen as an quality improvement per year – in the size of the houses and in their quality per m² – of the stock of owner-occupied one-family houses since 1920. Normally, the economic growth rate is higher. For example from 1966 to 2011 the average increases in GDP (2005 prices) was 1.78 %.

These results represent minimum-estimates of the quality improvements. First in the eight “overlapping years” the SPAR index follows the increase in the index for sale prices. Second, possibly, some qualitative improvements might influence the house prices but not the public assessed property values, why an qualitative determined increase in the SPA ratios will be the result and seen as an increase in the real SPAR house price index, even though this is a constant quality price index in principle. For example indoor and more subtle improvements that do not require a building permit and factors not included among the attributes at the appraisal would influence the sale price but not the public assessed property value, (Bourassa et al., 2006, p. 85).
Over shorter periods the real average sale price index will for the most but not always increase more than the SPAR index, which happened at the economic growth periods in the 1960s and 1970s. Peaks and troughs in the two indices do not necessarily appear at the same quarter or year and even though the correlation between the two indices might be rather high, the changes over the cycle can be somehow different. For example has the real SPAR house price index fallen most from its peak in 2007 Q2 and down to 2012 Q4 with 29.0 % against the fall at 16.2 % in the real average sale price index since the peak in this index in 2008 Q2. Over a housing cycle changes in the composition of the sold houses after location, size and price level might add the average sale price a higher volatility than the SPAR-index.

*Figure 3. Real average sale price index for houses, 1860-2012 Q4, and the real house price by the SPAR method, 1920-2012 Q4. Denmark (1920 = 100).*

Sources: see Table 2.

11. The Danish house price index 1860-2012.
   The final house price index for Denmark from 1860 to 2012 is presented in Figure 4. The index has been chained by the real average sale price index for houses for the years 1860-1920 and the real SPAR house price index from 1920 and up to 2012 Q4. Methodologically, still the index has not been corrected for the quantitative and qualitative improvements of houses over the first 60 years, while the last 92 years present a constant quality index due to the SPAR method. Still also the correction from registered to market prices is somewhat rough.

Nevertheless it has to be underlined that the constructed house price indices rely on original published and official data for the whole Danish nation – and not less interesting – on accurate sale prices for the houses, because the buyers and the lenders had obvious interests in a correct registration in the land registry. The statistical property price data for Denmark contain some of the best, if not the best, data on property prices in the world.
The real house prices course from 1860 to 2012 was inevitably connected with the economic development in Denmark over the 152 years and the many economic-policy changes. On the other side, the house price track can into some extend be seen as a result of this development and changes. Besides the house price changes form an indicator for future economic changes and might partly contribute to new economic progress as well as to recessions, especially through the investment channel. Moreover the real house price index from 1860 to 2012 is a good proxy for the development in real property prices for other types of properties. Similar long price indices for other Danish property types have not been constructed. However, it might be expected that the correlation between the real price indices for the different Danish property types is high over the many decades.

The real house price indices for Denmark over the 152 years release a unique contribution to future analysis of house price changes as well as to house price predictions. Moreover, it might be natural to compare this house price index with the already published long house price indices, as done in the next two sections. Also, Peter Englund observed some of the same features in the Swedish house price development, (2011).

There are none horizontal lines in the Danish real house price curves and thereby no periods at more than a couple of years, where the real house prices have been stable, why no examples on ”soft landings” are met over the 152 years. It is tempting to conclude that ”soft landings” are very rare at a housing market in a market economy.

As Figure 4 clearly indicates, Denmark has “always” had remarkable cycles in the real house prices. These cycles have varied both in length and in depth. The cyclical course express that the house prices are auto correlated: the house prices continue to increase, when they increased in the period(s) ahead, and they continue to fall, when they did fall in the period(s) ahead. Therefore the most possible outcome at predicting the future change in the house prices is that the direction and the strength in the recent real house prices changes will continue in the next period.

However, no real house price trend, increasing or falling, can be permanent. This is ample proofed by the course of the real house prices in Figure 4. Sooner or later, the increasing or falling real house prices will turn around at a peak respective a trough and be drawn back against a long-run equilibrium price level. There are peaks and troughs through all the 152 years in the Danish house price index.
At an immediate introspection the Danish real house price index follows an upward rising trend. For the years 1860-1920 a part of the increase are caused by that the index for real average sale prices for houses is used, why both some quantitative and qualitative improvements by mistake are included as price increases. However, also the SPAR index contains a rising trend from 1920 and up to the peak in 2007, and even to the end of 2012. It also has to be watched that the actual house prices does not seem to have approached a trough yet. An appearance of a permanent real house price increase trend is further treated in section 18.

The real house price index in Figure 4 covers the whole nation. The regional developments in house prices might diverge somehow from the national course but for the most the correlation between a region’s and the national house price development might be expected to be high; also the regions house price development might be highly correlated internally. Similarly inside the regions, the different municipalities and local areas might be expected to have somehow individual courses but might be highly correlated over longer periods.

Lack of data, some changes in the administrative structure in Denmark, and changes in the content and in the publishing form for the property statistics have resulted in that it only been possible to construct a real house price index for the capital, the Copenhagen area, (see Section 19).

12. The house price indices for the U.S. (1890-2012) and for Denmark (1860-2012) compared.

Shiller’s work on a long house price index has been an inspiration for the construction of this index and it is obvious to compare the two indices as in Figure 5.

Figure 5. The real house price index for Denmark, 1860-2012.Q4, compared to the Shiller real house price index for the U.S., 1890-2012.Q3. (1920 = 100).

The similarities among the house price development since 1890 in the two indices alternate with decisive differences. There are only few common peaks in the real house price indices. The highest degree of similarity is found around the “rocket”, which starts at 1993 for Denmark and 1997 for USA, and have few quarters in between the two peaks in 2006.Q1 (for the U.S.) and 2007.Q2 (for Denmark). It is fascinating to watch the strong similarities for these few years as depicted in Figure 6 below. The rise and fall have been of similar strength. Before, Denmark had been through two downturns from 1979 to 1982 and from 1986 to 1993 where real house prices did fall 1/3. In between Danish real house prices recovered. For the years up to the “rocket”, a somehow similar camel’s back can be seen in the real US house priced but with smaller humps.
A significant difference is seen up to and after World War II. From 1942 and up to the middle of the 1950s the house prices did increase more strongly in the U.S. and according to Shiller among other factors also influenced by The Servicemen’s Readjustment Act of 1944. 10 years later a similar strong upturn appeared in Denmark.

Overall the Danish real house prices are more volatile than for the U.S. Contrary, Shiller’s index has a relative weakness with few data in longer periods and for 1934-53 asking prices in an annual number of around 30 were used. Especially in this period, from 1930 to 1941, did the real house prices fall 47.1 %, while they increased 43.2 % from 1941 to 48 and decreased 29.5 % from 1948 to 1956. Obviously, Shiller finds his index “is imperfect, and I hope to improve it someday,” (2005, p.12). In all cases, a house price index for the whole continent, USA, might be less volatile than a house price index for a sovereign state which only form a minor part of the continent Europe.

13. The house price indices for Norway (1819-2012) and for Denmark (1860-2012) compared.
It is obvious to compare the Danish house price index with the similar index for Norway, not least because of the common constitution until 1814. The Norwegian house price index starts in 1819 and covers the four largest towns. Therefore, the house price index for the capital region – the Copenhagen area – is also included in Figure 7 below. – Please remark 1998 has been chosen as basic year, while 1920 is used in most of the paper.

Possibly surprising is the many similarities between the development in the real house prices for Norway and Denmark. These are more pronounced at the national Danish level than if the Copenhagen area is compared with Norway’s four largest towns. The similarity might surprise as even though the two countries have strong similarities as size, closely related language, democratic tradition, educational level, etc., they have different currencies, occupational structure and economic policy as well as different housing markets and housing policy.

As seen the real house price development has followed quite similar tracks, for example over the first many years of the indices. Norway was slightly more exposed through the two world wars. The “Great Depression” in the 1930s hit Denmark worse, while Denmark was better off through the 1960s. The
differences have been leveled out over the years. At least until 2009, where the house price decrease in Norway stopped and turned around for to start a new strong upward rise. Today the Norwegian news is filled up with housing news, also a housing bubble indicator.

Figure 7. The real house price indices for Norway (1819-2012) and Denmark (1860-2012). (1998 = 100).

Source: Norges banks homepage and Statistics Denmark, see above.

14. Upturns and downturns also form the Danish housing cycles
The house price index form obvious cycles with upturns and downturns of different size and length and the cycles since 1920 are identified in Table 3. Definitely, the house price cycles are not regular and have not included any longer periods with stable nominal or stable real house prices.

The identified upturns have lasted from 2 and up to 18 year and the downturns between 2 and 11 years. The strongest upturn was met from 1993 to 2007, where the real house priced did increase 167.8 %, and the strongest downturn appeared under the ”Great Depression” from 1930 to 1941, where the real house prices did fall 47.1 %.

In this paper the development in the real house prices are described and analysed. However, a digression has to be made here. Only the nominal house price changes are of larger importance, if they fall, as the owner-occupiers debt is nominal, and as owners with even a moderate loan-to-value can fall into negative equity, if nominal house prices fall a lot.

Through the index period the first serious nominal house price fall appear in the 1920s, where the nominal house prices in average did fall 37.8 % from 1920 and until 1932, where after the fall in nominal house prices was smoothing somehow. After a long and rather inflationary period through the 1960s and 1970s with still increasing nominal house prices, the first nominal house price fall appeared from 1979, 2. half-year to 1982, 2. half-year, where an important deflationary economic policy was set through. Through the next housing downturn from 1986, 1 half-year to 1993,Q2 the nominal house prices did fall again. Recently, from 2007,Q3 to 2009,Q1 the nominal house prices did fall 17.3 %. After, they have followed some irregular changes around a slightly falling trend until 2012,Q4.
The changes in real house prices constitute house price or housing market cycles. These cycles have a strong influence not only at the residential building activity but also at the macro economic performance. To make a narrative for all the housing cycles seems would take us too far. Instead three important periods are chosen:
- the ”Great Depression” in the 1930s
- Sustained economic growth 1956-1973
- The ”Rocket” or housing bubble period from 1993 and across the 2007 peak.

15. The Danish house prices through the ”Great Depression” in the 1930s.
As the actual housing, financial and economic crisis keep ongoing, it is of obvious interest to study the depth in the “Great Depression” in the 1930s as also Denmark was hardly hidden. Danish owner-occupiers and farmers were seriously affected by the fall in real house prices at 47.1 %. The nominal house prices did only fall 14.6 %, but besides there was a significant inflation at 61.4 % from 1930 to 1941, which contributed much to the strong fall in real house prices. Many foreclosures were set through in the 1930s, especially among farmers, but for these years no statistics on foreclosures exist.

1932 was the worst year with the strongest fall in real house prices with 17.8 %. Possibly, the strongest annual house price falls in the Danish history and at least over the 152 years in the presented index. As the inflation was as low as 0.5 % in that year, the nominal house price fall was of similar strength. In the Copenhagen area the fall in real house prices was even stronger, with 28.4 % in 1932 and 55.8 % from 1930 to 1941.

Unfortunately the house price index values for 1932 contain a higher uncertainty than otherwise. At first 1932 is one of the eight “overlapping years”, where the change in the index for the average sale prices is copied directly to the SPAR index, why the advantage of this method at correcting for differences in size and quality has not been captured.

At the second, for 1932 it became compulsory to report all property sales to public registration. As only half of the transactions have been reported beforehand the number of transactions increased 86 % from 1931 to 1932, see Table 1. According to the data the value of the transactions did only increase with 54 % and the public assessed property values for all the sold properties did only increase with 56 % from 1931 to 1932.
But as the registered price fall from 1931 to 1932 was 17.5 %, in total the market values of the sold houses increased 53 %. The coincidence of these macro numbers indicates that the prices of the registered sold houses have not changed in average, when the public registrations were made mandatory.

In the central bank’s "Dansk Pengehistorie" [The Danish monetary history] the then leading governor of the Danish central bank Erik Hoffmeyer concluded: "1932 was the worst year of the crisis." (Olsen & Hoffmeyer, 1968, p. 169). The import did fall 36 % from 1929 to 1932 and the export 33 % (1929 prices). GDP (1935 prices) dropped 5.7 % in 1932 and again heavily with 9 % in both 1940 and 1941. The rate of unemployment got up to 32 % in 1932. Also Denmark decided very wide-ranging economic policy interventions in these years. At that background the estimated fall in the Danish real house prices for 1932 and for 1930s as a whole seem realistic and correct.

The U.S. experiences through the “Great Depression” were very serious and the many bank failures did end in a totally restructuring of the financial system in U.S. Without doubt the prices at the property markets, farms, houses, residential rental properties, were hurt seriously and property defaults and foreclosures were rather common. But how strong was the house price fall?

The most obvious source is Shiller’s home price index. Here real house prices did fall 33 % from 1912 to 1932, and in these years the index followed an earlier work by Grebler. Later Shiller wrote: "the last major housing crisis in the United States took place in 1925-33. Home prices fell a total of 30 % over this interval.” , (2008, p. 12). Through the rest of the 1930s Shiller’s index is nearly stable, possibly due to a lack of statistical quality as only few asking prices for 5 cities were used for the index from 1934 to 1952.

Estimates from other sources are: Green and Watcher: “But during the Great Depression in the early 1930s, property values in the United States declined by 50 percent relative to peak values”, (2005, p. 94). And similar Calverley found that through the Depression in the 1930s in the U.S.: “Property prices are less well documented for this period, but they declined sharply too. Home prices fell an estimated 30 percent during the period and commercial property prices fell as well.” (Calverley, 2009, p. 40)

Also in the U.S., housing prices might have fallen more in the capital area than for the country as a whole. In constructed real estate price indices for Manhattan between 1920 and 1939, real prices peaked in 1929:Q3 for then to be more than halved onto the end of 1932. This study also shows that the real estate downturn coincided with the stock market crash but that the real estate crash lasted much longer. (Nicholas & Scherbina, 2013).

The few other long run house price indices in other nations have followed a somehow other course than for Denmark and the U.S., who both in the 1930s had dominating agricultural productions. First in 1933 did the real houses prices peak in Norway for to start a slow fall until 1939 at 4 % in all but with varying speed. The war years affected the Norwegian economy badly and also the real house prices, which were lowered 34 % from 1939 to 1944. (Eithrheim og Erlandsen, 2004). The Australian house price index tells, however, a different story. In Australia, the real prices actually rose: 15 % for Sydney (1932-1939), 4 % for Melbourne (1931-1939), and 5 % for all capitals (1931-1939)

16. Did the economic growth in the 1960s and the transformation of the nation to a welfare state have a permanent influence on the housing prices?
According to the index, real house prices did fall from 1931 and until 1956 with no less than 46 %. In the years between, from the war year 1942 and until 1948 did the real house prices increase temporarily with 1/3 for then to fall again.

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8 As late as in 2009 Denmark experienced a similar strong fall in GDP with 5.7 % (2005 prices).
As late as in 1956 did the real house prices reach a final trough. Just to begin at a 17 years long increase at 135.8 % until the second half year of 1973, where the first oil crisis appeared. This rise has been the longest and the second strongest upturn through the price index period. At the beginning, the upturn had to catch up with the house price fall since 1931. It lasted until 1966 before real house prices reached the 1931-level again. Moreover the period contains the strongest upturn in nominal house prices in a rather inflationary environment.

The last years of the 1950s mark the most important turning point in Danish Economy since World War II. The economic growth rate started to increase after 1956. A purpose for the economic policy was to stimulate investments through better credit facilities and improved depreciation rules in the taxation rules for firms. Besides, important structural reforms were introduced. In 1958 the primary school system was improved. Later it was made possible to increase the participation rate in high schools and universities.

Beside this “educational revolution”, an intense transformation of the Danish society was going on through the 1960s. The industrial structure was changed as the farms were mechanized and the surplus labors moved from the rural districts to the towns, where they were employed in the new industries. Also the women became better educated, and married women began to work, partly rendered possibly by modern facilities in the homes and public kindergartens. The Danish public sector started to grow fast and thus more and more public activities were started.

Access to mortgage and other types of credit was improved at the same time. The access to new state loans was terminated in 1958. The year after some new private third priority mortgage banks were established, to issue mortgage loans at higher loan-to-value strata than before and especially to finance new built houses and other properties. From the end of the 1950s the commercial and mortgage banks’ lending increased significantly to comply with the increasing demand for loans. Clearly the large residential property building activity and the increasing house- and property prices stimulated the demand for mortgages and bank loans.

From the relatively low interest rates at the end of the 1950s, the interest rate level was nearly doubled through the 1960s and this increase continued in the 1970s until the peak for long interest rates at 22.2 % in August-September 1982. Somehow in parallel inflation increased and became a normal feature. Still increasing public activities were financed through higher taxation, where VAT was introduced and income tax rates raised. The borrowers could deduct the nominal interest expenditures in the taxable income. As result borrowers experienced they had to pay very low and in long periods even negative real interest rates after tax. Of course this stimulated the growth in the house and property prices and the building activity in the 1960s and 1970s. Therefore the government and central bank introduced a set of borrowing and lending restrictions; in general this regulation was abolished in the 1980s and first years of 1990s.

All in all, from 1956/57 on Denmark experienced a period with sustained growth until the oil crisis in 1973. The structural reorganization of the society could be arguments for a permanent higher housing demand, and possibly this could contribute to a more permanent upward shift in the real house prices. However land prices might have increased a lot through the 1960s but other building costs should not have been much influenced by the mentioned trends. In fact the construction of houses and other residential properties increased to a very high level through the 1960s and especially in the 1970s. And the real house price index started at a more fluctuating route after 1973.

17. The ”Rocket” – on its way to landing.

The most dramatic path in the Danish house price index’ story started in the price trough in 2. quarter of 1993 and passed on to the peak in 2. quarter of 2007, in order to start an ongoing decrease. Through the upturn, real house prices increased 168 % and they have taken 29 % downwards without having reached a

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9 Land prices are not included in the paper as land price indices are scarce and of disputable quality.
new trough yet. In public this event has been nicknamed the “housing bubble” independent of the development could be explained somehow by economic fundamentals and only partial by behavioral factors.

In “Irrational Exuberance” Shiller noticed “the striking recent behavior of home prices since the late 1990s. The home price market has taken off sharply. There has been a “rocket taking off”, (2005, p. 12). At that time Shiller’s index was only updated until 2004.

At the start of 2006 OECD published a study of the recent house price developments and reached the highlights that “A number of elements in the current situation are unprecedented: the size and duration of the current real house price increases; the degree to which they have tended to move together across countries; and the extent to which they have disconnected from the business cycle.” And “If house prices were to adjust downward,... the historical record suggest that the drops (in real terms) might be large and that the process could be protracted, given the observed stickiness of nominal house prices and the current rate of inflation. This would have implications for activity and monetary policy.” (Girouard et al., 2006).

In 2007 the house prices reached a peak in the most OECD countries and started to fall, (Lunde, 2009). At that time the house prices in most OECD countries did move in parallel. According to the OECD house price statistics, the largest real house price decreases until 3. or 4. quarter of 2012 have been experienced by Ireland (48.1 %), Spain (34.2 %), Denmark (28.3 %), USA (25.8 %), the Netherlands (21.4 %) and UK (17.2 %). Shiller’s “rocket” is more or less down again.

The house price indices for the OECD countries express that the majority has experienced a housing bubble – or a ”rocket taking off” – in the house prices from middle of the 1990s and until 2007 or in adjoining quarters. In the very long house price indices for the U.S., Norway, France, Australia and now Denmark this is the only period with such an unprecedented strong and long upturn followed by a strong downturn. The Herengracht index with its 300 years long history does not include a bubble of similar size.

Also Norway experienced a long upturn in the real house prices up to a peak in 2007 and a decrease down to 2009. Then the house price development turned around and continued at an upward rising until now. Not surprising it is discussed in Norway if real house price increases can continue.

The housing bubble – or in general the property bubble – has had a large influence in many market economies and has contributed to the financial crises and the recessions in several of these countries. Thereby the published long run house price indices are important in the interpretation of the economic history in the countries.

The popular notion has been and still seems to be that house prices increase more than consumer prices in the long run. Also many economic analyses contain this presumption. The construction of a long house price index for Denmark render it possible empirically to verify if the Danish house prices have increased more than consumer prices over the 152 years. However it is necessary to have in mind that if the used index method does not lead to a “pure” house price index – as for example the average sale price index used from 1860 to 1920 – a part of the measured real house price increase will represent qualitative improvement of the housing consumption.

In economic theory the appearance of cycles, also at the housing markets, are well studied. Housing market cycles exist as a more or less permanent feature as also this paper shows. Therefore housing price volatility is observed. Also empirically the housing cycles are rather long, for the years after 1970 in the OECD countries, in average, around 10 years (André, 2010) and with some autocorrelation in house prices. Contrary, the idea that housing prices permanently should increase more than the consumer prices, i.e. that there should be a long run upward trend in the real house prices, is in conflict with economic logic.
The economic arguments against that house prices increases more than the consumer prices in the long run are straightforward. If this was the case, housing expenditures would throw the expenditures of the other goods and services out of the "basket of goods" (i.e. the cuckoo in the nest effect) in the household budget, and/or the housing consumption would quantitatively be lower and the families housing conditions worsened. The opposite has happened: the families live in still larger and qualitatively better dwellings as result of the real income growth. Therefore, the house prices cannot in the long run increase as much as the incomes as in that case the housing consumption would not be quantitatively and qualitatively improved.

Changes in economic, taxation, monetary and housing policy might influence house prices. Recently in Denmark for example changes in the tax treatment of owner-occupied housing (1999 and 2001), access to raise adjustable rate mortgages (1996) and interest-only mortgages (2003) have influenced the house prices into some degree. But created upward changes in housing prices will run out shortly, in practice over few years, and will in the long run be offset by higher residential building investments. Thus it is not credible that economic policy changes can lead to that house prices increases more than consumer prices in the long run.

The argument is often met that there are no empty land for building and that effect will create an excess increase in housing prices. In central city business districts this argument seems not valid as the scarce land has been capitalized in high property prices already as these prices may be well up above re-building costs. In nearly all countries free land exist, also from redevelopment of brownfields.

The Herengracht index contains large oscillations in the house prices but it is well known that the index does not show any increasing trend over the index’ 346 years as the oscillations appear around a “long run equilibrium”, (Eichholtz, 1997). The Norwegian index (see Figure 7) contains a gradual increase from the start in 1819 and up to 1900, and a strong real house price increase appears from the start of the 1980s. Possibly part of the increase can be attributed to the index only contains the four largest towns (and less in the first many years) and to the repeat sale index method, which can contain some quality improvements, (Eithreim et al., 2004). The real house price index for Paris (and later also France) shows relatively small changes from 1840 and up to the 1960s, and then starts at a steep rise until the peak in 2007, (Friggit, 2002; OECD house price data).

Shiller did not see a strong uptrend in real house prices in the long run. He found “so little evidence of an increase in real home prices in the United States over so long a period.” And “Actually, the theoretical argument that home prices can be expected to appreciate faster than consumer prices in general is not strong”. (Shiller, 2005, pp. 22-23). After 2006 house prices have been falling in the U.S., until recently.

For the here presented real house price indices it is not obvious how to identify a “long run equilibrium price” level and then to argue for a meaningful "mean reverting house price”-process.

At drawing a trend line from 1860 to 2012.Q4, the average annual increase was 1.17 %. As average sale prices were used to construct the index from 1860 to 1920, the index covers some quality improvements, which can’t be seen as house price changes. Drawing another trend line from 1920 to 2012.Q4 the average annual increase was 0.86 % and therefore somehow lowers.

Even in the SPAR index from1920 on, a minor part of the increase in the real house prices are due to insufficient correction for quality improvements. The mentioned eight overlapping years give an unknown extra increase. Also we cannot disregard that some quality improvements can be hidden in the used house price-to-public assessed property value ratios.

Seen from the demand side, the long real house price increase from the end of the 1950s and up to 1973 was caused by the married women’s participation at the labor market and by the change from farming to an industrialized country. This permanent economic progress could argue the “long run equilibrium price” level
had been elevated. Also the fast inclusion of adjustable mortgages and interest-only mortgages after 2000 resp. after 2003 can be seen as another permanent addition to the “long run equilibrium price” level.\footnote{These arguments include only the cash flow effects. The new low payment types of mortgages are raised at market conditions and in a period with easy access to credit. The cash flows differ from traditional fixed interest rate mortgages, but they contain other and possibly higher risks, where the negative outcomes have not been met yet. Moreover all mortgages have to be repaid with income or sold assets.}

Seen from the supply side, houses are produced goods, why an increasing demand may result in higher building activity, which will outbalance most of the increase in the house prices.

However, a glance at Figure 4 expose that \textit{if} there is no upward increasing trend in the real house prices, the distance to any realistic “long run equilibrium price” level seems hard to overcome for some ”mean reverting house price”-process. Still the Danish real house price level lay above the earlier decade’s level.

Also rents seem to be stable in real terms over the long run. A result of construction a long run constant-quality housing rent index over 300 years for Amsterdam was that while rents fluctuated somehow over time, ”average Amsterdam house rents, in real terms, had approximately the same level in 1850 as they exhibited in 1550”. (Eichholtz et al., 2012, p. 269).

\section*{19. Regional differences in the real house price path: the Copenhagen region and Denmark.}

The house price statistics document that house price changes in the single region, municipality, town and local area might be of different strength over the short run. Thus it might be expected that the house prices in the Danish capital region – the Copenhagen area – might move with different speed and otherwise not follow the national house prices. The “normal” house price structure in a country would imply that the house prices in the capital are higher than for the country as a whole. The research question here might be to detect, if the price structure is widening or narrowing over time.

Fortunately, it has been possible to construct a house price index for the Copenhagen area with 1920 as the first year. We have no earlier house price data for the region.

Moreover, the Copenhagen area has changed a lot due to the capital’s expansion: new suburbs, urban renewal, and improved traffic solutions and, besides, a lot of administrative changes. Both the average house sale price index and the SPAR house price index are constructed but only the last one is presented here.

The sources for the data are the same as mentioned above, see Table 2. In the data for the first period of years the Copenhagen region or area include the municipalities \textit{København and Frederiksberg} and \textit{Gentofte}, but through the period the Copenhagen area is extended with still more suburbs. From 1965 to 2006 \textit{1. half-year SKAT’s index for the larger area “Københavns amtskylkedredse”} were included, and from 1973 half-year data are used. For the last period, 2006.Q1 and up to now, Statistic Denmark’s house price index rely on the new and larger \textit{Copenhagen region}.

Below the constructed real house price index for the Copenhagen area and for Denmark as a whole are compared. First in Figure 8 the basic year is the same as elsewhere in the paper and 1920 = 100. In Figure 9 the basic year is 1998 instead. Of course, the house price indices are exactly the same but at the virtual inspection; the reader might possibly see different “stories” behind. In Figure 8, the house prices in the capital region look as if they have been through a “catch up” to the national trends. In Figure 9, the house prices are falling from a high level after World War I just for to follow the national house price changes through the decades until the end of the 1990s, where the upturn in house prices were much more pronounced in the Copenhagen area than at the national level.
Thus the choice of basic year might have theoretical and practical implications.

Figure 8.
Real house price indices for Denmark 1860-2012 and for the Copenhagen area 1920-2012. (1920 = 100).

Sources: Statistic Denmark and SKAT.

Figure 9.

Sources: Statistic Denmark and SKAT.

Following the index in Figure 9 there are two periods, where the house price changes in the Copenhagen area differ a lot from the rest of the country: first from 1920 on and until World War II and second through the "housing bubble" or "rocket" period.

Around year 1900 a building boom started up in Copenhagen due to – at that time – low interest rates and general economic growth. Some local commercial banks in Copenhagen had financed speculative building investors, who came into serious difficulties as the flats were difficult to rent out. In 1908 a couple of the banks had large losses and a “bank run” appeared. (Olsen, 1969, pp. 264-265). However, Copenhagen and
Frederiksberg has experienced a strong population growth through the preceding century, (Boligministeriet, 1990, p. 36). And the building activity continued to be relatively high in the capital region in the following decades. Therefore, possibly, the price level for residential properties in Copenhagen might have been high in the beginning of the 1900 century and the fall in property prices might have taken some years as property prices are sticky downwards.

However the real house price index expose such a strong price fall in real house prices from the start of the 1920s and through the “Great Depression” – as seen in Figure 9 – as it might not be explained by statistical mistakes. According to the index, real house prices in the Copenhagen area did fall 57 % from 1922 to 1941. From 1920 and until 1958 the house price index contains data for “properties with residential character”, and especially in Copenhagen these properties might have included small rental residential properties. Thus the establishing of a hard rent regulation in 1939, capitalized as lower rental residential property prices, might have had some – unknown – negative influence on the house price index for Copenhagen at that time. Both the national real house price index and the index for Copenhagen was falling much around that time and the special influence from the rent regulation for properties with more than one flat is impossible to track in the index.

The other remarkable difference is found around the housing bubble. In the Copenhagen area the housing cycle oscillation was much stronger as the real house price increased by 252.7 % from 1993 1 half-year up to the third quarter of 2006, and at the national level “only” 167.8 % through that upturn. After the peak in 2006-07 real house prices have fallen 36.4 % in the Copenhagen area and 29.0 % for the whole nation.

Especially these two more pronounced housing market cycles confirm that the volatility in the house prices is larger for the Copenhagen area than for Denmark as a whole. However, through the half century in between World War II and the beginning of the 1990s, the two indices moved closely along the same path.

Even though the price oscillations are higher in the house price index for the Copenhagen area than for the Danish nation, the indices are moving somehow in parallel. All peaks in the two indices appear in the same year, except the peaks for the recent strong house price cycle, where the peak appears in 2006.Q3 for the Copenhagen area or three quarters earlier than for the whole country. Also the troughs were in nearly the same years.

However, the most important result of the comparison is that the house prices in the Copenhagen area in the long run – over the 93 years – have not increased more or less than the house prices for Denmark in total. Neither a house price widening nor a house price narrowing has been an outcome over the many years.

20. Conclusion: Possibly, the qualitatively best long national house price index.

The long house price index for Denmark from 1860 to 2012 was constructed by official and already published statistical data. The validity of the index is high. Since 1932 all property transactions have been included in the property sale statistics at the registration of the sale in the Danish official land registry book, and no one has had any interest in wrong registrations. The quality of the constructed house price index is rather high and it forms a constant quality index due to the SPAR-method used since 1920.

However nor this house price index is perfect, and especially the necessary use of different type of houses trough the index period, the reformulation of the registered sale prices to market prices, and the eight “overlapping” years add some uncertainty to the constructed index. Other researchers could have made other choices but would be faced by the same problems.

The resulting Danish house price index is of highly interest. The development in the Danish (real) house prices has formed remarkably long cycles with several peaks and troughs over the 152 years and no longer stable price periods, forming “soft landings”. The recent “rocket” cycle up to 2007 was an unprecedented
long and strong upturn and might still be ongoing as no clear trough has been observed at the end of 2012. The longest and second strongest upturn in real house prices and the strongest upturn in real house prices were observed for the growth and inflationary years from 1956 and up to 1973. Until now, the strongest real house price fall has appeared from 1930 and until 1941 as a part of the “Great Depression”.

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