

Revisions and break-adjustments in composite house price
indices

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11.1 Introduction

Norges Bank published its first long time series for House Price Indices (HPIs) for Norway in 2004. In this chapter we publish a set of revised historical HPIs. The revisions reflect our own learning and practical experiences from using these HPIs for Norway over the past three decades. We have also benefitted from the participation in a working group on Historical Monetary and Financial Statistics (HMFS), which is today organized under the Irving Fisher Committee on Central Bank Statistics at the Bank for International Settlements (BIS). The working group has recently published a report on historical monetary and financial statistics for policymakers (Bignon et al., 2022). Methodological aspects related to the design and construction of HPIs are discussed in Eitrheim and Jobst (2022), which illustrates the complexities involved in the aggregation of price information on heterogeneous assets into an HPI for the country as a whole.

In addition, when we want to construct HPIs which cover a long historical period this will in practice force us to splice together HPIs of different types. In a later section we provide a short overview of different methods which are used today to construct HPIs. In practice the choice of method may be dictated by the availability of data from primary sources. This means that one may be severely restricted in choosing between these methods in subperiods when the availability of data is scarce. The box below provide a short summary of the splicing procedures we have used when we have constructed HPIs for Norway from 1819 onwards.

Splicing procedures

Sales-weights

The splicing of HPIs based on *sales-weights* involve the combination of five types of HPIs starting with *Repeat Sale HPIs* before 1985. From 1985 onwards we use HPIs produced in different private sector partnerships, first between The Real Estate Agents Association (NEF) and the Norwegian Building Research Institute (NBR), later in a partnership with a consultancy company Econ (see Econ (2004) for an overview). *Mix-adjustment HPIs* are used for the late 1980s. From 1989 onwards we use two types of *Hedonic HPIs*, one available on a quarterly or tertial basis from 1989 to 1996 and one available on a monthly basis from 1997 to 2013. Later, from 2014 onwards, we have used the monthly *SPAR-type HPI*, notably a *Sales Price to Predicted Price Ratio HPI*, produced by Eiendomsverdi AS.

Stock-weights

The splicing of HPIs based on *stock-weights* from 1985 onwards starts with *Mix-adjustment HPIs* for the late 1980s, which are spliced with the *Hedonic HPIs* produced by Econ from 1989 to 1991 followed by Statistics Norways quarterly *Hedonic HPI* from 1992 onwards.

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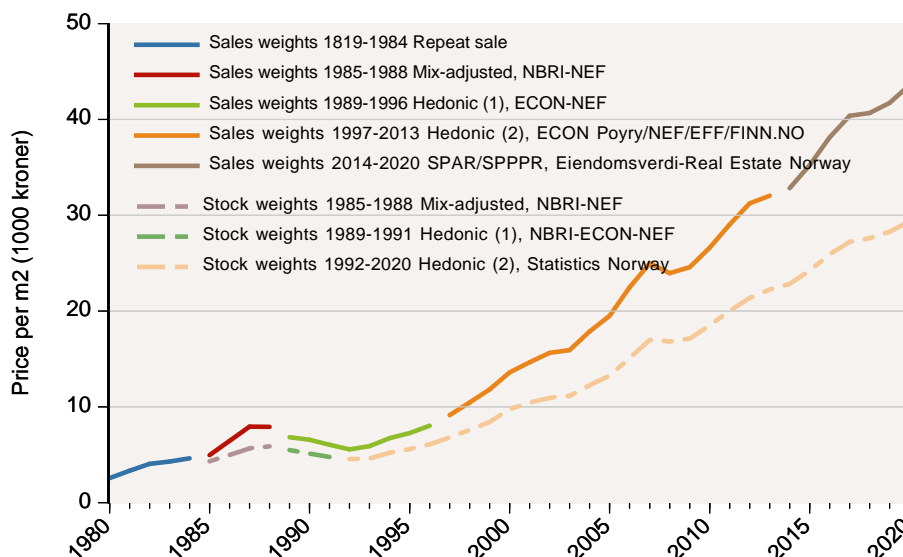


Figure 11.1 Sales-weighted and stock-weighted composite House Price Indices, 1980-2020. The data are expressed as prices per m² (in 1000 kroner). We have normalized the sales-weighted and stock-weighted HPIs, respectively, using benchmark estimates of the average price levels observed in 1985 provided in Econ (2004). A short description of the splicing procedure is provided in a box on the previous page.

Figure 11.1 shows the developments in HPIs in Norway since 1980, focusing on how we have spliced HPIs based on different methods when constructing *sales-weighted* vs. *stock-weighted* HPIs from 1985 onwards.¹ We see that the trends of the two HPIs differ from 1985 onwards. A short article by Baug, von Brasch and Takle (2018) zoom in on the 2010s and explains why this is the case between 2011 and 2017.

The remaining sections in this chapter discuss properties of the different types of HPIs we have combined to form the composite historical HPIs shown in Figure 11.1. We start with a short recapitulation of the first vintage of HPIs in HMS I (Eitrheim and Erlandsen, 2004), followed by a short overview of sales-weighted and stock-weighted HPIs. We provide a detailed historical account of the available HPIs for Norway from different sources from 1985 onwards.

We wrap up this chapter with two historical illustrations of long run trends in Norwegian housing prices. Firstly, we have provided a brief presentation of the *Kristiania crash*, a crash in the real estate market in the country's capital in 1899, illustrated by a comparison of real housing prices in the capital relative to the country average. Secondly, we have illustrated how housing prices have

¹ Here *sales-weights* denotes the case where aggregated HPIs are constructed using sample specific weights calculated from the actual sample of houses sold in a particular period, whereas *stock-weights* denotes the case where aggregated HPIs are constructed using weights based on the entire population of houses in Norway.

developed relative to the wage level, using wage data from Grytten (2007). See also Chapter 14 in this volume for more details about the aggregated historical wage data.²

11.2 The first vintage of composite historical HPIs in HMS I

In order to construct the composite housing price indices published in HMS I we combined HPIs from two different sources, which were based on different methods of construction. For the 1800s and 1900s until 1985 we employed the repeat sale HPIs reported in Eitrheim and Erlandsen (2004, 2005). From 1985 onwards we spliced these HPIs with HPIs which had been published by the Norwegian Association of Real Estate Agents (NEF). The basis for these HPIs were observed transaction prices collected by NEF, from the early 2000s in collaboration with the Association of Real Estate Undertakings (EFF) and the internet adviser FINN.NO.³

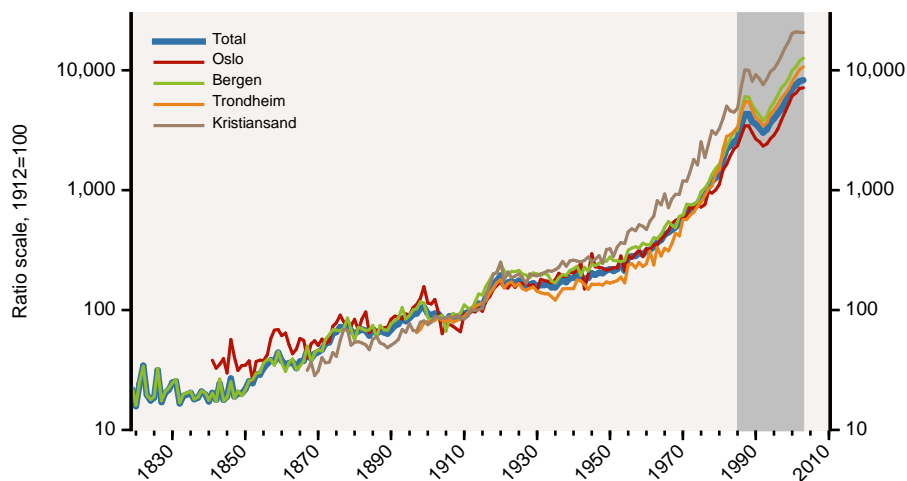


Figure 11.2 Composite House Price Indices (HPIs) in HMS I (2004). Repeat sale based HPIs are combined with HPIs based on hedonic regressions from 1985 onwards (shaded in grey). Ratio scale, 1912=100

Figure 11.2 shows the composite historical House Price Indices (HPIs) as they were published in HMS I (2004) including data until 2003.

The present study of the revision history of the HPIs will provide useful information about the

² Thanks to André Kallåk Anundsen and Lisa Reiakvam for thoughtful comments to a previous draft of some of the sections in this chapter. Thanks also to the members of the HMFS BIS project for input, in particular to Marc Flandreau, Clemens Jobst and Jan F. Qvigstad. The views expressed in this paper are solely those of the author.

³ For most of the period from the early 1990s onwards these were hedonic HPIs constructed by a private consulting firm Econ in a partnership with NEF and from 2002 on also with EFF and FINN.NO. For the period from 1985 onwards NEF had published weighted average housing prices (a form of mix-adjusted HPIs) for the years 1985-1988 and from 1989 onwards they published hedonic HPIs which were calculated by Norwegian Building Research (NBR) in a joint partnership. Section 11.5 below provides a brief description of the history of modern era HPIs in Norway from 1985 onwards.

11.2 The first vintage of composite historical HPIs in HMS I

need to make break-adjustments in the updated and revised composite national HPI we employ in *HMFS for Norway*. Before we dig deeper into the details of the calculation of national HPIs and their revisions in realtime it may be useful to take a bird's perspective on the "modern era" of HPIs from 1985 onwards. This corresponds to the grey-shaded area shown in Figure 11.2.

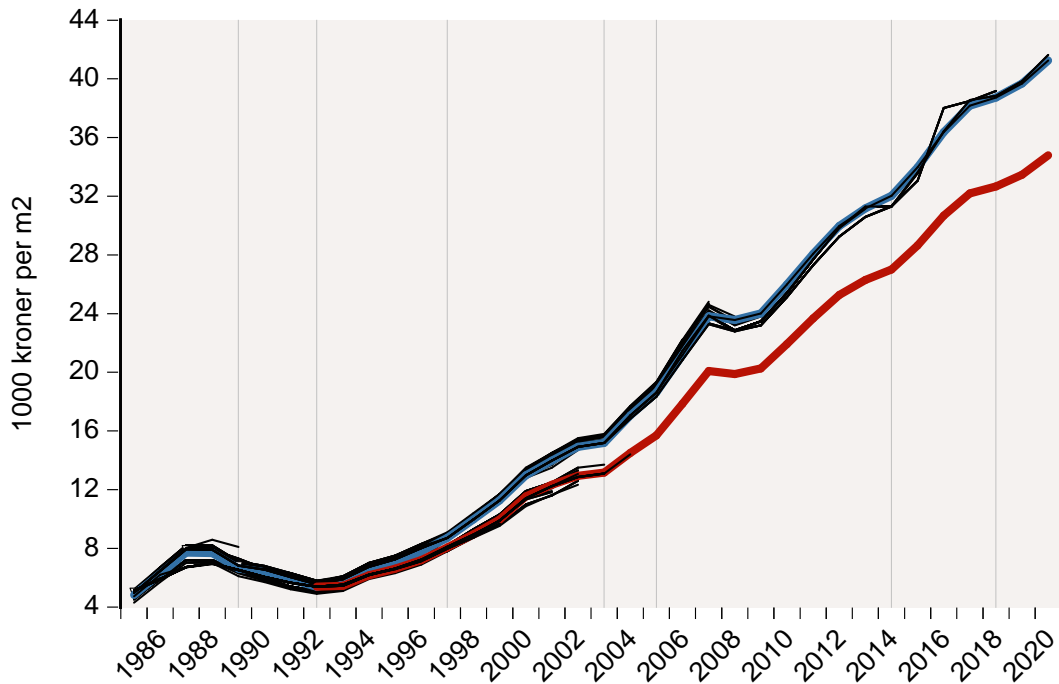


Figure 11.3 A collection of 88 House Price Indices (HPIs) for Norway for the period 1985-2020 (in 1000 kroner per square meter). HPIs which were originally normalized to 100 in a base year have been rescaled such that their value in 1992 is set to, respectively, 5 293 kroner per square meter (*stock-weighted*) and 5 543 kroner per square meter (*sales-weighted*). The main distinction between the two groups in this graph relates to whether the HPIs are based on sales-weights (represented in blue) or housing stock-weights (represented in red).

Figure 11.3 shows a collection of 88 aggregated national HPIs observed in realtime for Norway. The data are produced and published by different agencies and institutions since the mid 1980s onwards. For HPIs that were originally normalized to 100 in a base year we have rescaled these such that their value in 1992 is set to, respectively, 5 293 kroner per square meter (*stock-weighted*) and 5 543 kroner per square meter (*sales-weighted*), whereas HPIs that were originally reported in prices per square meter have been left "as is". This figure shows that although there seems to have been numerous revisions in these HPIs in real-time as they were updated, the HPIs seems to fall quite

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neatly into one of two main categories of HPIs, depending on whether they are based on *housing stock-weights* or *sales-weights*.⁴

A main purpose of this exercise is to describe the sources and methods behind these HPIs which will help us understand their complicated revision history since the first HPIs of the "modern era" appeared around 1985. This exercise will also provide insights in properties of the first vintage of composite historical HPIs published in HMS I (2004), and it will be a useful guide when we revise the composite national HPI and regional HPIs for this *HMFS for Norway* project. We will also give a brief account of the history of national HPIs in Norway since 1985.

11.3 A brief overview of sales-weighted and stock-weighted HPIs for Norway

Figure 11.3 illustrates that revisions in HPIs have been frequent and there are also several examples of level shifts in the data series. These shifts represent key differences underlying these individual HPIs, such as the type of model used to control for quality differences in the sample or the choice of weights used in the aggregation procedure. We will provide more details on this below. The key message we take out from Figure 11.3 is that the HPIs seem to follow distinct trends as we observe the developments from the early 1990s onwards depending on whether the HPIs are based on *housing stock-weights* or *sales weights*.

In the following subsections we will discuss the main sources behind these revisions and shifts in further detail. Furthermore, this section also draws on related work in the HMFS-BIS project mentioned in Chapter 1, which involves ongoing work in ten central banks on the collection and documentation of historical monetary and financial data, including house prices.

- The *HMFS for Norway* project offered an opportunity to conduct a broader evaluation of the sources and methods available to construct long runs of composite historical HPIs for Norway.
- We detected a break in the updates from 2014 to 2018 right after the transition to NEF/Eiendomsverdi, which required correction to make the HPIs consistent with previous constant-quality HPIs.
- The evaluation revealed numerous breaks in real time updates of the hedonic HPIs produced by NEF/FINN/Econ. In a study we have evaluated the real-time properties of a wide range of monthly, quarterly and annual HPIs from this source across the period 1985-2013 (Eitrheim, 2022). Over this period the production and publication of HPIs was becoming more frequent and extensive, the number of regions which were covered increased, quarterly updates appeared from 1994 onwards and monthly updates replaced the quarterly reports in 2002.
- The brief history of HPIs from 1985 have reminded us about changes in aggregation procedures in 1996 and 2004, respectively, when house stock-weights first replaced sales weights in 1996 and

⁴ Figure 11.3 thus corroborates the view stated in Eurostat's Handbook on Residential Property Price Indices (RPPIs) in Eurostat (2013, 1.6 on page 14), "Broadly speaking, two separate types of RPPi can be distinguished: a constant quality price index for the stock of residential housing at a particular moment in time and a constant quality price index for residential property sales that took place during a particular period of time. The construction of these two types of index will be different; most particularly, the weighting associated with the two types will differ."

11.4 Econometric approaches to estimating HPIs

the years thereafter until this was reversed from 2004 onwards, and sales-weights have replaced house stock-weights thereafter.

- There is also a need to account for the sequence of breaks observed in 1997 due to real-time updating procedures and annual revisions of hedonic model estimates from 1997 onwards. There were also adjustments due to the enlargement of the sample of transaction prices from 2002 onwards when one started to use data collected by FINN.NO. See Eitrheim (2022) and Section 11.6 for more details.
- The changes in HPIs produced before and after 2013 needs some explanation. Unfortunately we lack comprehensive documentation of the SPAR-type HPIs produced by Eiendomsverdi AS in collaboration with NEF & FINN.NO. Access to data from Eiendomsverdi is subject to a licencing agreement and the data are not available in the public domain (private sector data).
- Quarterly HPIs produced by Statistics Norway are publicly available for the period back to 1991 for the total country, and from 2005 for regions similar (but not equal) to the cities covered by the repeat sale based housing price indices presented in HMS I.

Before we continue and explore in more detail the properties of the available vintages of aggregated HPIs in Norway since the mid 1980s we will provide some background and history of their sources and methods of construction.

Before we discuss the details of the different HPIs shown in Figure 11.3 it is useful to provide some background and a brief presentation of the main types of HPIs we consider in this chapter.

11.4 Econometric approaches to estimating HPIs

The construction of HPIs raise methodological problems primarily due to two main characteristics of the housing market. Firstly, houses are inherently heterogeneous in nature because of obvious quality differences between houses of different dwelling type, size, amenities and location. Secondly, houses are put to the market only infrequently. Typically, less than ten percent of the housing stock is subject to a sale/purchase transaction in any given year. In the following we provide a brief overview of the most common methods used to construct HPIs.⁵

We distinguish between crude average based HPIs and constant-quality HPIs. When we consider long runs of HPIs we have to combine different types of HPIs such as we have seen above. Depending on the amount of details available on house sales in a given period one may use different methods to control for quality differences when constructing HPIs from sample observations of transaction prices. We refer to Eitrheim and Jobst (2022) for a broader discussion of methodological aspects related to the design and construction of historical HPIs.

⁵ An international overview of HPIs appeared in BIS (2005) and offered some recommendations for future work. International standards on HPIs appeared in Eurostat (2013), Handbook on Residential Property Price Indices (RPPI handbook) and Eurostat (2017), Technical manual on Owner-Occupied Housing and House Price Indices (OOH manual).

Crude average HPIs

House price indices based on only broad summary statistics, such as the annual mean or median sales price, may be of some interest as they are readily available, albeit crude, indicators of house price developments. But it is important to recognize that such crude indicators might be heavily affected by compositional effects if the houses, which are traded in a given year, have a composition which changes from year to year, reflecting differences in quality, relating to the size, amenities, geographical location, etc. of the houses being traded. The quality of a given house may also change over time as a result of renovation and/or depreciation.

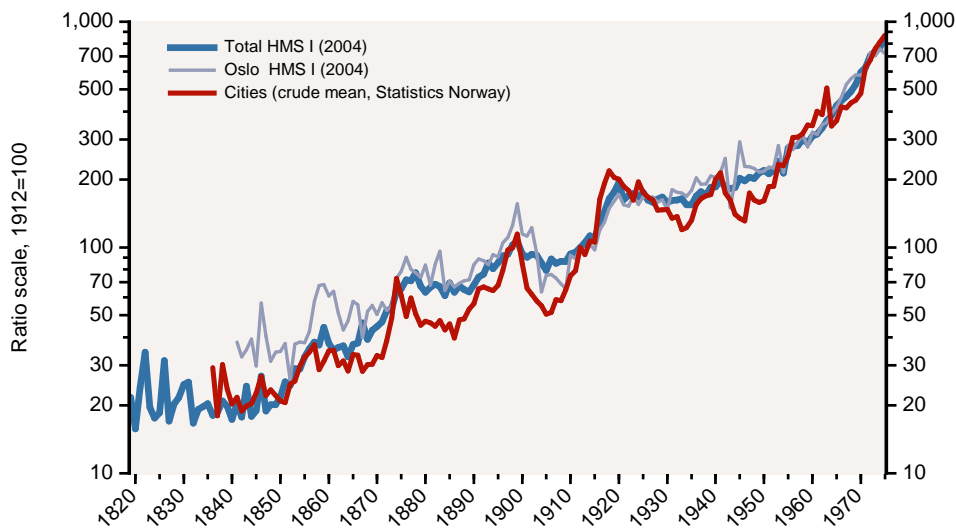


Figure 11.4 A comparison of composite historical HPIs in HMS I (2004) with the crude average property price HPI for Norwegian cities published by Statistics Norway from 1836 to 1975.

One example of a crude average HPI is the average property price for Norwegian cities which was published by Statistics Norway from 1836 until 1975. These data are shown in Figure 11.4 together with the Total and Oslo constant-quality HPIs published in HMS I (2004).⁶ The crude average HPI for Norwegian cities shown as the red line is clearly more volatile and shows larger swings compared with the two constant-quality HPIs in Figure 11.4. But in some of the periods with large swings in the 1800s, the crude HPI from Statistics Norway matches the development in the constant-quality HPI for Oslo (which was named Kristiania until 1925), in particular this seems to be the case during the buildup period before the Kristiania crash in 1899. We will return to this episode in a later section. From 1920 onwards Figure 11.4 shows that both constant-quality HPIs are less volatile in comparison with the crude HPI for Norwegian cities. We suspect that this has to do with changes in

⁶ See Eitheim and Erlandsen (2004, 2005).

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the composition of property sales, at least this is a reasonable hypothesis during the crisis years of the 1920s. Interestingly, the constant-quality HPIs show only a moderate downward trend during the deflation years of the 1920s and early 1930s. We will therefore expect to see a significant rise in real house prices measured this way during these years.

Constant-quality HPIs

The following list give an overview of the methods which are typically being used to control for quality differences in HPIs. We note that for many countries constant quality-HPIs will often be available only for the past two or three decades or so. Their availability may also be limited in the public domain in cases when constant quality-HPIs are provided by one or more private companies subject to subscription and licencing conditions.

- 1 Mix-adjustment (stratified)
- 2 Hedonic model (data intensive)
- 3 Repeat Sale (wasteful of data)
- 4 Sales Price to Appraisal Ratio (SPAR)
- 5 Hybrid models combining 2 & 3 or 2 & 4

The methods for constructing HPIs we have listed above differ in their requirements for data input. The hedonic model is by far the most data intensive as it needs data on both sales prices and all available house characteristics required to form a well specified hedonic regression model from which the HPI can be backed out. The SPAR method requires data on sales prices and a matching appraisal value for each house in order to form the sales price to appraisal ratios, which constitute the basis for calculating the HPI. The repeat sale model only needs data on the sales price but restricts the sample to contain only those houses, for which matching pairs of two consecutive sales prices exist. The repeat sale method also require that the depreciation of the house which takes place between the times of two consecutive sales should match the upgrading and maintenance of the house during the same period.

11.5 A brief history of modern era HPIs in Norway from 1985 onwards

The Norwegian housing and credit markets were deregulated in the 1980s.⁷ A credit-fueled boom-to-bust episode developed and resulted eventually in a fully fledged banking crisis in Norway from 1988 onwards. The housing price bubble which emanated during these years triggered a lot of interest in HPIs, but the information available at that time was scarce.⁸

It may seem like a paradox in hindsight, but Statistics Norway had discontinued the reporting of their crude HPI-measure only a decade earlier (Figure 11.4). Statistics Norway had been reporting a small set of crude average property prices since 1836. For some reason, which is not known to the author of this chapter, these crude HPIs were discontinued in 1975, maybe because they were regarded as being of insufficient quality.

There was also a growing interest in HPIs internationally. The BIS started to pay closer attention to developments in property markets in the late 1980s and early 1990s. It was also recognized that there were numerous challenges involved in collecting good house price data. The time was ripe for a new era of HPIs to emerge on the scene, which could be of help to evaluate the developments in real estate and residential housing markets and their effects on the real economy.

The strong credit growth helped fuel the strong growth in housing prices as well as strong growth in GDP, in particular in private consumption and investment. This strong growth in private consumption was, however, largely undetected in the National Accounts data, in particular for 1985, and were subject to large revisions as described in a study of real-time data uncertainty and monetary policy by one of the editors of this volume (Qvigstad, 2001).

The role of housing prices as an explanatory factor for the cyclical behaviour of household saving in Norway was discussed in empirical studies of wealth effects on private consumption (Brodin, 1988; Brodin and Nymoen, 1992). These interactions between private consumption, household income and household wealth were also important building blocks in the household sector submodel of Norges Bank's macro model RIMINI (Bårdsen, Eitrheim, Jansen and Nymoen, 2005, Chapter 2).⁹

Equipped with better HPIs it became possible to make useful empirical models of housing prices, which were grafted into RIMINI from 1993 onwards (Eitrheim, 1993, 1994). These HPIs, which will be described in more detail below, entered into RIMINI's submodel for the household sector to help capture the interaction between housing prices and credit to households. Furthermore, on the basis of these submodels a set of indicators of financial fragility was also derived and integrated in RIMINI as explained in a BIS paper (Eitrheim and Gulbrandsen, 2001).

⁷ See Krogh (2010) for a detailed discussion of how the use of regulatory instruments of the 1965 Credit Act was changed in this period.

⁸ This bubble episode and that of the Kristiania crash in 1899 are among the 23 bubble episodes which were discussed in Brunnermeier and Schnabel (2016).

⁹ RIMINI is an acronym for a model for the Real economy and Income accounts – a MINI version. RIMINI was used by Norges Bank from the early 1990s until 2003 as a tool for making projections 4-8 quarters ahead as part of the bank's Inflation reports (Olsen and Wulfsberg, 2001). See also Berg and Kleivset (2014) for an overview of methodological developments in Norges Bank in the period 2001-2013.

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HPIs produced in partnerships with the Real Estate Agents Association (NEF)

A set of constant-quality HPIs for Norway are available from 1985 onwards. A private partnership was established in the late 1980s between the Real Estate Agents Association (NEF) and the Norwegian Building Research Institute (NBRI).¹⁰

The NEF-NBRI partnership produced a small set of sales-weighted hedonic HPIs which covered the period from 1989 onwards. For the period 1985-1988 a set of HPIs were constructed as crude average prices of observed sales prices for different dwelling types. Two sets of aggregated HPIs were made available from these, using either sales weights or stock weights. We denote these as mix-adjustment HPIs for these years.

The first constant-quality HPIs for Norway appeared in 1989 in two reports from NBRI, which reported estimates of HPIs based on hedonic regressions across three different dwelling types for each of the final three quarters of 1989. The main gain from these hedonic regressions was that they controlled for differences in size of the houses which were traded in each period and their location. The published HPIs were based on assumptions about a representative size of each of the three dwelling types, apartments, semi-detached homes and single homes. These representative sizes were based on sales-weights, i.e. on the average size of houses of each dwelling type which were traded across the three quarters in 1989 for which it was considered to be a sufficient number of sample observations. In addition there were estimates of HPIs across size groups for each dwelling type ranging across small, medium and large units. Regional HPIs were provided for four distinct geographical areas. In 1990 NBRI published three tertial reports each of which covered consecutive four-months periods.

In 1991 a consultancy company, Econ, took over as NEF's partner and continued to construct and update sales-weighted hedonic HPIs three times each year, and from 1994 on a quarterly basis. The published HPIs were predominantly sales-weighted until 1996 when Econ made changes both in the underlying model and in the weighting scheme. They still used sales-weights to form average prices for different dwelling types but the national HPI was from 1996 onwards based on stock-weights for these dwelling types using weights from the 1990 population and housing census. All HPIs were revised back to 1985 and we will see examples of the level shifts caused by the changes in weights in a later paragraph.

A substantial change took place in 2002 when the Association of Real Estate Undertakings (EFF, from 2014 Real Estate Norway) and the internet advertiser FINN.NO joined the partnership.¹¹ The set of transaction data underlying the reported HPIs was then substantially enlarged as FINN.NO, who collects data on behalf of the members of Real Estate Norway, contributed with IT-technology

¹⁰ The Norwegian Building Research Institute (NBRI) was originally established in 1946 as a free standing research institute in the public sector. With the increased interest in housing prices in Norway after the deregulation of housing markets in the early 1980s a few researchers at NBRI started to work on HPIs and joined this partnership with NEF which lasted until 1991. In 2007 NBRI joined the research organization SINTEF and was included into Sintef Building Research, which has thereafter expanded its research and marketing activities. In 2019 Sintef Building Research changed its name to Sintef Community.

¹¹ EFF/Real Estate Norway is since 2002 the owner and rights holder of these HPI statistics but continued the joint partnership and cooperation with NEF.

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which could collect transaction data more effectively. Regional HPIs were from January 2002 onwards published on a monthly basis and the enlargement of the data set also allowed for HPIs to be calculated for a larger number of geographical regions. The national HPI was revised using monthly data going all the way back to January 1997 whereas the monthly HPIs with a higher degree of regional granulation started in January 2002.

The Econ/NEF/EFF/FINN.NO partnership continued for more than two decades from 1991 through 2013. A substantial revision took place in 2004 when they decided to revise the weighting scheme in a way which affected the regional HPIs for the different dwelling types and consequently the national aggregated HPIs. One effect of this revision was that it reversed the 1996 decision such that the HPIs were again from 2004 onwards based on sales-weights rather than on stock-weights. This would in itself cause a new shift in HPI levels. It was however also decided that the HPIs from 2004 onwards should be based on a set of weights and assumptions about the representative size of each dwelling type which was updated on an annual basis.

The new aggregation methods implied that the history of HPI levels would change back to 1997 each time the weights were updated. This was as a consequence of the decision to let the HPIs from 2004 onwards be based on weights which were updated on an annual basis while the history of HPI levels before 2004 would be calculated on the basis of fixed weights and extrapolated backwards using historical growth rates. In Econ (2004) and the subsequent reports it was stated that these changes were small. We have looked at this in more detail and conclude that the accumulated revisions back to 1997 are of a magnitude which calls for a break-adjustment in 1996/1997.

In 2007 Econ merged into the Finnish consultancy company Pöyry and formed its Norwegian branch Econ Pöyry. The joint partnership between Econ Pöyry/NEF/EFF/FINN.NO continued and produced monthly updates of HPIs throughout the year 2013. In total the HPIs from this partnership cover the period 1985-2013, and on different frequencies, monthly, quarterly and annual. Annual data for the national HPI are available from 1985, quarterly data from the late 1980s and monthly data from 1997 onwards. We will look at the revision history of the national HPI in more detail in a later subsection.

This private sector partnership changed in 2014. A newly established company Eiendomsverdi AS, which is owned by four of the largest banking constellations in Norway, DNB, Sparebank 1, Eika and Nordea, joined a new partnership with Real Estate Norway, and they took over from Econ Pöyry the task of constructing monthly HPIs using transaction data from FINN.NO. Real Estate Norway owns and publishes The Norwegian Housing Price Statistics in cooperation with Eiendomsverdi AS and FINN Eiendom AS. In doing this Eiendomsverdi decided to apply a different methodology, a variant of the SPAR-method (Sales Price to Assessed price Ratio) briefly mentioned above, but where predictions from hedonic models are used to form the appraisal values in what we will denote as SPAR-type HPIs or Sales Price to Predicted Price Ratios HPIs (SPPPR HPIs). This set of SPAR-type HPIs have been calculated back to January 2003, which is still used as basis month-year and set equal to 100. Unfortunately, there is only a brief description available which explains the main

11.5 A brief history of modern era HPIs in Norway from 1985 onwards

elements of the econometrics behind the construction of SPAR-type HPIs from Eiendomsverdi. We will return to this in a paragraph below on revisions in the national HPIs.

We may summarize and note that the Norwegian Association of Real Estate Agents (NEF) contributed to the production of HPIs from the mid-1980s onwards, in different private sector partnerships, since 2002 with Real Estate Norway as the owner and rights holder of these HPI statistics. Their current partnership with Eiendomsverdi AS can be seen as the fifth generation of such arrangements, as briefly summarized in the following list.

- 1985-1988 Crude measures of average prices for some housing types with no further adjustments for quality differences. The first vintages of housing price statistics cover the years 1985-1988 and show crude average prices for different type of dwellings across different regions. The mix-adjustment HPIs for these years do not control for house size or other quality variables.
- 1989-1995 Hedonic HPIs were initially produced by NBRI/NEF until 1991 when Econ took over as partner. The HPIs were based on hedonic regressions controlling for house size and location. Econ/NEF calculated HPIs for up to 19 regions and three housing types. From 1992 onwards these HPIs were updated on a quarterly basis. A stock-weighted national HPI was calculated from estimates of sales-weighted national HPIs for the different type of dwellings.
- 1996-2001 Hedonic HPIs were based on a revised model developed by Econ/NEF. The HPIs were calculated for up to 39 regions and were updated on a quarterly basis. The HPIs were recalculated from 1985 onwards and reported for single homes with size 150 m², semi-detached homes with size 115 m² and apartments with size 80 m², respectively. A stock-weighted national HPI were calculated from estimates of sales-weighted national HPIs for the different dwelling types assuming constant dwelling sizes.
- 2002-2003 Hedonic HPIs were calculated by Econ/NEF/EFF/FINN.NO for up to 39 regions, from now on using data from the internet advertiser FINN.NO which joined in as a partner together with NEF, EFF and Econ. Since January 2002 on a monthly basis using data from 1997 in the estimation. A stock-weighted monthly HPI for the national HPI is available from January 1997. Regional monthly HPIs are reported from January 2002.
- 2004-2013 Hedonic HPIs were calculated by Econ/NEF/EFF/FINN.NO for up to 52 regions, on a monthly basis using data starting in January 1997. The aggregation methods are discussed in detail in Econ (2004). National HPIs were calculated from estimates of HPIs for different dwelling types using sales weights. Constant weights based on sales 1985-1995 were used when calculating national HPIs for the period 1986-1996. The weights were updated on an annual basis from 1997 onwards based on three-year rolling averages of reported sales of different dwelling types as well as their size. The result of this shift from stock-weights to sales-weights was a significant positive shift in the levels of the national HPI.
- 2014-2020 SPAR type HPIs (SPPPRs) are calculated by Eiendomsverdi/Real Estate Norway for up to 23 regions, starting in January 2003 and the HPIs are updated on a monthly basis. These HPIs are chain-linked and the data history is in general not subject to revision. There has been one exception in 2018 when the underlying calculation methods were changed. The resulting HPIs

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are available subject to a licence fee for subscribers. When this overview is written there is still no publicly available technical documentation of these HPIs, e.g. in the format of a published working paper.

HPIs used in Norges Bank's model RIMINI

As we have mentioned above, equipped with new HPI data in the late 1980s the first attempts were made to model in RIMINI empirically how private consumption would respond to changes in household income and wealth, but also how house prices would respond to shocks to unemployment and interest rates in a deregulated economy. We were also interested in exploring potential propagation channels of such shocks when the banks' mortgage loans to households were secured using housing capital as collateral. For these purposes we considered two alternative HPIs in empirical research.

The first HPI combined information about housing prices collected from different sources. Until 1984, it was simply equal to the price deflator for housing investments in the quarterly national accounts (QNA). Between 1984 and 1986, the index was based on information from the central register on real estate and dwellings in Statistics Norway¹², cf. Brodin (1989). From 1986 the HPI was based on market prices collected by the Norwegian Association for Real Estate Agents (NEF) and show a *sales-weighted* average of the prices of traded dwellings (a weighted average of prices on owner occupied single house units traded in different regions). From 1991 onwards a *stock-weighted* HPI was produced by Econ/NEF on demand from Norges Bank's Research Department for the purpose to supply the RIMINI-model with a *stock-weighted* HPI, which was used to calculate the value of the housing capital owned by the household sector as an important part of household wealth. These *stock-weighted* HPIs were updated on quarterly basis until 2003 and are shown in the lower branch of data shown in Figure 11.3.

The second HPI took into account some aspects of the Norwegian housing market during the 1970's and early 1980's which were not covered by Brodin's HPI. This HPI incorporated the effect on average housing prices from the price deregulation which took place in 1982 for a substantial fraction of the apartment buildings. By changes in the relevant legislation, price ceilings were either abolished completely or raised sufficiently to render price regulation practically ineffective after 1982. From 1988 this HPI was spliced with growth rates from the first HPI. This HPI was used in the empirical house price model in (Eitrheim, 1993, 1994), which was grafted into Norges Bank's macromodel RIMINI from 1993 onwards.

HPIs published by Statistics Norway

A small set of quarterly HPIs were published by Statistics Norway (SSB) from 1993 onwards. The HPIs started in 1991 and were based on hedonic regressions, which accounted for qualitative attributes of different types of dwellings across a small set of regions. A *stock-weighted* HPI for the country as a whole was also constructed. SSB's HPIs have later been revised and extended to cover

¹² The GAB-register.

11.6 A summary of real-time revisions in Norwegian HPIs

more geographical regions. From 2009 SSB's HPIs are based on data on house sales collected by FINN.NO, supplemented with information from the central property register (the cadastre). The most important explanatory quality variables represent house size and location.

The *sales-weighted* HPIs from Eiendomsverdi/Real Estate Norway, which appears on a more timely basis only a couple of days into each month, are frequently compared with the official *stock-weighted* quarterly HPI from Statistics Norway. On several occasions, the two indices have shown different developments in the housing market. A short article by Baug, von Brasch and Takle (2018) explains why.¹³

The article first states that the underlying price data material is the same for both indices, covering about 70 per cent of the turnover in the housing market. However, the indices are different in how the price trends for different types of housing by geographical region are weighted together. Large regional price growth differences, especially between the western parts of Norway and the Oslo area 2014-2018, explain the gap between the two indices according to Baug et al. (2018). In contrast to the HPI from Eiendomsverdi/Real Estate Norway the HPI from Statistics Norway is well documented in a series of documents (Lillegård, 1994; Statistics Norway, 2006; Takle, 2012).

11.6 A summary of real-time revisions in Norwegian HPIs

This section provides an overview and evaluation of the composite housing price indices (HPIs) which originally appeared in HMS I in 2004. Since then the composite HPI has continuously been updated in Norges Bank's HMS II (www.norges-bank.no) database. The updating has mainly been undertaken by Norges Bank's Data Management unit, which was established in the mid 2000s. The numerous changes in the HPIs listed in the paragraphs above indicate that it would have been an almost impossible task to monitor all these developments in real-time.

In the following we take a closer look at some properties of the updated HPIs which have appeared at www.norges-bank.no during the HMS II period since 2004. We have also conducted a study of the real-time properties of Norwegian HPIs (Eitrheim, 2022). This study has in particular been concentrated on describing revisions of HPIs produced by the private sector partnership Econ Pöyry/NEF/EFF/FINN.NO for the period 1985-2013, but we have also included the more recent vintages of HPIs produced by Eiendomsverdi, Real Estate Norway and FINN.NO Eiendom from 2014 onwards.

The main lessons from this study are the following: The main sources of revisions are changes in weighting schemes and changes in sample properties such as the average size of the traded houses in a given period. A minor source of instability arises from a cutoff of trading days when the HPIs were reestimated for a particular month, such that the HPIs could be published only a few days into the new month. Therefore, an incomplete sample of house price observations is used for the final month

¹³ This article originally appeared in Norwegian on 5 April 2018 on Statistics Norway's website. An English translation of this article is today available from Real Estate Norway's webpage at <https://eiendomnorge.no/blog/why-do-the-price-indices-from-real-estate-norway-and-statistics-norway-vary-article1459-944.html>

Revisions and break-adjustments in house price indices

and the sales that took place during the last trading days in that month would not enter the sample until the following month. A break-adjustment was deemed necessary to restore a reasonable rate of change in the national constant-quality HPI between 1996 and 1997.

The study confirms that we have more precise knowledge about the rate of growth in HPIs than in their levels. We also acknowledge the fact that the two current producers of HPIs, Eiendomsverdi and Statistics Norway, only publish HPIs in a true index format, which means that the published constant quality HPIs are set equal to 100 in a base year. Secondly, we take note of the fact that both producers follow the rule that their HPIs are not subject to revision. But, as we saw in January 2018, this rule has been subject to one exception for Eiendomsverdi's HPI.

We round off this chapter with an overview in Figure 11.5, which shows the national HPIs as they have developed through different vintages from 2005 until 2020. To keep track of the different HPIs we introduce some simple terminology. We denote as HMS0 and HMS1 the historical repeat sale HPIs which were reported in Eitrheim and Erlandsen (2004, 2005). HMS2 denote the composite HPIs which appeared in the updated HMS database, which spliced the repeat sales HPIs for the period prior to 1985 with hedonic HPIs produced by *Econ/NEF/FINN.NO* for the period 1985-2013, and, thereafter with the SPAR-type HPIs produced by *Eiendomsverdi/Real Estate Norway/FINN.NO* from 2014 onwards. Figure 11.6 shows a similar overview of the composite historical regional HPIs for Oslo, Bergen, Trondheim and Kristiansand as they developed in the period 2005-2020.

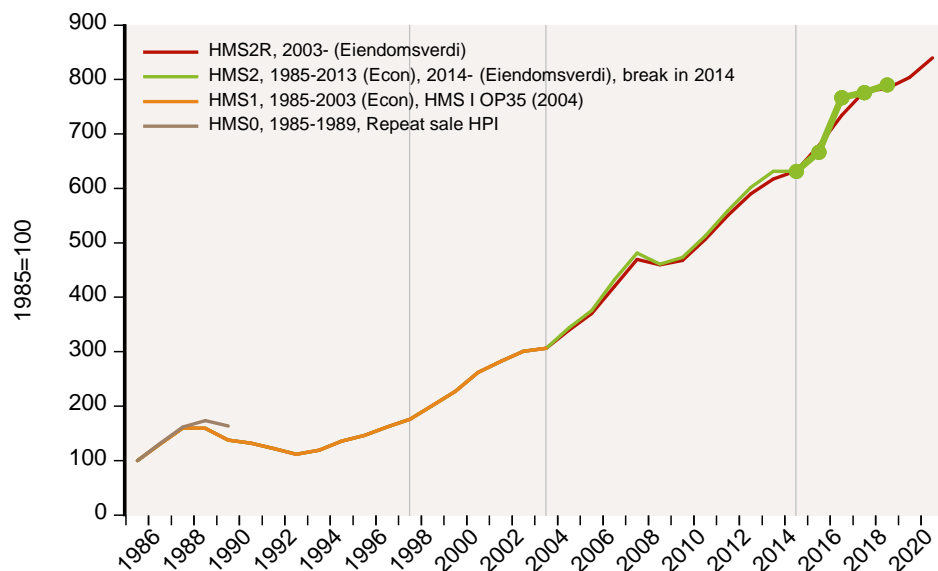
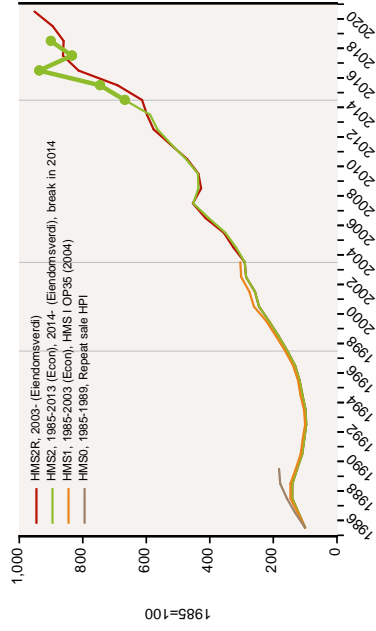
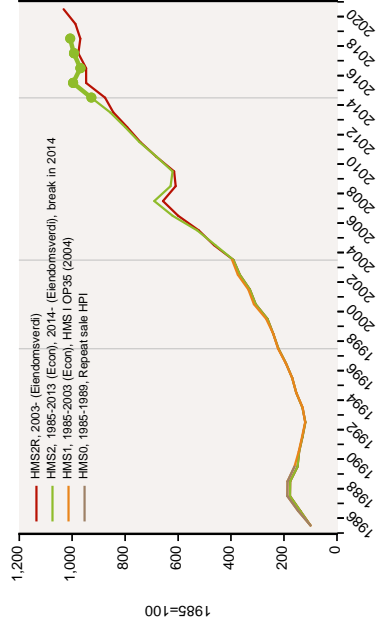


Figure 11.5 Total House Price Indices (HPIs) in different HMS vintages 2004-2020.

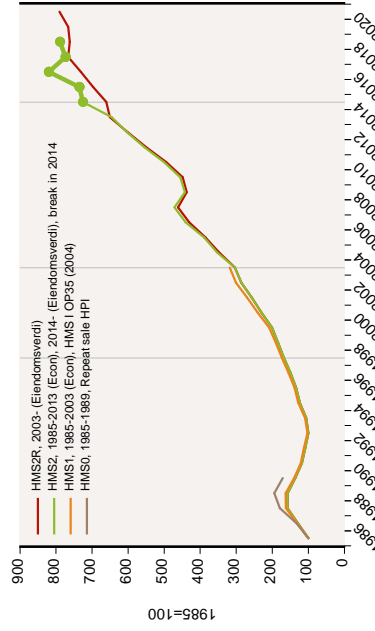
One problem we detected is illustrated by the green lines which are highlighted in Figure 11.5



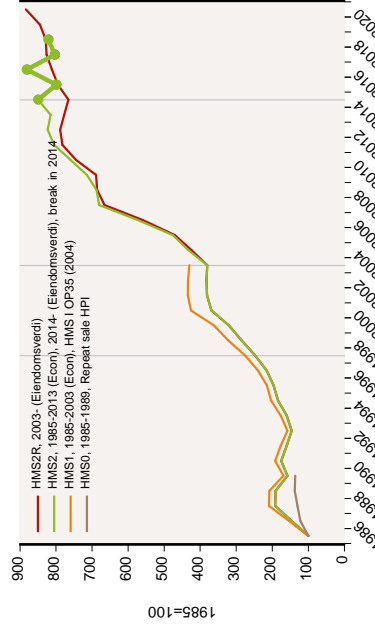
(a) Oslo



(b) Bergen



(c) Trondheim



(d) Kristiansand

Figure 11.6 Regional House Price Indices (HPIs) in different HMS vintages 2004-2020.

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and Figure 11.6. We see clear indications of a shift both in the national HPI and the four regional HPIs for Oslo, Bergen, Trondheim and Kristiansand, respectively, when we compare the green lines for 2014-2018 with the red lines which represents the constant-quality HPIs produced by *NEF/Real Estate Norway*, and which should have been used to update the HPIs in HMS from 2004 onwards. The constant-quality HPIs pick up the relevant differences in growth rates in this period but turn out to be much less volatile in comparison with the crude average house prices. Note that we have set all HPIs equal to 100 in 1985 for this comparison.

This problem started in 2014 when the HPIs in the HMS database were updated for the first time after *Eiendomsverdi* had taken over as producer of HPIs in the private sector partnership, and, instead of publishing constant-quality HPIs measured in 1000 kroner per m², *Eiendomsverdi* published HPIs which were normalized and set equal to 100 in January 2003. It is important here to recall that all constant-quality HPIs which had been produced and published by Econ/NEF had been reported in measures of 1000 kroner per m². In their report *Eiendomsverdi* published a table with HPIs expressed in 1000 kroner per m² measured as a crude average, but this was not comparable with their new constant-quality HPIs. Unfortunately this lapse was not detected before we started this evaluation in 2018.¹⁴

A revised version of the HPI spreadsheet in the HMS database was published in 2019, which separated more explicitly between the primary HPIs as they emerged from different sources. Each of the primary HPIs were presented using their original units of measurement. The composite HPIs are now only available in an index format, normalized and set equal to 100 in 1912, as was originally the case with the first vintage of HPIs in HMS I (2004). This underlines what we have already stated above that estimates of house prices in levels, say measured in 1000 kroner per m², have greater uncertainty attached to them than estimates of growth rates in constant-quality HPIs.

We do recognize the strong focus many people have on house prices reported in prices per square meter. There are also other novel and creative metrics, which, e.g., express the purchasing power in the housing market for different groups of workers, say, registered nurses, in a geographical dispersed housing market.¹⁵ We will provide a simple example below which illustrates how we may combine historical data for wages and housing prices to provide a historical perspective on how expensive housing capital has been in different time periods.

¹⁴ We have no good excuse for this lapse. A note had been included already in the 2014 House Price Report from NEF/Eiendomsverdi which explained this difference between the constant-quality HPIs and the crude average price calculations underlying assessment of house prices per square meter. This note was unfortunately overlooked.

¹⁵ Real Estate Norway have since 2018 published The Norwegian Registered Nurse Index, with estimates of the shares of houses traded in a given period (in percent) which would be affordable for a single registered nurse across the five largest cities, Oslo, Bergen, Trondheim, Stavanger and Tromsø. The most recent estimate for the South-Eastern part of the country around Oslo published January 2021 indicate that only 2-5 % of the houses are within reach for a registered nurse in this area.

11.6 A summary of real-time revisions in Norwegian HPIs

Figure 11.7 zoom in on the developments from 1985 onwards for a closer comparison between the national HPIs in the different HMS vintages 2004-2020. For this purpose we have calculated HPIs into the metrics of house prices per square meter (in 1000 kroner). We have chosen as benchmark levels for the HPIs the 2003-levels collected from the final vintage of HPIs produced by Econ/NEF, which was produced on a data sample ending in 2013. Figure 11.8 shows similar measures of regional HPIs across different HMS vintages 2004-2020. Figure 11.9 shows their respective growth rates (annual rate of change in percent) from 1985 onwards.

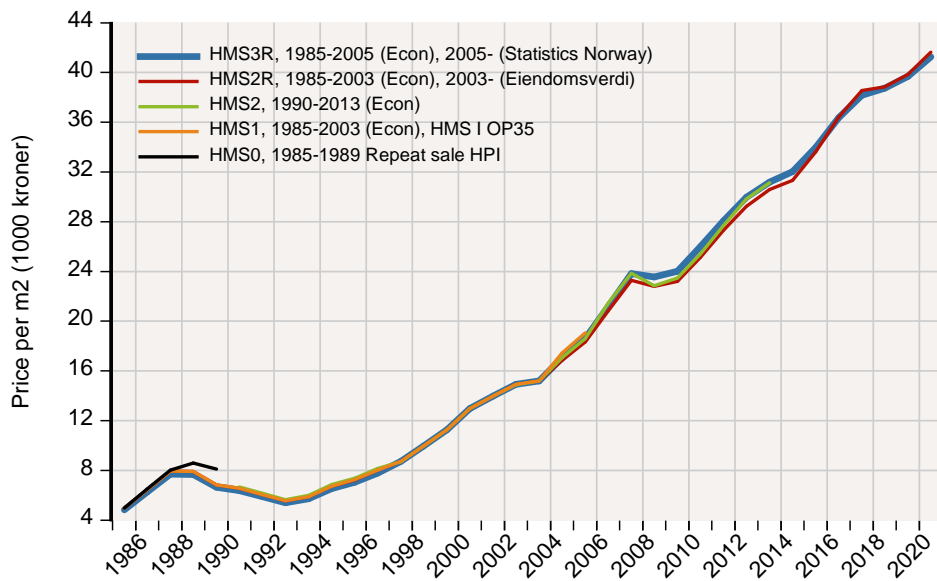
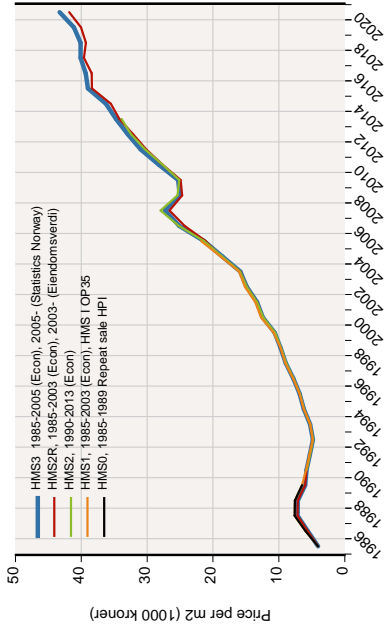
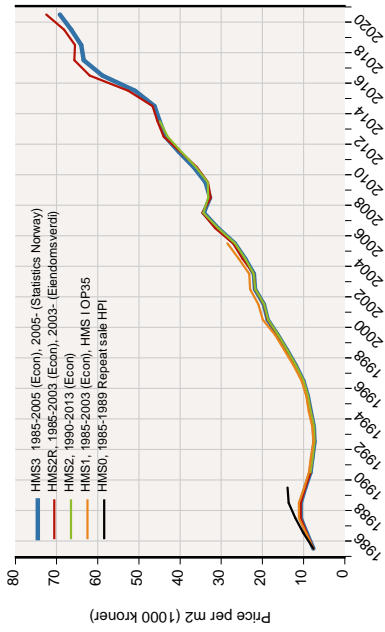


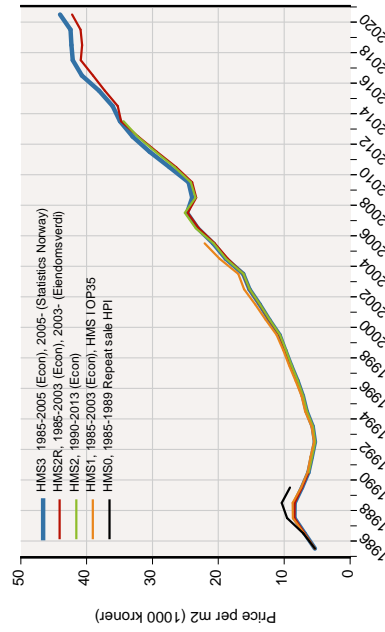
Figure 11.7 Estimated house prices per square meter (in 1000 kroner). Total House Price Indices (HPIs) in different HMS vintages 2004-2020. The composite historical HPIs are linked up against the benchmark house price levels reported for 2003 in the final vintage of HPIs produced by Econ (December 2013).



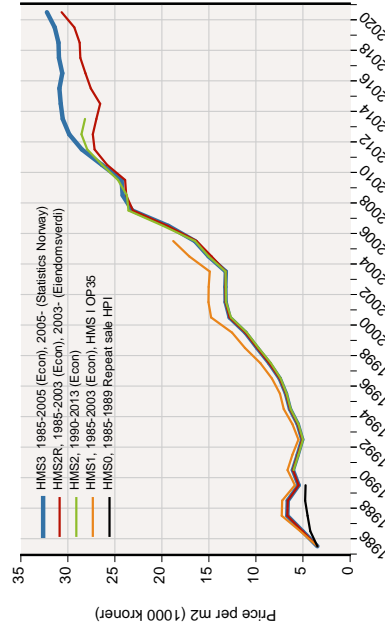
(a) Oslo



(b) Bergen

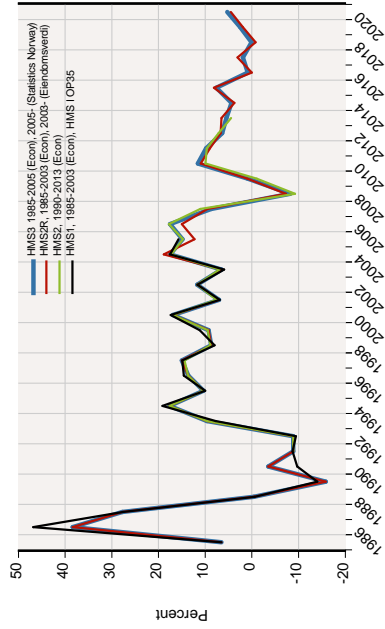


(c) Trondheim

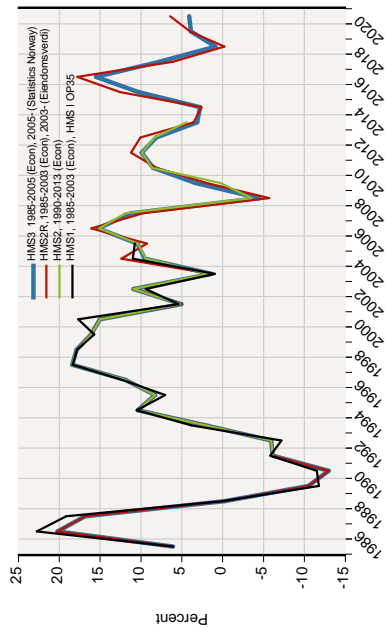


(d) Kristiansand

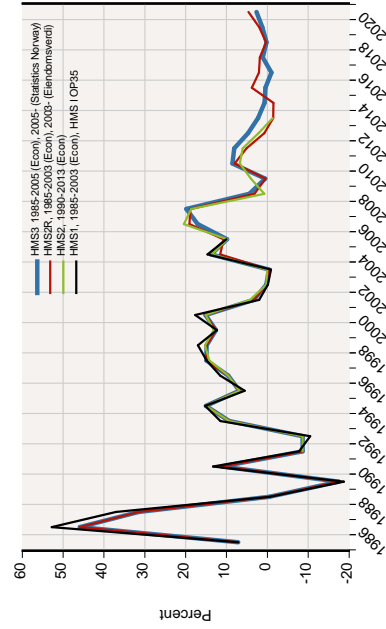
Figure 11.8 Estimated house prices per square meter (in 1000 kroner). Regional House Price Indices (HPIs) in different HMS vintages 2004–2020. The composite historical HPIs are linked up against the benchmark house price levels reported for 2003 in the final vintage of HPIs produced by Econ (December 2013).



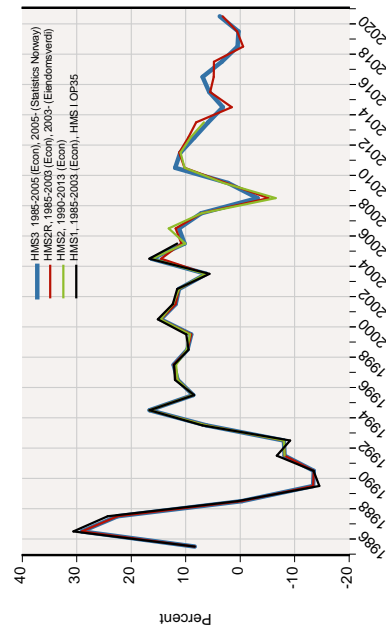
(a) Trondheim



(b) Bergen



(c) Oslo



(d) Kristiansand

Figure 11.9 Regional House Price Indices (HPIs) in different HMSI vintages 2004–2020. Annual rate of change (in percent).

11.7 Two historical illustrations

The Kristiania crash

Figure 11.10 shows the developments in real housing prices in Norway across the past two centuries. The *Kristiania crash* in 1899 stands out as a pivotal point in time, the deep fall in real house prices in Norway's capital Kristiania would take a very long time to recuperate, and it was not until more than a century later in 2003 that the level of real house prices in Oslo had passed the previous peak level from 1899.

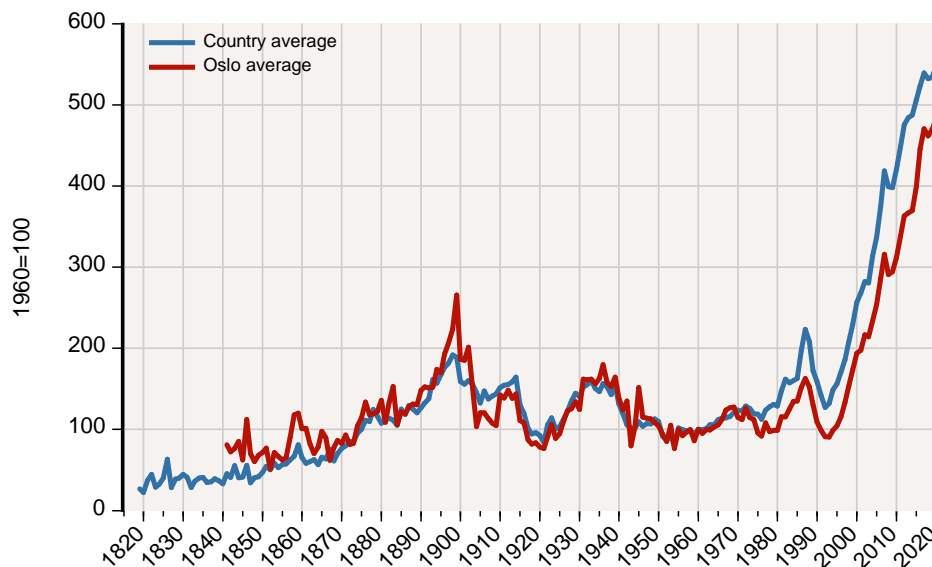


Figure 11.10 Real house price indices across two centuries. A comparison between Oslo (Kristiania until 1925) and the country average.

As the moniker suggests, the *Kristiania crash* was a homespun crisis. The core of the crisis was a property boom in the capital Kristiania, which had expanded rapidly and increased its population by 50 per cent to a quarter of a million inhabitants only during the course of the 1890s. The boom was broadly based and spread from real estate and related industries to banking, fueled by easy money and greatly helped by capital inflow from the increasingly integrated Scandinavian money markets, which had emerged under the Scandinavian Currency Union. In the course of 1897-99, six new banks were established in Kristiania, all heavily exposed to real estate.^{16 17}

In the summer of 1899, the failure of one of the main players, Chr. Christophersen, a highly

¹⁶ Eitrheim, Klovland and Øksendal (2016, Section 6.6, p. 237).

¹⁷ The *Kristiania crash* is included in the overview of historical asset price bubbles in Brunnermeier and Schnabel (2016), see also Gerdrup (2003, 2004) for additional details on this event.

11.7 Two historical illustrations

leveraged non-financial firm, triggered a chain reaction involving banks heavily exposed in real estate. At the critical point, Norges Bank stepped in and provided rediscounting facilities for the distressed banks, and later played a key role in managing the resolution of the crisis, through the restructuring and liquidation of insolvent banks. Norges Bank had graduated from a bank issue to a central bank acting as a lender of last resort.

We also note that Figure 11.10 shows significant increases in the real house price both for Oslo and the country average during the 1920s and early 1930s. We recall that the constant-quality HPIs only showed a moderate deflation during this period, in which the general price level followed a strongly negative deflationary trend.¹⁸

The purchasing power of wages in the housing market

This chapter ties together work on nominal consumer prices, wages and house prices and shows developments in these nominal variables over more than two centuries. Figure 11.11 relates the development in house prices to the average annual wage level. We get an idea of the developments in the purchasing power of the average wage level over this long period by dividing the wage level with the average level of house prices per square meter. Hence, we gauge the purchasing power in the housing market by estimates of the number of square meter housing which can be purchased at different points of time by an average wage.

It emerges clearly that houses were really expensive in the 1800s. Figure 11.11 shows that it was not until after World War 2 that the average wage sufficed to purchase more than 10 square meter in Oslo, and if we look at the country average house price the same holds on average although there were periodical exceptions like the deflation phase in the 1920s when real house prices increased since the general price level fell more than average house prices. The purchasing power increased rapidly during the post-war period until the housing and credit markets were deregulated in the early 1980s.

We have commented earlier in this chapter on the housing boom of the 1980s which burst in 1988. In Figure 11.11 these large swings in the house prices are captured in similar large swings in the number of square meter housing which could be purchased by the average wage. Between 1980 and 1990 these swings ranged between 15 and 27 square meter for Oslo and between 20 and 40 square meters for the country average.

The long period with strong growth in house prices over the past three decades since the early 1990s have eroded much of the purchasing power wages had accumulated during the 1950s, 1960s and 1970s. In 2020 we see that the purchasing power in Oslo is back at its pre-war level below 10 square meter, and similarly, for the country average at its pre-war level around 15 square meter.

¹⁸ See Chapter 10 and 14 for more information on data for historical Cost of Living/Consumer Price Indices (CLI-CPIs).

Revisions and break-adjustments in house price indices

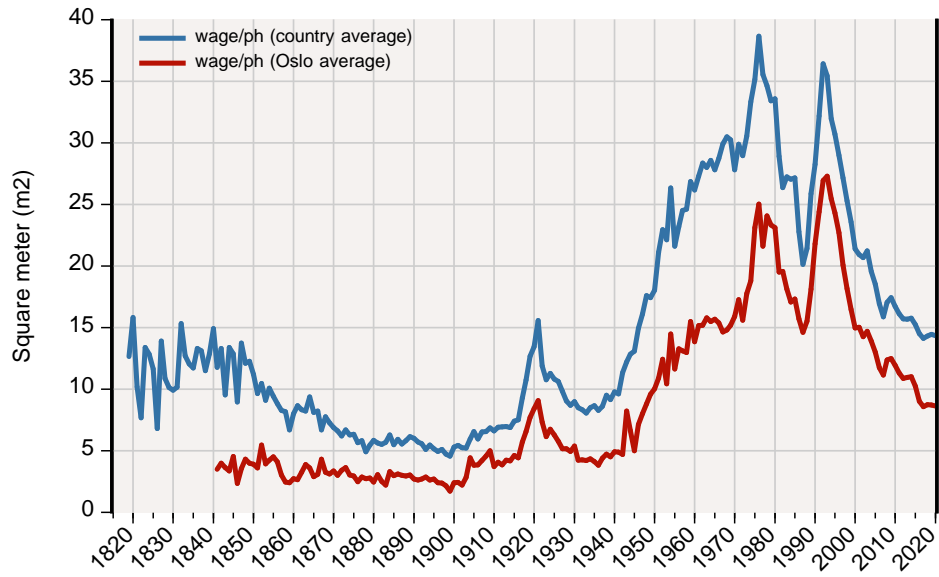


Figure 11.11 The purchasing power of average wages measured in number of square meter. A comparison between Oslo and the country average across two centuries.

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