Chapter 9 – House price indices for Norway 1819–2003

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In this chapter we present annual house price indices for four Norwegian cities over the period from 1819 to 2003. Existing Norwegian house price indices start in the mid-1980s, and hence we present new information about Norwegian house prices for more than 160 years. Raw data are compiled from the real property registers, and the house price indices are constructed by the use of the weighted repeat sales method. The cities in our sample are four of the five largest in Norway - Oslo, Bergen, Trondheim and Kristiansand. We construct house price indices for each city in addition to an aggregate index. The new house price indices are spliced with existing house price indices from 1986.

1. Introduction

Existing price indices for houses in Norway typically cover only a short time span of a few decades or so. Statistics Norway has published house price indices for new single-family houses since 1989 and for existing homes since 1991. Furthermore, the Norwegian Association of Real Estate Agents (NEF) has compiled and published regional and nationwide house price indices back to 1985.[2] Besides this, some Norwegian house price indices which cover either a limited time period or a particular region, or both, are available. An example of such an index is provided in Hanisch and Ryggvik (1993). They constructed a house price index for apartment blocks in Oslo for the period 1890-1899. Another example is the price index for an area of Oslo for the period 1956-1976 which is published in NOU (1981). Also in an international perspective long runs of house price indices are rare. Generally, house price indices are constructed only for the last decades, and few house price indices are available for the period before World War II. However, some exceptions are noted. One is Eichholtz (1997), who constructed a biennial house price index for an area of Amsterdam for the period 1628-1973. Another is Friggit (2001), who constructed an annual house price index for Paris for the period 1840-1999.

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[2]From 2002 onward NEF collaborates with Eiendomsmeglerforetakenes Forening (EFF), ECON and FINN.no in producing the house price indices.

In this chapter we present annual house price indices for Norway from 1819 and up to today. More specifically, we construct a historical house price index for the inner cities of each of the four cities in our sample - Oslo, Bergen Trondheim and Kristiansand - in addition to an aggregate index. The five indices start in different years in the 19th century, and they are spliced with NEF's house price indices from 1986. For the period up to 1986 the house price indices are based on nominal transaction prices of real property, compiled from the real property registers. The city house price indices are constructed by the use of the weighted repeat sales method, while a hybrid method is applied to construct the aggregate index.

The remainder of this chapter is organized as follows. In Section 2 we provide a brief description of the four cities in our sample. Data are described in Section 3, while the empirical approach used for constructing the indices is outlined in Section 4. The house price indices are presented in Section 5, and Section 6 concludes. Appendix A tabulates the nominal house price indices.

2. Background

The cities in our sample comprise four of the five largest in Norway, and the cities inhabit currently more than one fifth of the country's population, cf. Table 1 which shows the population development in Norway and each of the four cities since 1815. In the following we give a brief description of some main characteristics of the housing developments in the four cities. At the end of this section a historical overview of Norwegian housing market regulations is provided.

Table 1: Population*(in thousands), 1815-2000

	Norway	Oslo	Bergen	Trondheim	Kristiansand
1815	885	11	16	10	7
1845	1 328	26	22	15	8
1890	2 001	151	54	25	13
1930	2 814	253	98	54	19
1960	3 591	476	116	59	28
2000	4 503	507	229	149	72

*Note that the city boundaries have been enlarged several times over this period.
Sources: Statistics Norway, Bratberg and Arntzen (1996), Tvedt (2000) Hagen Hartvedt (1994), www.kristiansand.kommune.no.

2.1. Oslo[3]

Oslo is the capital of Norway, located south-east in the country. The city is by far Norway's largest, with more than 10 percent of the country's inhabitants currently living in it. Although the city was founded a millennium ago, the modern Oslo originates from 1624, as a fire had destroyed the old

[3]This section is in large based on Tvedt (2000).

city.[4] The new city was built in brick. Both the construction of buildings and the population evolved slowly over the first centuries. It was not until the second half of the 19th century that both the population and the activity in the construction sector increased sharply. The construction sector was in particular booming in the 1880s and 1890s, when a large part of Oslo's current inner city residential buildings were built. Typically, the buildings were four-, and five-story brick apartment blocks, built for rental.[5] The city boundary has been enlarged several times over the last centuries. With the enlargements in 1859 and 1878 many wooden residential buildings were included in the city's housing stock. The biggest enlargement took place in 1948, when the Aker region was incorporated. After World War II and up to the 1980s construction of residential buildings in Oslo took mainly place in the new suburbs in the previous Aker region.

Oslo's population has increased from 11 000 in 1815 to more than half a million today, cf. Table 1. Except for some few periods the population growth has been continuous over the period. An exception is the period from 1900 to 1905 when the population declined with more than two percent.[6] Another is the period from 1969 to 1984. During this period the population declined from 488 000 to 447 000 inhabitants. At the same time a large internal relocation of Oslo's population took place, as many people moved from the inner city to the new suburbs in the previous Aker region.[7]

2.2. Bergen[8]

Bergen is Norway's second largest city, situated on the west coast of the country. The city was for centuries the country's leading commercial marketplace, and until the beginning of the 19th century it was the most populated, cf. Table 1. Through the centuries Bergen has been haunted by many fires. The 1702 fire was in particular devastating, in which almost 90 percent of the city's buildings burnt down. However, as the houses mainly were rebuilt as small wooden houses, and the narrow streets and alleys were retained, the fire did not change the city's character substantially. A new housing type was introduced in the city after the 1855 fire, when brick apartment blocks were constructed in an inner city area. In the last decades of the 19th century the activity in the construction sector was high also in Bergen. Typically, the new buildings in the inner city were brick apartment blocks of several floors, while two-story wooden dwellings were constructed on its outskirts. Many buildings in the inner city were destroyed by the 1916 fire. Similar to Oslo, housing construction in the post-WWII period took mainly place in suburbs outside the city centre.

The population of Bergen has ten-folded from 1815 to 2000, and it is currently above 230 000. A large share of the population growth is due to enlargements of the city boundary. The 1972-

[4] The city was both moved and renamed to Christiania/Kristiania in 1624, a name it retained until 1925.

[5] At the turn of the century around 95 percent of Oslo's households were tenants, cf. e.g. Gulbrandsen (1980).

[6] Source: Hanisch and Ryggvik (1993).

[7] While 70 percent of the city's population lived in the inner city, defined as Oslo before the 1948-enlargement, in 1949, this share was reduced to 29 percent in 1988.

[8] This section is in large based on Hagen Hartvedt (1994).

enlargement alone increased the number of inhabitants in Bergen from 111 000 to 212 000. In the 1970s population growth levelled out in Bergen, and the number of inhabitants in the inner city area declined.

2.3. Trondheim[9]

Trondheim is Norway's third largest city, situated in the middle of the country. The city was founded for more than 1000 years ago. Also Trondheim has been haunted by many fires over the centuries, and from the mid-19th century new buildings in the city had to be built in brick. At the end of the 19th century and the beginning of the 20th century many three-, and four-story brick apartment blocks, built for rental, were constructed in the city. However, old wooden houses, of one- to three-story, still dominate many inner city areas. The city boundary was extended three times during the 19th century and in 1952 and 1964. In the decades after WWII construction of new residential buildings took mainly place in these new Trondheim areas.

The population of Trondheim has grown almost continuously over the centuries and it inhabits currently around 150 000 people. In the period 1946-1970 the annual average population growth rate was 1.5 percent. Similar to Oslo and Bergen, the growth rate declined in the 1970s before it levelled out in the 1980s. Towards the end of the 1980s the number of inhabitants started to increase again.

2.4. Kristiansand[10]

Kristiansand is the fifth largest town in Norway, located at the south coast of the country. The city was founded in 1641, and it is characterized by its quadratic inner city called "Kvadraturen". The houses in the inner city were originally built in wood. However, after the conflagration in July 1892, the houses in the burnt-down area were obliged to be rebuilt in brick. One-, and two-story houses dominated housing in the city, also after the 1892 fire. The activity in the residential construction sector was huge, both in the inner city and on its outskirts, in the first decades after WWII. In this period many wooden houses in "Kvadraturen" were demolished and replaced by four-, and five-story apartment blocks.

The population of Kristiansand has increased from around 7 000 at the beginning of the 19th century to more than 70 000 people today, cf. Table 1. The city boundary was extended both in 1921 and in 1965. In particular the latter extension increased the city's population substantially.

[9] This section draws on the exposition in Bratberg and Arntzen (1996).
[10] This section is mainly based on Garmann Johnsen (2002).

2.5. Housing market regulations[11]

Price regulations of the Norwegian housing market have not been substantial over the period from 1819 to 2003 as a whole. However, in some sub-periods housing has been subject to massive regulations. This is in particular the case for the period from 1940 to 1969, when sale prices on almost all types of real property were strictly regulated. Rents have also been controlled in several periods. First, in the period from 1916 to 1936 rent control applied for some types of flats. Then, from 1940 onward rents on unfurnished flats in elder buildings in some cities have been regulated. The scope and extent of these regulations have been gradually reduced, and for the period 1985-2010[12] the law has been/is in force only in Oslo and Trondheim. The housing market has also been subject to other regulations than price regulations from time to time. For instance, in the period 1976-1983 it was forbidden to convert rental apartment blocks and housing co-operatives into condominiums.[13] Table 2 summarizes the main features of the housing market regulations.

Table 2: Regulations of the Norwegian housing market

Type of housing	Period	Type of regulation
Rental dwellings	1916-1935	Rent control on some types of flats.
	1940-2010	Rent control on some types of flats.
	1976-1983	Condominium conversion forbidden.
Owner-occupied dwellings	1940-1954	Prize freeze.
	1954-1969	Price regulations.
Housing co-operatives	1940-1954	Price freeze.
	1954-1982/88	Price regulations on new/old flats.
	1976-1983	Condominium conversion forbidden.

3. Data

Real property transaction data are compiled from the real property registers of the four cities. The data set covers transactions for the period from 1819 to 1989 for the sample as a whole.[14] Over this period the real property registers are stored at different places for two sub-periods. For the period up to around 1935,[15] the real property registers are stored at the regional state archives (statsarkivene), while for the period from 1935 to 1989 the registers are scanned and made available through the internet by Norsk Eiendomsinformasjon AS.[16,17] In the real property registers information on all transactions of a property are recorded at the same place. Hence, repeat sales information on the

[11] See e.g. NOU (1981) and Gulbrandsen (1980) for more details on the Norwegian housing market regulations.

[12] The rent control law for old unfurnished flats was repealed in 1999, resulting in a gradual deregulation period until 2010.

[13] See e.g. Wessel (2002).

[14] Up until around 1989 the real property registers were recorded manually, whereas the registers are electronical from around 1989 and onwards. Since existing Norwegian house price indices start in the mid-1980s, we have not collected data for the latter period.

[15] 1949 in Trondheim.

[16] At: www.infoland.no.

[17] Except for Bergen; the real property registers for Bergen were stored at the State Archive in Bergen also for the latter period at the time we collected the data.

properties are easily available within each of the two sub-periods.

The samples for the four cities start in different years in the 19th century, and they all end in 1989. The Bergen sample spans the longest period with annual observations from 1819, while the Trondheim sample covers the shortest, starting in 1897. For each of the cities except Kristiansand we have collected two samples of real properties; a sample of real properties with transaction data for the period up to 1935,[18] and another for the period 1935-1989. The samples for the two sub-periods for each of the cities, hereafter denoted the first period and the second period samples, respectively, are overlapping in the 1930s. The Kristiansand sample consists of the same real properties in both periods. For each sample we have tried to construct a representative sample of real properties in the inner part of each city, where we define the inner part to be inside, or just by, the pre-WWII boundaries of the four cities, cf. Sections 2.1-2.4. We denote this as inner city samples in the following.

The way of choosing the samples has varied between cities and sample periods. The first period sample of Oslo consists of all real properties in some streets in different parts of the inner city, while the corresponding Bergen sample contains of a set of randomly chosen real properties. The real properties in the first period Trondheim sample have been chosen as a mixture of the Oslo and Bergen procedures. For these cities the second period samples consist of all dwellings of some housing types in some inner city areas. The Kristiansand sample includes all real properties in nine streets of ”Kvadraturen”, cf. Section 2.4.

The samples consist mainly of residential buildings, although some non-residential buildings also are included in some of the samples.[19] Many types of housing are represented, from rental apartment blocks of many dwellings to single-family houses. Note that prior to 1970 most rental apartment blocks were sold as one unit, hence they get the same weight in the sample as for instance a single-family house. However, in the early 1970s and in particular from the mid-1980s many rental apartment blocks were converted into multiple condominium units. Flats in housing co-operatives are not included in the samples, since transactions of these are not registered in the real property registers. The types of housing differ in the four cities, and they vary over time, cf. Sections 2.1-2.4. The housing types of the samples differ correspondingly.

We have recorded all transaction prices of each property in the sample, in addition to information on the property’s attributes. More specifically, we have registered the price and the date of all transactions of the property, its address, the size of its yard,[20] and, when available, the year of construction, type of housing[21] and special comments characterizing the transactions, such as e.g.,

[18] For Bergen we have collected two samples of real properties for the period 1819-1935; a sample of properties which were transacted between 1819 and 1935, and, to increase the number of observations at the 19th century, an additional sample of properties which were transacted between 1819 and 1900.

[19] The share of non-residential buildings is the largest in the Kristiansand sample.

[20] For the second period sample in Oslo we have registered the size of the dwelling unit, not the yard.

[21] For the real properties in the second period samples we have collected information on the housing type and the year of construction of the *current* dwelling on the property from ”Norges Eiendommer, 3/2003”, published by Norsk Eiendomsin-

when the property has been sold to family members or when it only is a part of the property which has been sold. Tables 3 and 4 show two typical examples of the type of information which was collected for two selected properties. The house on the property *Claus Frimanns gate 4*, which is in the first period Bergen sample, is an inner city brick building constructed in the last decades of the 19th century. The property *Skippergaten 125* is in the Kristiansand sample, and it is a typical example of the dwellings in the wooden house area of ”Kvadraturen”.[22]

Table 3: Claus Frimanns gate 4, Bergen

Brick house; built in 1881.			
Date of sale	Price	Sqm	Comments
Apr 1898	15.800	150	
Jun 1910	14.610	165	Auction
Apr1914	20.000	165	
May1918	43.000	165	
Feb 1919	48.000	165	
Oct 1920	58.000	165	
Oct 1928	47.000	165	
Jun 1936	42.000	165	

Table 4: Skippergaten 125, Kristiansand

Single-family wooden house of one-story; built in 1859.		
Date of sale	Price	Sqm
Jan 1883	4 210	261
Sep 1912	8 500	261
Mar 1918	15 000	261
Sep 1944	16 000	261
Apr 1957	33 000	261
Jun 1957	33 000	261
Feb 1971	80 000	261
Mar 1971	100 000	261
Nov 1978	542 000	261
Sep 1987	1 566 000	261
Dec 1988	1 400 000	261

The samples of the four cities consist of more than 21 000 transaction prices in total. The sample periods and the number of transactions in each sample and in total are summarized in Table 5.

Figures 1(a)–1(b) plot the annual distribution of the transactions in the samples for each of the four cities and in total, respectively, over the period 1819-1989. Note that, with the exception of the Kristiansand sample, the number of transactions are not comparable before and after 1935 since the

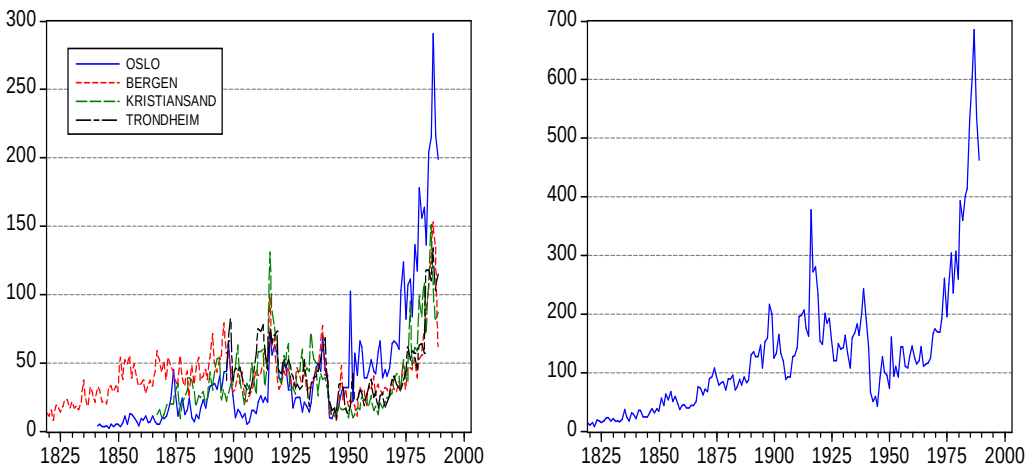
formasjon AS.

[22]Garmann Johnsen (2002).

Table 5: Sample description

	Sample period	No. of observations
Oslo	1841-1989	6 171
Bergen	1819-1989	6 720
Trondheim	1897-1989	4 239
Kristiansand	1867-1989	4 821
Total	1819-1989	21 951

city samples for the two sub-periods are of different size. In addition, the samples for the two sub-periods are partly overlapping in the 1930s. On the contrary, the Kristiansand sample consists of the same dwelling units in both sub-periods.



(a) City samples *(b)* Total sample

Figure 1: Transactions per year in the samples for Oslo, Bergen, Trondheim, Kristiansand and the total over the period 1819-1989.

Figure 1(a) indicates that the activity in the housing markets have co-moved in the four cities in many periods. For instance, during World War I the turnover in the real estate market was high in all the cities, with 1916 being a peak year in three of them. During World War II all four cities experienced, on the other hand, low activity in the real estate market. In the decades after WWII the pattern of the real estate activity was also similar in the four cities; in the 1950s and 1960s the turnover in the real estate market was low, while it increased gradually in the 1970s before it took off in the mid-1980s. Conversion of rental apartment blocks and housing co-operatives into condominiums can partly explain the increase in the number of real property transactions at the beginning of the 1970s and in the mid-1980s.

While the activity in the real estate markets in the four cities share many common features, the cities have also some special characteristics. For instance, at the end of the 1890s the activity in the real estate market in Oslo boomed, before it busted after the turn of the century. Also the Bergen sample shows a similar, but milder, course over this period. The Kristiansand sample does not show an increase in the number of transactions at the end of the 1890s. On the other hand, many real properties were sold in 1892-94 in Kristiansand. This can partly be explained by that many burnt-out properties, or shares of these, were sold in the aftermath of the July 1892 fire. 1951 stands out as a year with many real estate transactions in the Oslo sample. This is due to that more than 80 of the observations in the sample are local government purchases of apartment blocks in an area of the city in November this year.[23]

4. Empirical approach

Different methods are applied in the literature for constructing house price indices. This is due both to the special characteristics of houses, being heterogeneous and infrequently sold, and data availability. Some house price indices are based on changes in the average or median price of houses which are transacted in different periods. However, such house price indices may suffer from composition biases, as houses of different types and quality may be sold in different time periods. It is thus more common to construct house price indices by the use of constant quality methods, like the repeat sales method or the hedonic method, or a combination of these two. Case and Shiller (1987, 1989), Eichholtz (1997) and Røed Larsen and Sommervoll (2003) are examples of studies which use the repeat sales method for constructing house price indices. The Norwegian house price indices published by Statistics Norway and NEF/EFF/FINN.no/ECON are, on the other hand, examples of indices which are constructed by the use of the hedonic method. Among others, Englund, Quigley and Redfern (1998) use a combination of repeat sales and hedonic methods to construct Swedish house price indices.

Repeat sales house price indices are based on repeated transactions of individual houses in the sample, while hedonic house price indices are based on detailed data of the houses' characteristics. Consequently, the hybrid hedonic-repeat sales method utilizes both repeat sales information and data on the houses' attributes.[24] As noted in Section 3, the real property registers in Norway are organized such that repeat sales information on the individual houses are easily available. The registers do however not contain much information on the houses' attributes. Thus, due to data availability we have chosen to use the repeat sales method, or a refined version of it - the weighted repeat sales method -, to construct the historical house price indices for the four Norwegian cities. To construct the aggregate index a hybrid method is applied, as in addition to use the repeat sales information of

[23] Most of these apartment blocks were resold to exactly the same price after a couple of years. We have excluded these transactions from the repeat sales sample.

[24] See e.g. Shiller (1993) for a more thorough presentation of these methods.

the total sample of the four cities, we allow the four cities to have different intercepts.

The main advantage of the repeat sales method compared to the hedonic method is that it does not require detailed data on specific characteristics of the dwellings. Thus, the method relies less on dwelling characteristics that may be difficult to observe. Among the drawbacks of the method is that it wastes data. The repeat sales method uses only pairs of transactions of houses, hence observations of houses which are sold only once over the sample period are not used. Another potential disadvantage of the repeat sales method is that houses which are frequently sold may be lemons, starter-homes or speculation objects, and represent houses of a different quality than the rest of the market. In addition, new houses are likely to be under-represented in the sample at the end of the sample period.

A more formal presentation of the weighted repeat sales method is given in Section 4.1, while the samples used for estimation are presented in Section 4.2.

4.1. The weighted repeat sales method

The repeat sales method was introduced by Bailey, Muth and Nourse (1963), and it is, as noted above, based on repeated transactions of individual houses. The method assumes constant quality on the houses between the two transactions in each transaction pair. Bailey et al. (1963) suggested to use the ordinary least squares method (OLS) on the following regression equation

$$y = x\beta + u, \tag{1}$$

where y is a vector of log price differences of n transaction pairs, x is an $n \times T$ matrix of time dummy variables which indicate the timing of transactions within the period indexed by $t = 1, \ldots, T$. Each row of the x matrix represents a transaction pair and take on the value -1 in the period of the first sale, +1 in the period of the second sale, and 0 otherwise. The time dummies in the base period are set to 0 for normalization. Furthermore, β is a $T \times 1$ vector of coefficients to be estimated, and u denotes an $n \times 1$ vector of model residuals. The residuals are assumed to have zero mean, constant variance, and be mutually independent. However, as noted in Case and Shiller (1987, 1989), the variance of the residuals may increase with the time interval between the sales in the transaction pairs, and hence violate the assumption of constant residual variance. Such residual heterogeneity may for instance be due to the fact that it is more likely that unobserved characteristics have changed for transaction pairs which span long time intervals.

Case and Shiller (1987) suggested a three-step procedure to take into account this potential heterogeneity, such that transaction pairs of long time intervals are given less weight than transaction pairs

of shorter time intervals.[25] The three steps of the weighted repeat sales method are conducted as follows. In the first step, equation (1) is regressed by OLS. Then, in the second step, the squared residuals are regressed on a constant and the time interval of each transaction pair using OLS. In the third step we first divide each variable in equation (1), i.e. both the log price differences and the time dummy variables, with the square root of the fitted values from step two and reestimate the equation with OLS.

House price indices for each of the four cities are estimated with the weighted repeat sales method described above. The levels of the indices are represented by the $\widehat{\beta}$ coefficients from step three. Since the estimations are based on logarithmic values of transaction prices, the indices are in logarithms. Hence, to obtain appropriate levels of the indices we take the exponents of the coefficients.[26] The indices represent the expected values of geometric mean of the house price growth rates.

For constructing the aggregate house price index we use a hedonic-repeat sales method. Formally, we estimate an extended version of equation (1):

$$y = x\beta + z\gamma + u, \tag{2}$$

where z denotes a $n \times 3$ matrix of dummy variables for the different cities, where transaction pairs from the Oslo, Trondheim and Kristiansand samples take the value 1, respectively, and 0 otherwise.[27,28] γ denotes the associated 3×1 coefficient vector. The city dummy variables are introduced to allow differences in the price relatives in the transaction pairs of the different cities. The remainder of the equation is as before. We employ the weighted repeat sales procedure also in the construction of the aggregate house price index.

4.2. The repeat sales samples

The real property transaction prices described in Section 3, or pairs of these, form the basis of the repeat sales indices. However, not all of the price observations in the full sample are used in the construction of the indices. First, since we construct annual house price indices, we use annual average prices when a property is sold more than once during a year. In our sample it is in particular during WWI that many dwellings were sold several times in a year.[29] Second, as noted above, only observations of a real property which has been sold more than once over the sample period are used in the repeat sales method. Single transactions of a house are hence excluded from the repeat sales sam-

[25] It was first after the refinements of the repeat sales method by Case and Shiller (1987, 1989) that it became common to construct repeat sales house price indices.

[26] I.e. $\text{Index}_t = 100 \times \frac{\exp(\widehat{\beta}_t)}{\exp(\widehat{\beta}_0)} = 100 \times \exp(\widehat{\beta}_t)$, where t is the time period and period 0 is the base period ($\beta_0 = 0$).

[27] Bergen is the base city.

[28] The z matrix could also include other hedonic variables which may help explain the price relatives in the transaction pairs.

[29] E.g., the property *Nedre Møllenbergs gate 82* in Trondheim was sold thrice in 1918; in April for 54 000 NOK, in July for 62 000 NOK and in August for 69 000 NOK. The average 1918 transaction price for this property was hence 61 667 NOK.

ple.[30] A third group of transactions which we do not include in the repeat sales sample is transaction pairs with changed quality on the real property. We have excluded transaction pairs of a real property if the size of the yard has been changed or if a new house has been constructed[31] between the two transactions. Ideally, we should also have controlled for other changes in the houses' attributes, such as depreciation, refurbishments, electricity and sanitary installations, etc. Unfortunately, data on such characteristics are not easily available. In the early 1970s and in the mid-1980s a substantial number of rental dwellings and housing co-operatives in the cities were converted to condominiums. In the conversion process many tenantry or members of the housing co-operatives bought the flats in the condominiums to prices below market prices.[32] Many of these flats were later resold to market prices. To avoid that these transaction pairs disrupt the house price indices we exclude the first transaction of a condominium dwelling unit from the sample. The transactions of the real property *Erling Skjalgssons gate 3* in Oslo, which was converted to a condominium in December 1983, can be used as an example. As shown in Table 6, three of its dwelling units were sold at the time of conversion. Within a couple of years the three units were resold to prices more than 40 times the conversion prices. These three transaction pairs are excluded from the repeat sales sample, whereas the second transaction pair of dwelling unit no 1 (the 1986-1987 transaction pair) is included. The repeat sales sample is reduced by a substantial number of observations at the beginning of the 1970s and in the mid-1980s because of this. A fifth group of observations which is excluded from the repeat sales sample are transactions between family members and transactions of a part of a property, when the part is unidentified. Also this latter group amounts to a substantial number of observations.

After we have removed observations according to these criteria, a total of 10 827 transaction pairs are used to construct the house price indices. Table 7 shows the number of transaction pairs in both the city samples and in total. In addition, it tabulates the average, median, minimum and maximum time intervals of each of the samples. Note that the median time intervals of the transaction pairs are less than the average in all samples, and hence that their distributions are skewed to the left. Figures 2(a)–2(b) plot the annual distribution of the transactions in the repeat sales samples for each city and in total, respectively. Both transactions in each transaction pair are included in the figures.

[30] There are relatively few single transactions of houses in our samples, since the samples span long time periods.

[31] When we have information on this. In addition, we have excluded transaction pairs when we *believe* a new house has been constructed, for instance when the price of a property is multiplied from a year to another.

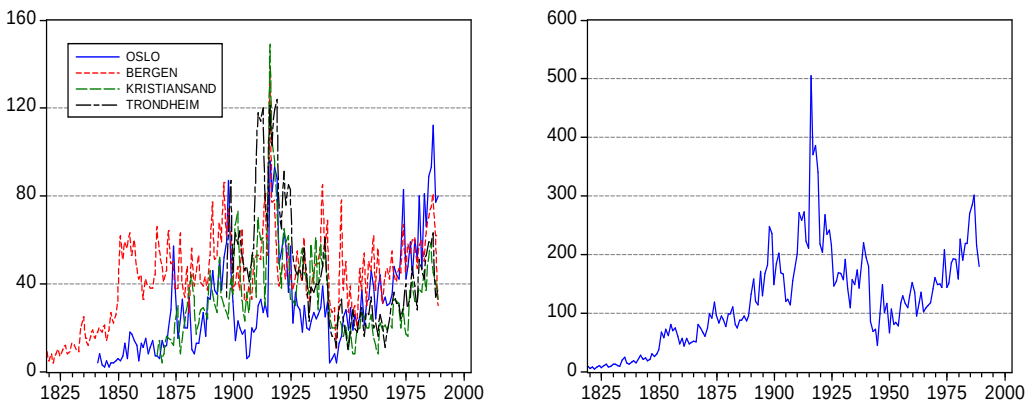
[32] See e.g. Gulbrandsen (1989) and Wessel (2002).

Table 6: Erling Skjalgssons gate 3, Oslo

6-story apartment block, built in 1899. Converted to condominium of eight units in Dec 1983.			
Date of sale	Price	Sqm	Comments
Mar 1917	112.500	2763	
Dec 1983	24.607	307	Unit no 1
Sep 1986	1.050.000	307	Unit no 1
Apr 1987	1.623.000	307	Unit no 1
Dec 1983	19.886	246	Unit no 2
Oct 1984	800.000	246	Unit no 2
Dec 1983	30.759	384	Unit no 4
May 1987	1.580.000	384	Unit no 4

Table 7: The repeat sales samples

	No. of trans-action pairs	Time interval of transaction pairs: average	median	min.	max.
Oslo	2 816	13 yrs	8 yrs	1 yr	69 yrs
Bergen	3 690	16 yrs	12 yrs	1 yr	77 yrs
Trondheim	2 178	9 yrs	6 yrs	1 yr	58 yrs
Kristiansand	2 143	12 yrs	7 yrs	1 yr	86 yrs
Total	10 827	13 yrs	8 yrs	1 yr	86 yrs



(a) City samples *(b)* Total sample

Figure 2: Transactions per year in the repeat sales samples for Oslo, Bergen, Trondheim, Kristiansand and the total over the period 1819-1989.

5. The house price indices 1819-2003

As noted above, the weighted repeat sales method is used to construct the city house price indices for the period up to 1985. From 1986 these indices are spliced with a weighted average of NEF/EFF/FINN.no/ECON's annual house price statistics for detached houses, semi-detached houses and flats for the corresponding city.[33,34] A hedonic-repeat sales method is applied to construct the aggregate index, cf. Section 4.1,[35] and the index is estimated on the repeat sales samples for the four cities. The aggregate index is hence based solely on the Bergen sample for the period 1819-1840, on data for Bergen and Oslo for the period 1841-1866, and so on.[36] From 1986 onward the aggregate index is spliced with NEF/EFF/FINN.no/ECON's statistics of annual house prices per square metre for Norway.[37] Table A1 in Appendix A lists the linear nominal house price indices for the four cities in addition to the aggregate index.

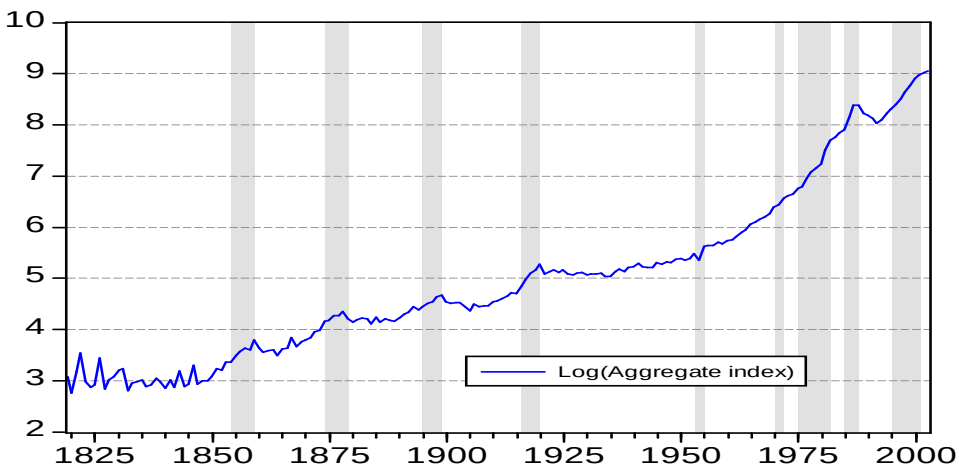


Figure 3: Aggregate nominal house price index 1819–2003 (1912=100, logarithmic scale). The shaded areas designate periods with high nominal house price growth.

Figure 3 displays the aggregate nominal house price index (in logarithms) over the period 1819-2003. It shows that the house price trend has been increasing over the period as a whole. The shaded areas in the figure designate periods of high growth in nominal house prices. Typically, these periods

[33] Sources: ECON Analyse (2004a) and ECON Analyse (2004b). Note that these indices are for the entire cities, whereas the indices we have constructed are based on data for the inner part of the four cities.

[34] The three housing types are given the weights 0.20, 0.28 and 0.52, respectively, which represent the share of housing types in Oslo, Bergen and Trondheim over the period 1993-2001. Source: Gulbrandsen (2003).

[35] The dummy variables for Trondheim and Kristiansand are significantly different from zero at the 1% level, while the Oslo dummy variable is insignificant.

[36] Cf. Table 5

[37] Source: ECON Analyse (2004a). Note that the NEF/EFF/FINN.no/ECON's house price index for Norway covers the entire country, while the aggregate price index we have constructed is based on data for the four cities in our sample.

have been associated with wars and boom periods in the economy. The growth in nominal house prices has in particular been large over the last three decades of the sample period. The nominal city house price indices are shown in Figures 5(a)–5(d).

Figure 4, which plots the aggregate house price index in real terms[38] (in logarithms), depicts a somewhat different picture of the house price development over the last two centuries than the nominal house price indices. The difference is in particular large in the first half of the 20th century. While nominal house prices trend upwards in this period, the trend in the real house price index is declining.

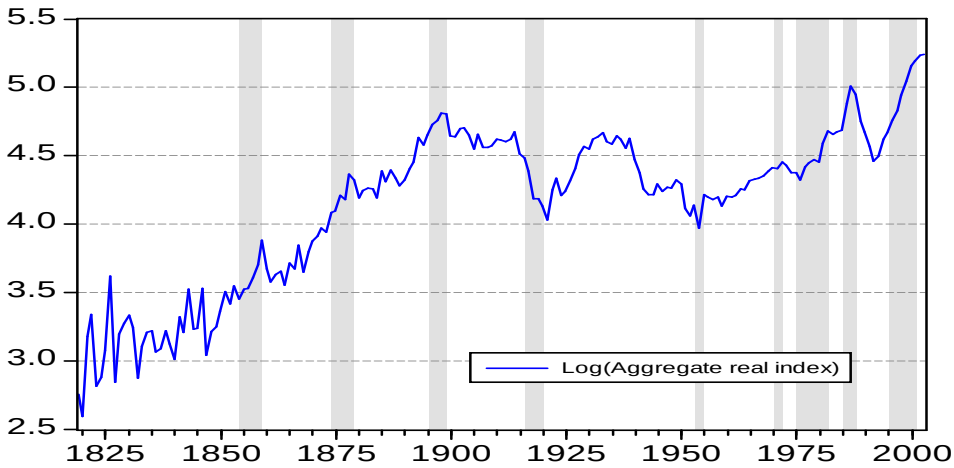


Figure 4: Aggregate real house price index 1819–2003 (1912 = 100, logarithmic scale). The shaded areas designate periods with high growth in the aggregate nominal house price index.

In the subsequent sections the house price indices for each city and the aggregate are briefly discussed for the four sub-periods 1819-1914, 1914-1940, 1940-1970 and 1970-2003. Figures 6(a)–6(d) plot the nominal house price indices (in logarithms) for the different sub-periods. The corresponding average growth rates over five year periods (in percent) are plotted in Figures 7(a)–7(d).

5.1. The period 1819-1914

The coverage of the city house price indices differ at the 19th century. The house price index for Bergen is the only city index spanning the period from 1819 to 1841. In this post-Napoleonic War period the annual house price growth hovers about zero. The index is however very volatile in this period, probably due to few observations, cf. Figures 2(a)–2(b). The index does not recover substantially before the Crimean War starts in the 1850s. Also the house price index for Oslo, which

[38] Defined as the aggregate house price index deflated by the consumer price index. The CPI is taken from Grytten (2004), Chapter 3 in this book.

starts in 1841, increases sharply during the Crimean War. Both house price indices decline after the war, and they do not rebound until the mid-1870s. The Kristiansand house price index, which starts in 1867, displays a similar rise in the mid-1870s. During the international depression period from the end of the 1870s to the beginning of the 1890s, the three house price indices flatten off again. Then, the Oslo house price index soars in the 1890s, in particular in the second half of the decade. At this time Oslo experienced a boom in the construction sector and fast population growth. However, after the turn of the century the index tumbles.[39] The Bergen house price index shows a similar, but less volatile, development over this period. The house price index for Trondheim starts in 1897. We observe that also the house price indices for Trondheim and Kristiansand tend to increase towards the end of the 1890s. However, rather than declining in the first years of the new century, these two indices flatten out. All four city indices as well as the aggregate index start to recover around 1910.

5.2. The period 1914-1940

The city house price indices share many common features during WWI and in the inter-war period. All four indices increase sharply under and shortly after the war, and all four are temporarily peaking in 1920. However, the house price indices decline in real terms over this period; the nominal aggregate house price index increases by 72 percent from 1914 to 1920, while the CPI rises by 197 percent over the same period.[40] Many of the properties in the samples are rental apartment blocks, and hence the decline in real house prices in this period may be related to the 1916 introduction of the rent control law, cf. Section 2.5. During the 1920s, in which decade a national banking crisis took place, the nominal house price indices first fall sharply before they level out. All house price indices recover in the second half of the 1930s. Real house prices increase in the inter-war period, cf. Figure 4.

5.3. The period 1940-1970

The Norwegian housing market was strictly regulated from 1940 to 1969.[41] In the first 14 years of this period, house prices were more or less frozen at the pre-WWII level. The house price indices indicate that the price freeze served its purpose, as the nominal aggregate house price index increased by a mere 15 percent from 1940 to 1954. For comparison, the CPI increased by around 90 percent over the same period. However, the city indices show some differences in this period. In particular, the Kristiansand index grows more than the other indices from the end of the 1940s. Futhermore, the Oslo index is very volatile during WWII, probably due to very few observations in the Oslo sample for this period. Although both house prices and rents continued to be regulated after the cease of the price freeze in 1954, the indices make a jump from 1954 to 1955. Prices on owner-occupied houses were fixed by local price boards until 1969. The scope and the extent of the regulations were

[39] This episode is often called the ”Kristiania (i.e. Oslo) crash”.
[40] Source for the CPI: Grytten (2004), Chapter 3 in this book.
[41] Cf. Section 2.5.

however gradually reduced. Over the period from 1954 to 1969 all the house price indices increase substantially.[42]

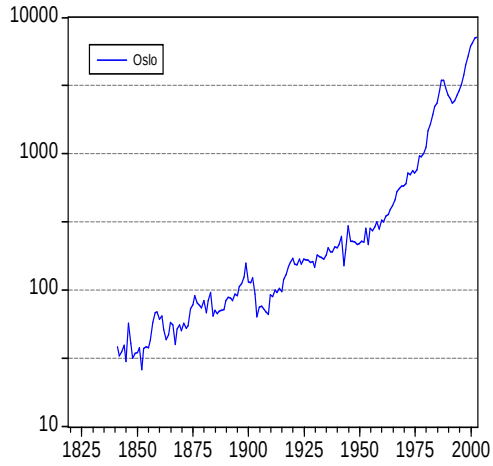
5.4. The period 1970-2003

The increase in the house price indices over the last three decades is tremendous, and from 1970 to 2003 the aggregate index rises by almost 1300 percent. Nominal house prices in the 1970s grows largely with the same rate as consumer prices, hence the aggregate real house price index shows a flat development in this period, cf. Figure 4. However, during the period of credit liberalization in the 1980s the house price indices also increase sharply in real terms. At the end of the decade and in the beginning of the 1990s, the house price indices tumble, both in nominal and real terms. The Norwegian economy is often characterized as a boom-bust economy in this period, and a national banking crisis took place at the beginning of the 1990s. The house price indices rebound sharply from the troughs in 1992-93 and up to today. The latter increase is in particular large in real terms; from 1993 to 2003 the nominal aggregate house price index rises by 158 percent, whereas the corresponding rise in the CPI is below 25 percent.

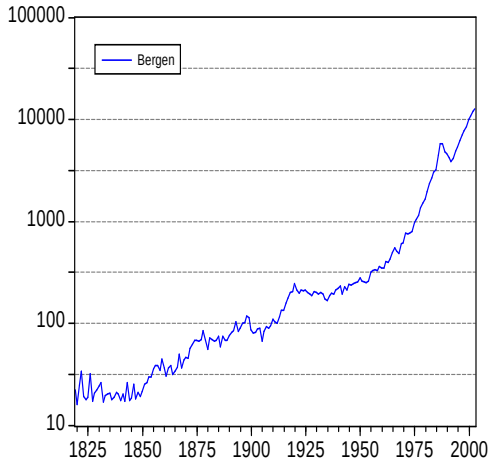
The Kristiansand index is somewhat more volatile than the other city house price indices over the period 1970-2003. This index is also distinctive from the others in that it is declining from 1982 to 1984. The other indices level out in this period.

Note that the house price indices are more volatile before 1986 than after, i.e., the house price indices we have constructed vary more than the NEF/EFF/FINN.no/ECON house price indices. This may be due to the fact that the house price indices we have constructed are based on fewer observations than the NEF/EFF/FINN.no/ECON indices.

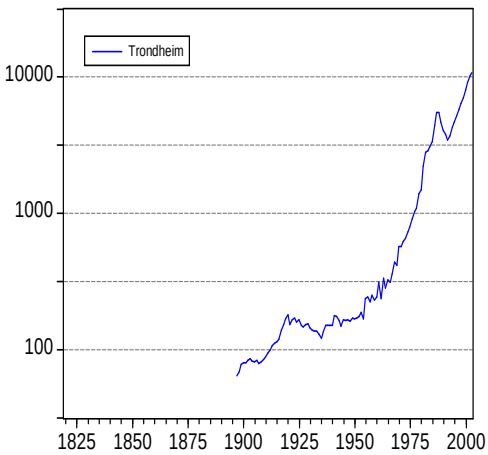
[42]Note that during the regulation period, a black market existed for purchase of real property. Hence, the registered transaction prices, which we base the house price indices on, could be lower than the actual prices the buyers paid during this period.



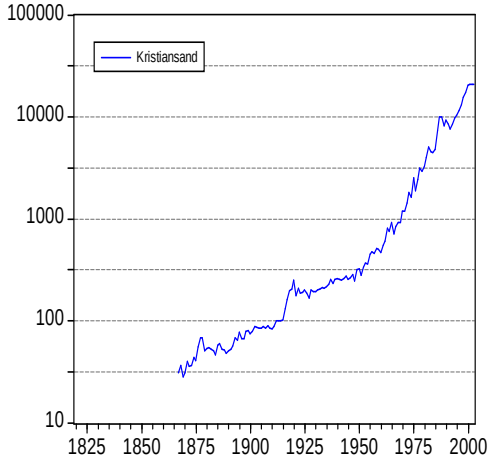
(a) Oslo



(b) Bergen

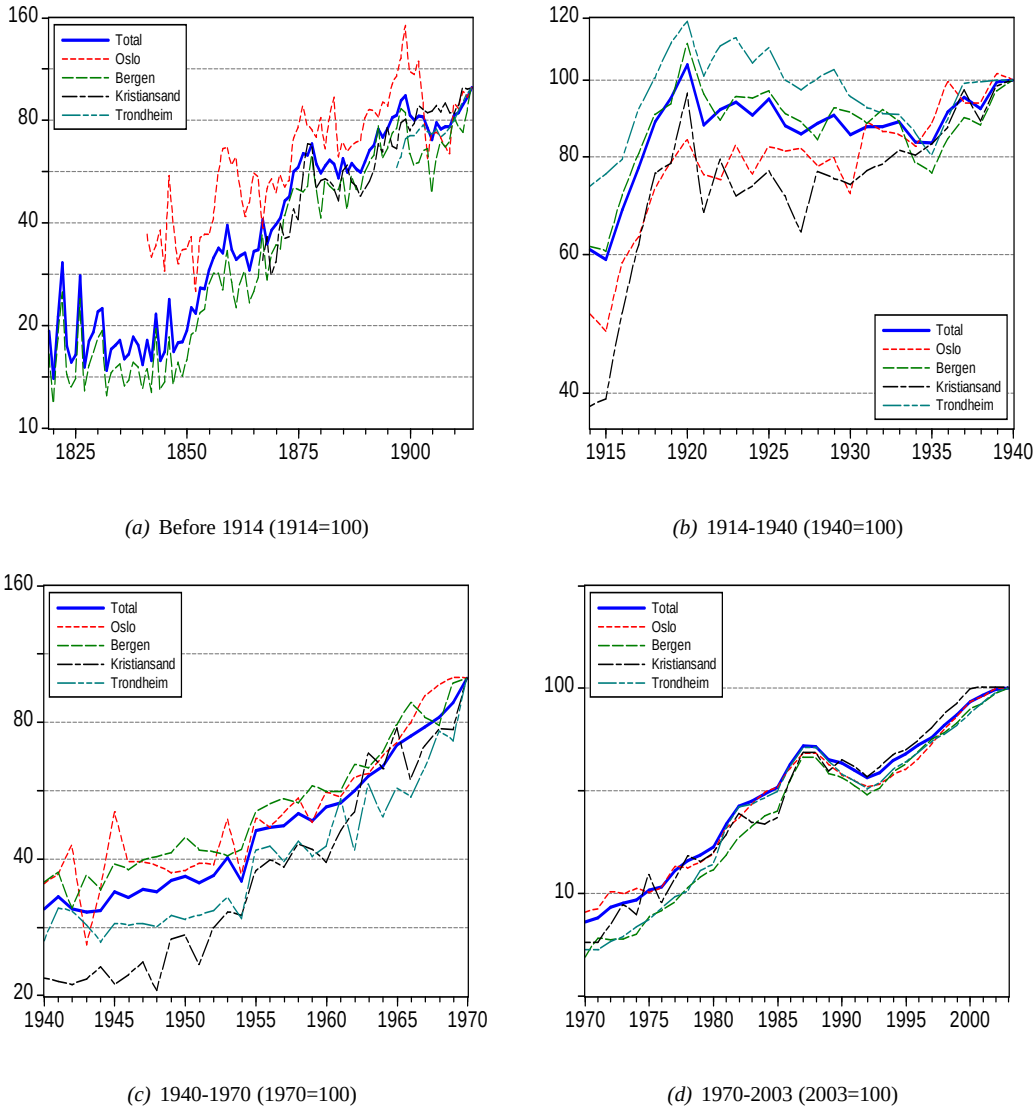


(c) Trondheim



(d) Kristiansand

Figure 5: Nominal city house price indices 1819-2003 (logarithmic scale, 1912=100)



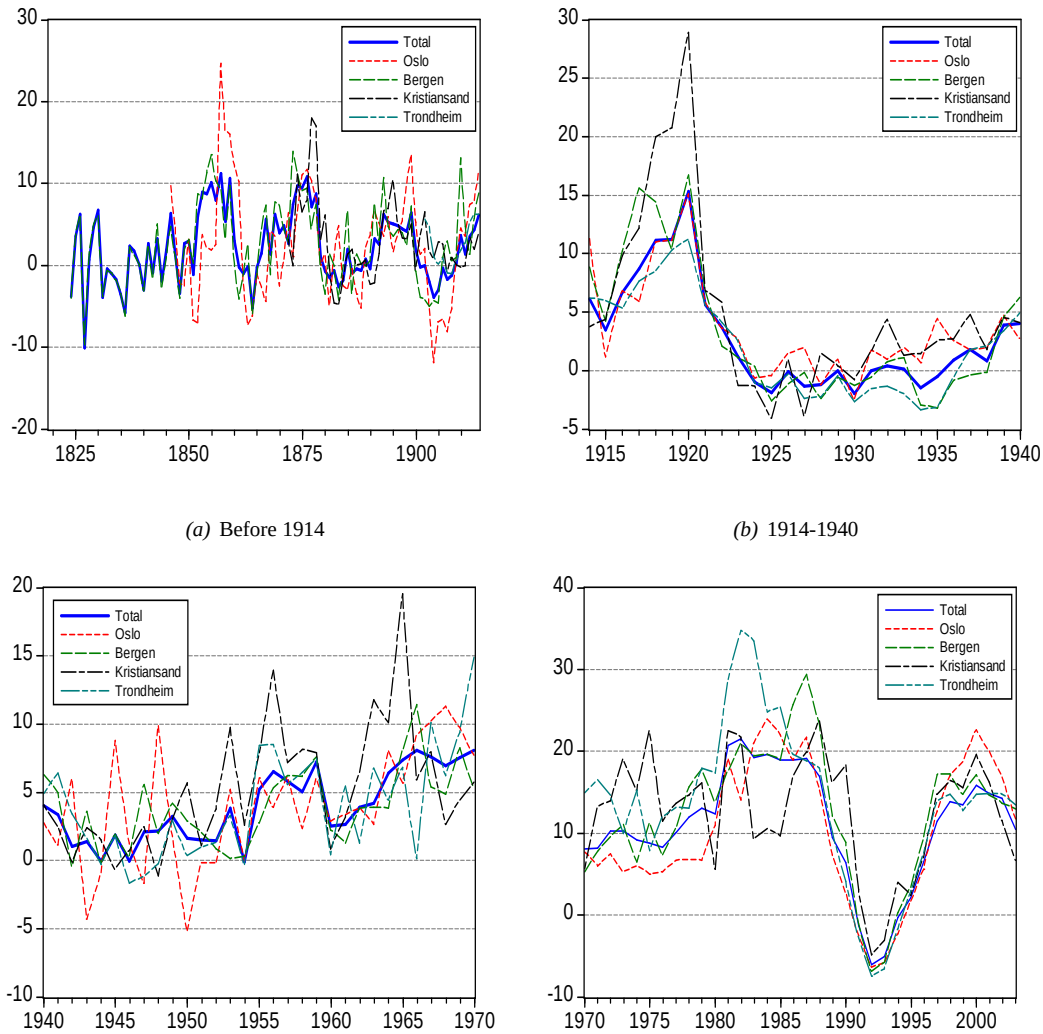
(a) Before 1914 (1914=100)

(b) 1914-1940 (1940=100)

(c) 1940-1970 (1970=100)

(d) 1970-2003 (2003=100)

Figure 6: Nominal house price indices for different sub-periods (logarithmic scale)



(a) Before 1914

(b) 1914-1940

(c) 1940-1970

(d) 1970-2003

Figure 7: Nominal house price growth rates (average over five year periods; in percent) for different sub-periods

6. Concluding remarks

In this chapter we have presented estimates of nominal house price indices for four Norwegian cities from the 19th century onward as well as an aggregate nominal house price index. To our knowledge, this is the first attempt to construct continuous house price indices for Norway for such a long period. Also internationally there are few long runs of house price indices available. The nominal house price indices seem to fit well in with historical events and available indicators of economic development. Typically, the nominal house price indices soar during wars and boom periods in the economy. The trend in the nominal house price indices is upward sloping over the sample period, and show particularly strong growth during the last three decades. In real terms, however, the picture looks different, especially in the first half of the 20th century. Although there are some differences between the city house price indices in some sub-periods, the overall regional differences are small.

The house price indices for the period up to 1986 are based on transaction prices of individual houses, and they are constructed by the use of the weighted repeat sales method. This method assumes constant quality of a house between the two transactions in a transaction pair. We have excluded transaction pairs from the sample if the size of a property's yard has been changed or, when we have information on this, if a new house has been constructed on the property in the period between the two transactions. Due to data availability we have not controlled for other changes in the properties' quality. Potentially, this can produce biases in the house price indices. It is not obvious, however, in which direction the indices will be biased in this case. On the one hand, a house depreciates, and preferences and tastes when it comes to e.g., the style of a house, may change when time passes. Hence, for many houses the physical and/or subjective quality may be lower at the time of the second sale than at the time of the first within a transaction pair. On the other hand, electricity and/or sanitary installations, substantial refurbishments, rebuilding, etc. may increase the quality of the house between two transactions. Thus, whether the former or the latter arguments dominate will influence the direction of the potential bias. However, if house owners on average retain the quality of their houses over time, quality changes may not influence the indices substantially.

When constructing the house price indices we have, with the exception of the aggregate index, only utilized the repeat sales information of our data set. Hence, we have calculated the geometric average growth rates over all the houses in our sample, independent of their location, housing type, year of construction, etc. However, different housing types can have different price development over time.[43] A topic for future research would be to test whether the use of hedonic-repeat sales methods can improve the house price indices. The construction of the aggregate house price index is a step in this direction, as we allow the four cities to have different intercepts. Although the coefficients of the aggregate house price index are not much influenced by the introduction of the city dummy variables, they are more precisely estimated.

[43] For instance, Røed Larsen and Sommervoll (2003) report that the house price growth for small apartments was higher than the corresponding rate for larger apartments in Oslo over the 1990s.

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A. Technical appendix: The data

Table A1. Nominal house price indices 1819-2003 (1912=100)

	Total	Oslo	Bergen	Trondheim	Kristiansand
1819	21.67		22.37		
1820	15.69		15.98		
1821	23.96		24.80		
1822	34.36		33.88		
1823	19.59		19.42		
1824	17.53		17.86		
1825	18.51		18.93		
1826	31.50		32.38		
1827	16.99		17.39		
1828	20.23		20.70		
1829	21.60		22.34		
1830	24.70		24.63		
1831	25.33		26.23		
1832	16.63		16.84		
1833	19.18		19.70		
1834	19.70		20.35		
1835	20.35		20.90		
1836	17.99		18.04		
1837	18.56		18.75		
1838	20.88		21.07		
1839	19.74		20.38		
1840	17.28		17.69		
1841	20.38	38.09	20.26		
1842	17.71	32.72	17.23		
1843	24.25	35.22	26.44		
1844	17.80	39.23	17.48		
1845	18.91	29.79	18.53		
1846	26.87	56.61	25.09		
1847	18.86	40.55	18.18		
1848	20.10	31.32	21.07		
1849	20.13	34.38	19.22		
1850	21.73	34.56	21.46		
1851	25.38	37.55	25.45		
1852	24.43	25.86	26.09		
1853	29.03	37.24	29.61		
1854	28.89	38.10	30.15		
1855	32.72	37.85	35.90		
1856	35.49	42.31	38.56		
1857	38.10	57.72	38.43		
1858	36.85	67.77	34.45		
1859	44.23	68.55	44.83		
1860	37.58	60.89	36.28		
1861	35.10	64.00	30.60		
1862	36.07	51.17	36.49		
1863	36.69	43.11	38.90		
1864	32.73	47.19	31.58		
1865	37.17	57.71	34.16		
1866	37.67	55.67	37.43		
1867	46.21	39.80	49.89		31.22
1868	39.14	52.00	36.79		36.63
1869	42.92	55.39	43.73		28.31
1870	44.49	50.37	46.60		30.91
1871	46.71	56.95	45.52		39.97

Table A1. Nominal house price indices 1819-2003 (1912=100)

	Total	Oslo	Bergen	Trondheim	Kristiansand
1872	52.45	52.54	56.83		36.19
1873	53.69	54.90	62.40		36.61
1874	63.75	73.11	68.40		44.13
1875	65.48	78.24	67.87		41.03
1876	71.91	90.42	66.93		55.78
1877	71.07	79.79	69.36		68.70
1878	77.09	77.18	85.52		67.74
1879	67.18	73.45	68.04		50.81
1880	63.25	83.59	55.86		53.64
1881	66.48	68.00	71.70		54.31
1882	68.77	84.00	69.40		52.96
1883	67.08	95.98	67.47		51.10
1884	61.11	64.38	68.04		46.68
1885	69.61	70.85	74.35		57.24
1886	63.35	66.71	59.40		59.57
1887	67.43	69.43	74.22		52.88
1888	64.93	71.08	68.05		51.48
1889	63.55	71.81	67.99		48.23
1890	68.28	83.72	76.55		50.67
1891	73.80	88.73	81.70		53.31
1892	76.23	87.26	85.64		56.81
1893	85.16	83.85	104.59		68.48
1894	80.36	93.03	83.98		64.88
1895	85.41	90.54	90.10		77.08
1896	91.60	104.85	99.61		67.54
1897	93.30	110.83	102.55	64.57	66.46
1898	102.78	125.17	117.34	69.10	79.03
1899	106.25	156.00	114.19	78.25	81.19
1900	93.44	114.38	86.77	79.84	75.06
1901	90.33	112.16	80.24	79.95	78.94
1902	93.06	122.27	81.52	82.85	88.37
1903	92.14	93.68	87.87	85.72	86.30
1904	85.27	63.50	89.70	82.28	84.43
1905	79.18	75.14	66.61	80.59	85.62
1906	88.83	75.83	84.14	83.34	88.92
1907	84.83	73.01	93.45	79.17	85.18
1908	86.60	68.90	90.35	81.32	90.34
1909	86.31	65.74	94.00	84.54	84.64
1910	93.52	92.12	110.19	88.25	84.31
1911	95.09	89.15	104.16	94.67	88.77
1912	100.00	100.00	100.00	100.00	100.00
1913	105.26	95.95	116.24	106.53	99.28
1914	112.70	102.86	135.48	110.78	100.56
1915	109.72	97.50	133.65	114.57	102.71
1916	126.80	119.53	157.52	119.73	132.20
1917	143.45	129.07	177.93	138.36	161.08
1918	164.08	148.61	199.66	151.87	198.70
1919	175.72	160.17	205.92	167.84	204.93
1920	193.87	171.24	245.35	179.02	251.12
1921	162.52	154.60	211.80	152.83	177.47
1922	169.83	152.36	196.28	166.60	207.38
1923	173.69	168.61	210.38	170.98	186.17
1924	167.29	154.78	209.16	158.67	191.43
1925	175.39	167.62	213.94	165.98	200.35
1926	161.96	165.76	200.03	150.74	185.87

Table A1. Nominal house price indices 1819-2003 (1912=100)

	Total	Oslo	Bergen	Trondheim	Kristiansand
1927	158.34	166.96	194.67	146.52	167.45
1928	163.39	158.40	185.21	151.73	199.92
1929	167.05	162.35	203.38	155.51	195.44
1930	158.00	146.48	200.44	143.73	192.20
1931	161.60	180.03	194.42	139.10	200.54
1932	161.68	175.21	202.14	136.91	204.36
1933	164.15	173.83	195.12	136.26	212.71
1934	154.55	168.05	173.47	129.22	209.80
1935	154.22	179.08	167.86	121.14	216.93
1936	168.71	202.99	185.90	134.53	227.50
1937	176.19	190.48	197.53	149.44	253.49
1938	170.62	190.75	193.39	150.29	231.86
1939	184.58	207.66	213.55	151.01	256.93
1940	185.27	203.84	220.53	150.88	261.06
1941	197.20	214.70	232.21	177.57	256.41
1942	184.97	247.49	193.35	174.93	252.40
1943	182.24	149.82	228.02	163.10	259.43
1944	184.04	197.15	211.76	149.05	276.13
1945	202.40	293.57	241.95	164.45	252.86
1946	196.75	228.41	235.20	163.01	265.60
1947	204.41	227.22	246.91	164.46	283.25
1948	202.00	223.88	250.72	161.28	245.10
1949	213.92	215.19	256.01	171.05	318.20
1950	218.71	217.77	277.05	167.40	325.15
1951	211.59	226.61	259.02	171.00	280.13
1952	219.37	224.30	257.05	175.45	337.07
1953	240.68	282.44	252.09	187.98	364.88
1954	213.01	214.55	260.33	168.04	359.22
1955	275.70	283.62	315.13	237.97	450.01
1956	280.43	271.02	327.95	243.60	475.16
1957	282.85	292.76	336.85	224.27	458.24
1958	300.86	315.41	329.54	248.87	513.65
1959	290.18	278.63	359.57	230.91	500.68
1960	310.39	324.47	350.18	243.38	469.13
1961	317.09	316.22	348.91	309.60	551.23
1962	337.65	348.74	401.30	238.20	606.18
1963	364.14	357.32	393.47	332.77	816.27
1964	382.78	390.96	428.05	281.91	754.22
1965	424.66	417.03	490.22	326.32	927.87
1966	445.48	461.01	548.06	311.22	715.22
1967	466.38	527.58	509.14	358.73	846.81
1968	490.36	559.16	488.58	436.07	925.09
1969	526.88	581.26	605.06	414.46	920.84
1970	596.68	578.03	620.38	569.52	1193.47
1971	626.67	599.81	762.25	568.51	1188.80
1972	706.21	725.49	752.27	619.21	1437.89
1973	741.32	705.86	759.93	654.21	1807.79
1974	769.77	755.37	801.63	730.25	1621.34
1975	857.46	720.99	971.18	793.31	2535.28
1976	886.26	757.15	1039.46	908.11	1871.17
1977	1062.84	967.71	1149.19	1026.49	2417.96
1978	1186.07	944.47	1352.66	1081.39	3134.39
1979	1271.47	1007.08	1516.55	1384.26	2933.58
1980	1388.81	1115.51	1646.11	1482.17	3244.54
1981	1805.68	1480.85	1952.24	2214.89	3975.91

Table A1. Nominal house price indices 1819-2003 (1912=100)

	Total	Oslo	Bergen	Trondheim	Kristiansand
1982	2207.75	1647.00	2353.20	2812.25	5041.71
1983	2329.60	1935.79	2669.27	2892.63	4583.88
1984	2522.28	2212.44	3007.13	3104.17	4490.05
1985	2703.30	2346.43	3202.25	3362.97	4810.33
1986	3513.14	2880.40	4464.23	4392.37	7348.04
1987	4323.73	3432.34	5810.70	5460.21	10071.68
1988	4306.90	3431.32	5775.99	5483.09	10009.08
1989	3718.72	3027.81	4843.17	4685.29	8135.18
1990	3572.15	2679.08	4627.70	4053.73	9218.15
1991	3293.68	2522.91	4224.35	3781.74	8502.54
1992	3022.19	2341.89	3826.95	3434.66	7611.82
1993	3213.58	2431.77	4123.68	3673.07	8487.61
1994	3670.24	2686.98	4914.06	4283.39	9779.03
1995	3953.52	2875.98	5405.58	4644.91	10323.99
1996	4367.81	3228.82	6193.39	5200.72	11518.82
1997	4750.10	3821.46	7115.91	5832.28	13232.87
1998	5433.96	4502.68	7683.84	6384.69	15480.47
1999	6145.57	5210.62	8542.46	7014.13	17394.71
2000	7076.32	6131.72	10029.17	8075.16	20468.24
2001	7621.23	6463.31	10721.08	9072.94	20879.08
2002	8131.01	7072.06	11969.09	10121.47	20853.01
2003	8275.88	7140.65	12677.25	10689.60	20667.43