Euro area residential property prices: the aggregation of non-harmonised national data

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The European Central Bank (ECB) regularly compiles an indicator for euro area residential property prices from non-harmonised national data and has recently established target definitions to improve the information. Main criteria used for selecting national components into the aggregate are geographical and market coverage, quality adjustment, and reliability of source data. In the absence of better quality harmonised indicators, it is difficult to precisely assess the reliability of the current index. Results from aggregating different national price series and using different country weights may, however, at least illustrate the potential error margins of the index. These margins are, compared to other euro area statistics, considerable, though it may be assumed that the price trend is correctly reflected and plausible. The most important and desirable improvements concern the quality of the primary statistics (coverage, quality adjustment) and the publication frequency of the euro area aggregate (from annual to quarterly).

1. Introduction

This paper discusses the euro area[1] residential property price indicator which has been published by the ECB since 2001. It begins with a discussion of the residential property price aggregates that are relevant for ECB use and a presentation of the series currently compiled for the euro area and the national sources used. It then tries to address the question of how reliable the euro area indicator is by analysing the methodological differences between the national data and the impact on comparability. The final section looks into the question of which weights should be used for the aggregation of national series from both a conceptual and a practical point of view.

2. Why are residential property price developments relevant for ECB use and what are the statistical requirements?

The buying or selling of a dwelling is typically the largest transaction a household enters into. Changes in house prices are therefore likely to influence substantially the budget plans and saving decisions of the prospective house buyers and sellers. House price changes will also have an impact on the wealth of owners of dwellings given that the dwelling is the largest asset in their portfolio. Further, to the extent they affect market rents, house prices also affect consumer price indices; in 2003, rents had a weight of 6.4% in the euro area harmonised index of consumer prices (HICP), which is the measure used by the ECB to define price stability in the euro area. Another reason to monitor these price developments is that owner-occupied housing costs are not yet covered in the HICP. Housing prices may also have an effect on residential construction investment, which accounted for 5.0% of gross domestic product (GDP) in the euro area in 2002. Finally, housing prices are used for financial stability analysis, since sharp increases and declines in prices can have a detrimental impact on financial sector health and soundness by affecting credit quality and the value of collateral.[2]

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1 The euro area consists of the 12 EU member states currently participating in monetary union: Belgium (BE), Germany (DE), Greece (GR), Spain (ES), France (FR), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Austria (AT), Portugal (PT) and Finland (FI).

2 See ECB (2003a, pp 8-14) and IMF (2003, Chapters 9 and 14).

How can these uses of property price statistics be translated into statistical requirements? First, as euro area statistics are compiled from national results, a sufficient degree of *comparability* between the national data is important. Second, in order to be useful in the current monitoring of price developments, *quarterly frequency* of the results is desirable. Third, the degree to which residential property price indices are able to eliminate the effect of *quality differences* between different dwellings compared over time is important. Fourth, property price data for the euro area is needed for the following breakdowns. For the *geographical breakdown*, given the substantial dispersion of developments across countries, results are needed for each individual euro area country in order to understand the trends in the euro area aggregate and form an assessment about its future development. In addition, a certain regional disaggregation of national data is often useful (eg West Germany compared to East Germany), since the regional developments may vary considerably. In addition, a distinction at national or euro area level dividing between price developments in urban areas (and/or capital cities) and non-urban areas may be very informative. For the prices for *different housing types*, the breakdown between new and existing dwellings is the most used distinction.

These and other breakdowns are further explored in Sections 3 and 4 below.

3. What aggregates are currently compiled by the ECB?

The ECB compiles a residential property price index for the euro area which is calculated as the average of the annual growth rates of national indicators weighted by 2001 GDP shares. The index is published in the *ECB Monthly Bulletin*.[3] The national components of the overall euro area index are detailed in Annex 1. The series from the four largest euro area countries, which together contribute to 79% of the euro area index, are shown in Graph 1. The selection of national components is based on the degree of market and geographical coverage, the methods used for quality adjustment, the quality of the data source and the sample size. These issues are discussed in detail in Section 4.

The euro area index is calculated when at least 80% of the national data are available. As all euro area countries produce some data on residential property prices the country coverage is close to 100% for most of the length of the euro area series. Where country data are missing at the start or end of the series, the weight is set to zero with the implicit assumption that the missing country follows the same development as the average of the countries for which data is available.

Also important for an indicator used for monetary policy are the frequency and timeliness of the data. The timeliness ranges from one month (Ireland, the Netherlands, Portugal, Finland) to between three to six months in the remaining countries. The euro area aggregate with a coverage of over 80% is available with a delay of around three months, with some countries' latest data being estimated using alternative sources. Since German data are currently available only at annual frequency, a euro area average with a high country coverage can be compiled only at annual frequency. A semiannual indicator can be compiled, but excludes Germany and Luxembourg. Quarterly or even monthly indicators are currently not possible, since, in addition to Germany and Luxembourg, Italy and Austria would not be covered.

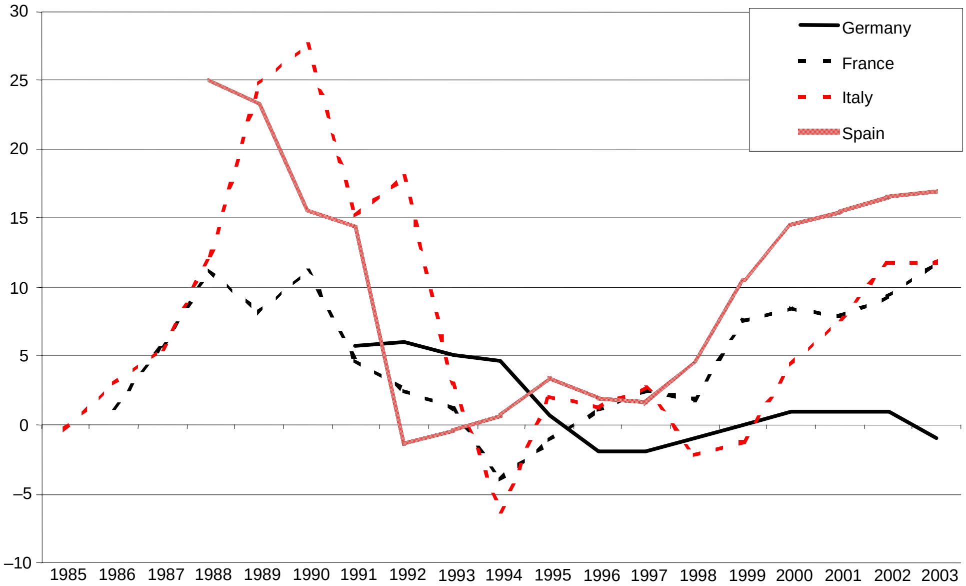
Recent efforts by the ECB and the EU national central banks have attempted to improve the homogeneity of the index and provide some additional breakdowns at both euro area and national level via the adoption of some target definitions of the desired market coverage of residential property price indicators. This work is based on *existing* sources, because EU central banks currently do not collect primary statistical information on house prices. However, the central banks have tried to use existing sources to match the target definitions as closely as possible. This has allowed the creation of breakdowns for new dwellings, existing dwellings and residential property price developments in urban areas of the euro area (Graph 2). Despite these improvements, much work remains to improve the quality of the national data and thereby of the euro area aggregate.

[3] See Box 3 in the *ECB Monthly Bulletin* of October 2002 for the most recent data; at the time of writing, an update was planned for the December 2003 issue.

Graph 1

Residential property prices in the four largest euro area countries

Annual changes, in per cent

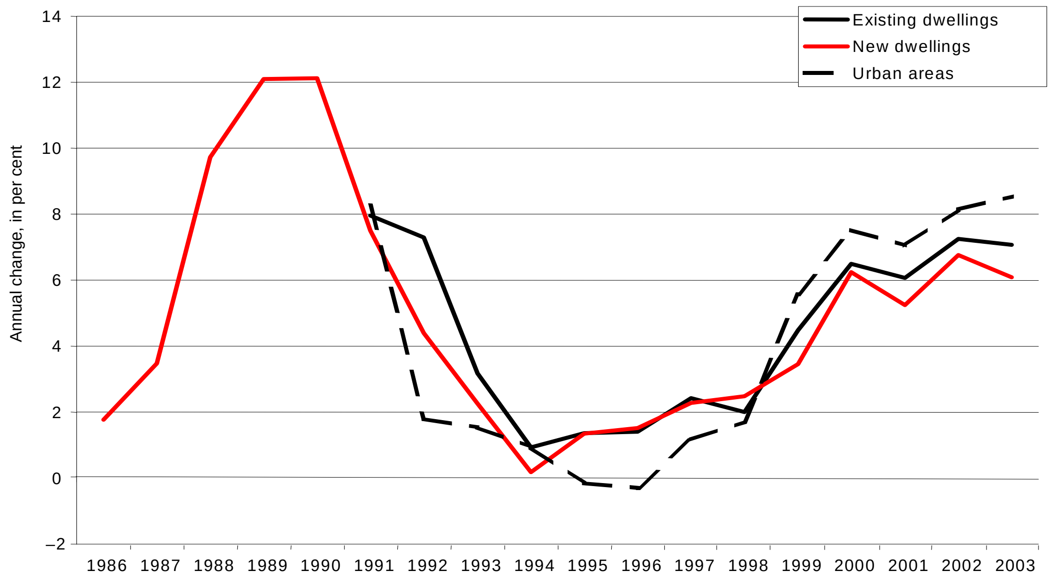


Note: The indicators are those which are included in the euro area aggregate. Germany: for 1991-95, West Germany only.

Sources: National sources; ECB calculations.

Graph 2

Residential property prices in the euro area



Source: ECB.

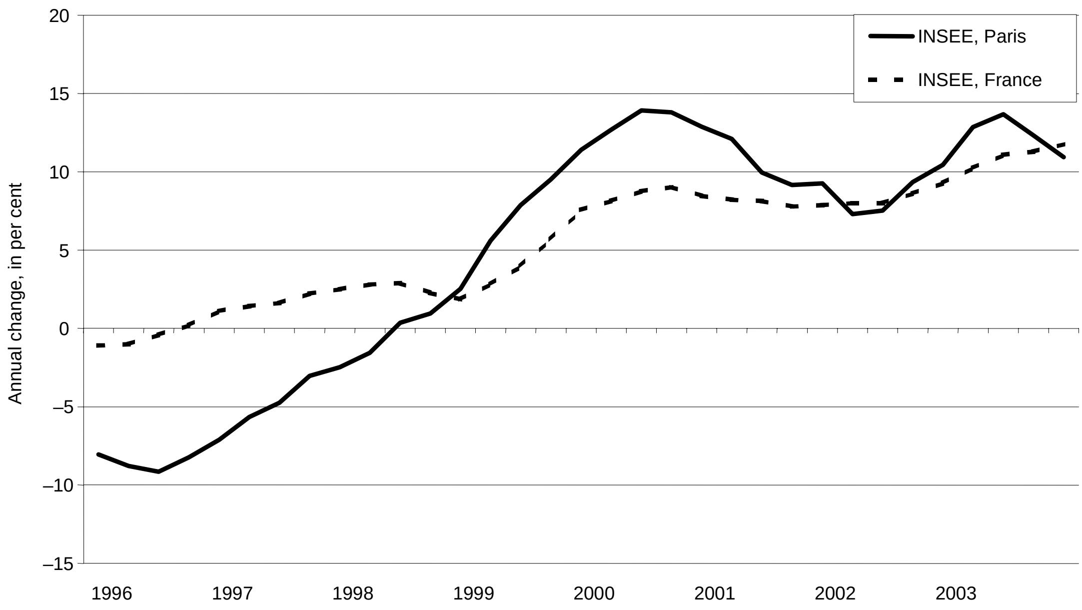
4. How reliable is the aggregation of non-comparable national data?

The methods employed for the compilation of house price indicators vary considerably *between* countries, and even between alternative sources *within* individual countries. A key question with regard to cross-country aggregation is which national series should be used and, given the high degree of heterogeneity between countries, how reliable the resultant index will be. The differences between the available house price indices concern almost every aspect: geographical coverage; market coverage (type of property, mortgage/cash transactions); quality adjustment; data source (tax records, mortgage applications, estate agents, newspapers); index construction; weighting. Each of these differences adds to the likelihood that the non-price factors will affect the aggregate price index and cloud interpretation by users.

Graph 3

Prices of existing dwellings in Paris/France as a whole

Annual changes, in per cent



Source: INSEE.

4.1 What are the differences and what might be their effects?

4.1.1 Geographical coverage

National data

Housing markets tend to be highly segregated between geographical areas. Factors such as population distribution and regional income levels and changes may lead to wide divergence in house price levels, and differing price developments. Many of the local and regional effects on housing markets may cancel each other out in a national aggregate, but this assumes that the national aggregate is a representative average of all regional markets. National sources which provide data on large/capital cities in addition to comprehensive national figures tend to show that city data are more volatile than national averages and sometimes follow different dynamics. Graph 3 shows the annual growth rates of existing dwellings in Paris compared with France as a whole. Whilst there is a high degree of co-movement between the two series (Paris is clearly an important component of the whole of France), the Paris series is more volatile. Even larger differences between local markets were observed, for example, in Germany. Residential property price changes for flats in the two largest German cities (Berlin and Hamburg) in the period from 1995 to 2002 differed substantially from prices in other large cities (eg Frankfurt and Munich) and from the national average (Deutsche Bundesbank (2003)). Reliance on the results for the two largest cities would signal a significant and continued price decline, and would be a misleading indicator for Germany as a whole. It is therefore important that the geographical coverage of national aggregates be as broad as possible and that over-reliance on large cities as a proxy for national data be avoided.

Euro area data

For euro area data similar arguments hold. Since the divergence of national price changes is high, coverage of the euro area aggregate must be high in order to produce a reliable aggregate. In 2002, annual growth rates of the five largest euro area countries varied between –0.2 and 16.6%. This implies that missing national data, or forecast errors for missing national data, may affect the quality of the euro area aggregate. Therefore, a coverage level of 80% of the euro area is considered as the threshold for compiling the aggregate.

4.1.2 Property type

Price developments may also differ between types of property, for instance between new and existing dwellings or between houses and flats. Purchasers are able to substitute between new and existing dwellings and therefore one might expect similar price dynamics. However, newly constructed dwellings may offer both advantages and disadvantages compared to existing dwellings and these may be valued differently according to societal preferences in different countries. Differences may also be due to taxation and subsidies, and regional differences due to a lack of land for construction in urban areas. New dwellings may differ considerably from the existing stock in terms of architectural and technical features as well as location. Prices for new dwellings are, at least in the short term, influenced by construction costs. The empirical results for the euro area countries are, however, not fully clear in this respect and suggest that the differences may be more important in some countries (Ireland, Germany) than in others (Italy, Spain).[4]

Many national sources distinguish between houses and flats, which may broadly represent upper and lower ends of the market. Given that these market segments behave differently under different property market conditions and at different points in the business cycle, the breakdown between houses and flats is useful, and it is important that both are represented in the national overall index. In the euro area aggregate our approach has been to use data which include both new and existing dwellings and both houses and flats. Where a combined aggregate is not available, data for existing dwellings are used as they usually account for a larger proportion of the transacted dwellings. Separate series for houses and flats are aggregated using weights of the respective shares in the housing stock, when available.

4.1.3 Quality adjustment

Price comparisons over time require the availability of comparable housing objects in the two periods under consideration. However, due to heterogeneity of housing markets and infrequent transactions, traditional “matched model” methods for price statistics fail. Quality adjustment is needed to ensure the comparison of “like with like” and to avoid long-term bias in the series. This bias could arise, for example, due to improving living and housing standards, or to new dwellings built further from city centres.

Very basic methods, such as unit value indices of square metre prices, attempt to adjust for the size of the dwellings in each period while still allowing other changes in the composition such as location, amenities, quality of housing, etc, to affect the index. Mix adjustment (or the “classification approach”) defines a classification of dwellings by the characteristics for which it intends to adjust. Individual price indices are then calculated for each cell in the classification, and the overall index is calculated as the weighted average of these subindices. The number of characteristics included in the classification is

[4] German data for new and existing flats differed by 3.7 percentage points in 2002, whereas the corresponding figure for Italy was 0.9 percentage points.

often limited by the number of observations that can regularly be found for each cell. The most advanced form of quality adjustment used is the hedonic regression approach, which uses a regression model to isolate the value of each of the chosen characteristics and thereby adjust the observed prices according to a standardised housing unit. It is sometimes used together with a mix adjustment. An additional method used in US indices is the so-called repeat sales technique, which matches pairs of transactions of the same dwellings over time. This requires a huge database of transactions and is not used by any of the European data producers. The crucial question for all quality adjustment procedures is whether the chosen characteristics used for adjustment are the main determinants of price differences. While some of these are easy to measure (eg size), other important factors (location) are often difficult to capture.

In practice, national indicators used for the euro area aggregate use a variety of techniques to adjust for quality and compositional changes. In three cases, the available measures are simple unit value indicators, ie which do not control for changes in composition and quality (Ireland, Luxembourg, the Netherlands; see Annex 1). In most other cases, quality adjustment tends to be rather basic, using measures such as square metre prices for individual cities or regions aggregated to a national total. For Germany, the data collection is limited to "good-quality" dwellings, which might imply a built-in measurement problem, since it is unlikely that the market definition of "good quality" is independent of the general increase in housing standards over time. Only two countries (France and Finland) use hedonic regression. These differences and shortcomings in the quality adjustment of national data are considered to be the most important deficiency of the euro area aggregate.

4.1.4 Cash/mortgages

In many countries, mortgage lenders are the main data source for house price indices. The databases of mortgage lenders can be a rich source of timely information; however, they exclude cash purchases. Research in the United Kingdom has indicated that cash buyers, who account for around 30% of the UK market, tend to purchase at the extremes of the market, ie very cheap and very expensive properties, and that dwellings purchased by cash follow a different development to those financed by a mortgage (Statistik Austria (2001)). It is not clear whether there is any bias in the house price data from other European countries where cash purchases are not included (Belgium, Spain, Ireland) as no alternative source is available.

4.1.5 Timing

The process of selling a house often takes place over a period of several months or more and the particular stage in this process at which the price is entered into the index varies, often depending on the source of the data, and has consequences for the comparability of the data. National indices used in the euro area aggregate include data at the following stages:

- As soon as the property is on the market. Typical data sources: newspapers, estate agents;[5]
- Mortgage approved. Typical data source: mortgage lenders;
- Signing of binding contract. Typical data source: lawyers;
- Transaction completed. Typical data sources: land registries, tax authorities.

Ideally a house price index would show actual transaction prices at the time when the property is first taken off the market. The signing of the first binding contract fits this requirement best; however, in practice the point at which a contract is binding, and what is considered as binding, differs between countries. The effect of the heterogeneous recording of the available data is likely to be limited in an annual frequency aggregate, but will become more significant as we move towards a quarterly index. For the euro area index it is clear that, whilst aiming for the ideal, compromises must be accepted.

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[5] Although not related to the issue of timing, a disadvantage of advertised prices and mortgage approvals is that not all of the prices included end in transactions, and in the former case, the price will tend to be higher than the final negotiated transaction price.

4.1.6 *Choosing amongst the available national sources*

Table 1 gives an overview of the correlation coefficients of the main alternative time series which have been considered for inclusion into the euro area aggregate. Graphs of the series compared are shown in Annex 2. The correlation coefficients vary considerably between 0.6 and 0.99. Generally, the series in which the *same* source provides breakdowns of different market segments show relatively high correlation. However, correlation coefficients for series with similar definitions but different sources are in most cases significantly lower. Differences between sources are particularly relevant in the short term, while the long-term trend of the time series is mostly similar.

This suggests that, as measured by the available data, the geographical and market coverage is less important than the choice of the source data and the methodology employed. It underlines the importance of relying on national expertise when selecting property price series for the purpose of compiling euro area aggregates.

Table 1

Correlation coefficients of alternative national sources

Country	Series	Correlation coefficient	Time period
DE[1]	Five largest cities vs 60 largest cities[2] (both Bulwien AG)	0.902	1991-2002
	New vs existing flats (both Bulwien AG)	0.818	1991-2002
	GEWOS vs Bulwien[2]	0.802	1991-2002
	RDM vs Bulwien[2]	0.790	1991-2001
	GEWOS vs RDM	0.585	1991-2001
GR[3]	BoG including[2] vs excluding Athens (same source)	0.910	1998 Q1-2002 Q4
ES[4]	MdF new vs existing dwellings (same source)	0.948	1988 Q1-2002 Q4
FR[5]	INSEE France, existing dwellings[2] vs INSEE Paris, existing dwellings	0.950	1995-2002
	ECLN France, new flats vs ECLN France, new houses	0.725	1995-2002
	INSEE France, existing dwellings[2] vs ECLN France, new houses	0.718	1995-2002
	INSEE France, existing dwellings[2] vs ECLN France, new flats	0.710	1995-2002
IE[6]	DoE new vs existing[2] dwellings (same source)	0.898	1997 Q1-2002 Q4
	TSB new vs existing dwellings (same source)	0.873	1997 Q1-2002 Q4
	DoE existing dwellings[2] vs TSB existing dwellings	0.714	1997 Q1-2002 Q4
	DoE new dwellings vs TSB new dwellings	0.584	1997 Q1-2002 Q4
IT[7]	Nomisma new dwellings vs existing dwellings (same source)	0.987	1989 H1-2002 H2
	BoI new dwellings[2] vs existing dwellings (same source)	0.952	1989 H1-2002 H2
	BoI new dwellings[2] vs Nomisma new dwellings	0.873	1989 H1-2002 H2
	BoI existing dwellings vs Nomisma existing dwellings	0.847	1989 H1-2002 H2

Note: Coefficients calculated from annual growth rates.

[1] Bulwien AG and GEWOS are private research institutes; RDM is a federation of estate agents. [2] Indicates series used in overall euro area aggregate. See also Annex 2. [3] Both series are compiled by the Bank of Greece (BoG) on the basis of data from a private research institute. [4] Both series are from the Ministerio de Formento (MdF, Ministry for Infrastructure and Urban Planning). [5] INSEE is the National statistical institute of France; ECLN (Enquete sur la commercialisation des logements neufs) is a survey run by the Ministry of Equipment, Transport and Housing. [6] DoE = Department of the Environment and Local Government; TSB = Permanent TSB mortgage bank. [7] Nomisma is a private research institute; BoI = Bank of Italy.

Source: ECB.

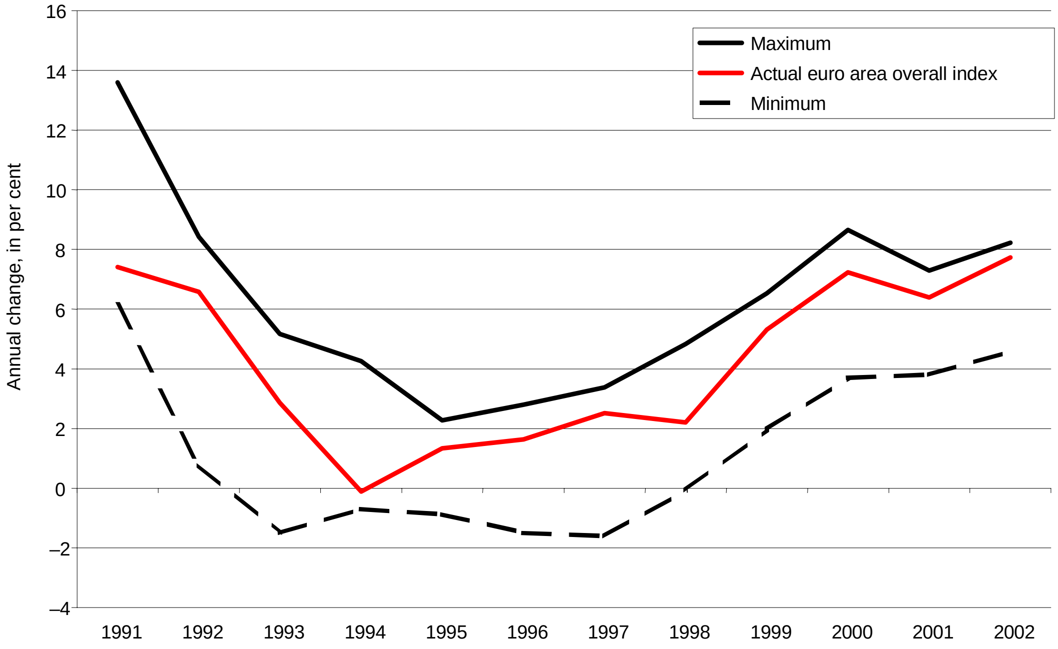
4.2 The effect of these differences on the euro area aggregate

From the available evidence it appears that the differences between the available national data may have a significant effect on comparability, although there may be some cancelling-out at the euro area level. Without true harmonised data for comparison it is impossible to be certain of the real effect. We may, however, look to the possible margins of error in aggregation of the existing data. In order to investigate this, we have taken for each of the countries where we have at least one alternative source (Germany, Greece, Spain, France, Ireland, Italy) the highest and lowest reported annual growth rate for each observation period from all the alternative series and then created a “minimum” and a “maximum” euro area aggregate. For countries where only one reasonable national source exists, we have used the same series in both aggregates. The results are presented in Graph 4 together with the actual ECB euro area overall index. The results show that there is a significant gap between the maximum and minimum series which corresponds to between 3 and 7.5 percentage points. This confirms that the choice of national components for the aggregate is important and that there is potentially a rather large margin of error. However, the distance between the actual euro area aggregate and the simulated two extremes is relatively stable and the trend over the past 12 years is broadly consistent in all three series. This confirms the ECB’s view that while the euro area residential property price index may be used to analyse trend developments, both smaller short-term changes in the index and the level of annual growth rates have to be treated with a considerable degree of caution.

Graph 4

Maximum and minimum boundaries of euro area aggregate

Annual changes, in per cent



Source: ECB.

5. The effect of alternative country weightings on euro area totals

Having selected the most representative and homogeneous available national indicators, the question of which country weighting scheme should be used for aggregation is still open. In principle the problem is no different from the decision on weights in a representative national index, which is often calculated as the weighted average of regional indices. The decision is limited to a much greater extent at the international level by the availability of coherent and harmonised structural indicators which may be used for weighting purposes. The construction of good-quality weights requires level data which have uniform coverage of markets in any country. For example, data on the stock of properties that include commercial properties will obviously overstate the weight of a country when compared with data for residential properties in other countries. The sources for such data within the European Union are scarce.

Conceptually there are two main decisions that must be taken in choosing a weighting scheme for cross-country aggregation; first, whether the indices should be weighted by the flow of transactions or the stock of all dwellings; and second, whether the weights should refer to the value of housing (ie in euros) or the volume (ie the number of houses).

5.1 Transaction vs stock weights

Whereas it is clear that the only observable prices that normally enter house price indices are for those transacted, it is less clear whether house price indices should *represent* only these transactions or whether the observed transactions should be used to produce an estimate for the change in the existing stock of dwellings. This choice has a significant impact on the relative country weights for several reasons. First, structural differences mean that some EU housing markets are much more active than others. In Germany, for instance, over the past decade only about 1.7% of the stock was transacted annually, whereas in Ireland and the United Kingdom the figure was closer to 5.5%.[6] Second, transactions are more volatile than the stock and so the share given to a particular country will depend on the state of the housing market in that country in the base period. There were, for instance, more than twice as many transactions in Greece in 1997 as there were in 1991. Third, some types of dwelling are likely to be transacted more frequently and at different stages in the property price cycle than others. Therefore, at any one time, it is unlikely that the make-up of transacted properties is a representative sample of the stock. Finally, the weight given to the subindex for new dwellings would be dramatically different under the two concepts. In Finland, for example, approximately 15% of transacted dwellings are newly constructed, whereas gross fixed capital formation in residential construction in 2002 was only 4.3% of the stock of residential buildings (as recorded in the national accounts balance sheets).[7]

If the house price index is to accurately represent the actual market conditions, ie the price changes faced by a potential house buyer, then a weighting according to the characteristics of transacted dwellings would be expected. As noted above, the price developments for new dwellings are often, at least in the short term, different from those for existing dwellings. However, the weight of new dwellings in a stock-based index would be negligible. Therefore, a transaction-based approach may be preferred on the grounds that it is more representative of the actual market situation.

Different considerations arise from the point of view of a property price index used as an asset price index. Most asset price indices, such as equity prices, are constructed according to market capitalisation. The reason for this approach is that a particular stock should not receive a higher weight in an equity price index because it is heavily traded in a particular period, as investors are interested in the value of their portfolio.

It would seem that the choice of the weights depends on the use of the index. A transaction-weighted index may be useful for analysis of the current market situation, analysis of the demand for credit, analysis of the realised gains by households of the appreciation of house prices, or for use as the owner-occupied housing component in a consumer price index considering housing as a durable good. In contrast, a stock-weighted index may be more appropriate for analysis of housing as an asset. This may include analysis of the influence of house prices on consumer behaviour via wealth effects, use of house price data as a financial soundness indicator (as the index should be representative of the houses used as collateral for securing loans), or comparison of property price data with other asset price indices.

5.2 Nominal vs volume weights

Independent of the decision on whether to use transaction or stock weights is the decision on whether the weights should be nominal (eg expressed in euros) and thus influenced by relative price levels in

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6 Number of transactions as a share of stock of dwellings (source: European Mortgage Federation).

7 Source: Statistics Finland.

each of the euro area countries, or non-monetary, volume weights (eg expressed as the number of houses or transactions). In between these two options are nominal weights corrected for differences in purchasing power. As with the decision on transaction versus stock weights, the current choices made by the producers of the available data differ between and within countries.

Nominal weighted indices consider that property price levels may vary greatly between regions and countries. For inflation analysis in the single currency area, nominal weights appear appropriate. The same applies for the analysis of wealth effects, because it would be counterproductive to eliminate the effect of different price levels of dwellings from a measure which is used to monitor the development of nominal wealth. There appears to be only one reason to use simple volume indicators for weighting purposes, and this is to use them as proxies in the absence of adequate nominal weights.

Volume weights are used in many of the national indices - eg Italy uses the size of dwelling space in square metres in various regions, Finland uses the number of houses in each cell and Germany and Spain use population weights for aggregating regional indices, although population is clearly a proxy weight in the absence of more appropriate measures.

5.3 Potential sources for the euro area country weights

The currently used weighting scheme for compiling the ECB euro area index is based on GDP results, mainly due to the availability of complete and comparable results for all EU countries. Moreover, GDP is the broadest monetary measure of economic activity and a frequently used indicator to aggregate national economic statistics. There are, however, alternative and potentially more appropriate weighting schemes, which are discussed in this section. Table 2 shows the framework of the four possibilities discussed in Sections 5.1 and 5.2 and gives the potential candidates for which data exist.

Table 2

Available sources of euro area country weights

Weights	Transactions	Stocks
Nominal	– *Proxy* - **National accounts gross fixed capital formation, housing** (source: NSIs; available countries: all; harmonised data)	– **National accounts balance sheets - dwellings** (AN.111) (source: NSIs; available countries: BE, NL, FI; harmonised data) – *Proxy* - **National accounts, actual + imputed rents** (source: NSIs; available countries: all except LU; harmonised data)
Volume	– **Number of transactions** (source: NSIs; available countries: all except ES, AT; non-harmonised data)	– **Number of dwellings (total stock)** (source: NSIs; available countries: all; non-harmonised data) – *Proxy* - **Population** (source: NSIs; available countries: all; harmonised data)

Note: NSIs = national statistical institutes.

Source: ECB.

As a transaction weight, gross fixed capital formation in housing would be a choice for an index for new dwellings; however, as discussed in Section 4, the share of new dwellings in total transactions is relatively small and varies between countries and so is not necessarily a good weight for the overall index. Moreover, gross fixed capital formation excludes the value of land, which is a non-produced asset. An alternative proxy is to use the number of transactions, with the caveats mentioned before. For all transaction weights, distortion of the weights by one-off influences must be avoided and multi-period averages are preferable to weights for one single period.

The harmonised weighting scheme most relevant for a stock-weighted index, the national accounts balance sheets (according to European System of Accounts (ESA95) definitions), is only available for three euro area countries. The national accounts balance sheets give the current replacement costs of the stock of dwellings, excluding land and including a breakdown by institutional sector. Although the exclusion of land is a disadvantage, as differences in relative land prices between countries would not be reflected in the weights, the national accounts balance sheets are a promising source for country weights but can only be used once they are compiled by more euro area countries.

As regards stocks, a possible proxy is the actual rents paid and imputed rents of owner-occupiers, which is available for all euro area countries except Luxembourg. The use of such data would require the assumption that the ratio of (actual + imputed) rents to residential property price levels is the same in all countries, which may not be the case due to different tax/subsidy regimes and societal preferences regarding home ownership. As regards "volume" or non-monetary weights, the data on number of transactions are available for euro area countries (except Spain and Austria) from the European Mortgage Federation (EMF) and the data on number of houses in the total stock area are available for all countries from the decennial Census of Population and Housing. The EMF transaction data are non-harmonised and so are not strictly comparable: some countries include, for instance, commercial properties, others exclude new dwellings or own constructions. Data on the number of houses in the stock of dwellings from the censuses come from national statistical institutes, are of good quality and are generally comparable. Unfortunately data from the 2001 census had not yet been published for all countries at the time of writing and so the 1991 round provided the latest available information. Finally, population data may be considered a proxy to a volume-based measure of the stock of dwellings. In practice it is often used to weight detailed regional data, presumably mainly due to the lack of more appropriate regional weighting indicators.

An important point is that, of all the potential data sets mentioned in this section, only gross fixed capital formation in housing, possibly used together with data on national accounts balance sheets, could provide a coherent breakdown between new and existing dwellings at the euro area level. All other data discussed would only provide weights for an overall index.

5.4 What is the effect of different weighting schemes on the euro area aggregate?

Having given an overview of the available data, this section looks at the effect of some of the potential weighting schemes on the euro area aggregate.

Table 3

Possible country weighting schemes for the euro area aggregate

Euro area = 100

	No of transactions[1] (1995-97)	**Housing stock (census data 1991)**	**Actual + imputed rents (2001)**	**Gross fixed capital formation in housing (1999-2001)**	**GDP (2001)**	**Population (2001)**
BE	3.5	3.1	3.8	3.0	3.7	3.4
DE	18.2	26.6	34.7	38.8	30.3	26.9
GR	2.5	3.6	2.2	1.7	1.9	3.6
ES	13.4	13.4	6.9	9.5	9.5	13.1
FR	24.4	20.4	22.9	16.6	21.6	19.9
IE	2.2	0.8	1.5	2.4	1.7	1.3
IT	18.1	19.5	17.0	14.3	17.8	18.9
LU	0.1	0.1	0.0	0.2	0.3	0.1
NL	8.9	4.8	5.0	6.8	6.3	5.2
AT	2.6	2.6	2.5	3.1	3.1	2.7
PT	3.3	3.3	1.0	1.8	1.8	3.4
FI	2.8	1.7	2.5	1.9	2.0	1.7

[1] Data from the European Mortgage Federation. Figures for Spain, Austria and Portugal estimated using data on housing stock.

Sources: ECB; EMF; Eurostat; national sources.

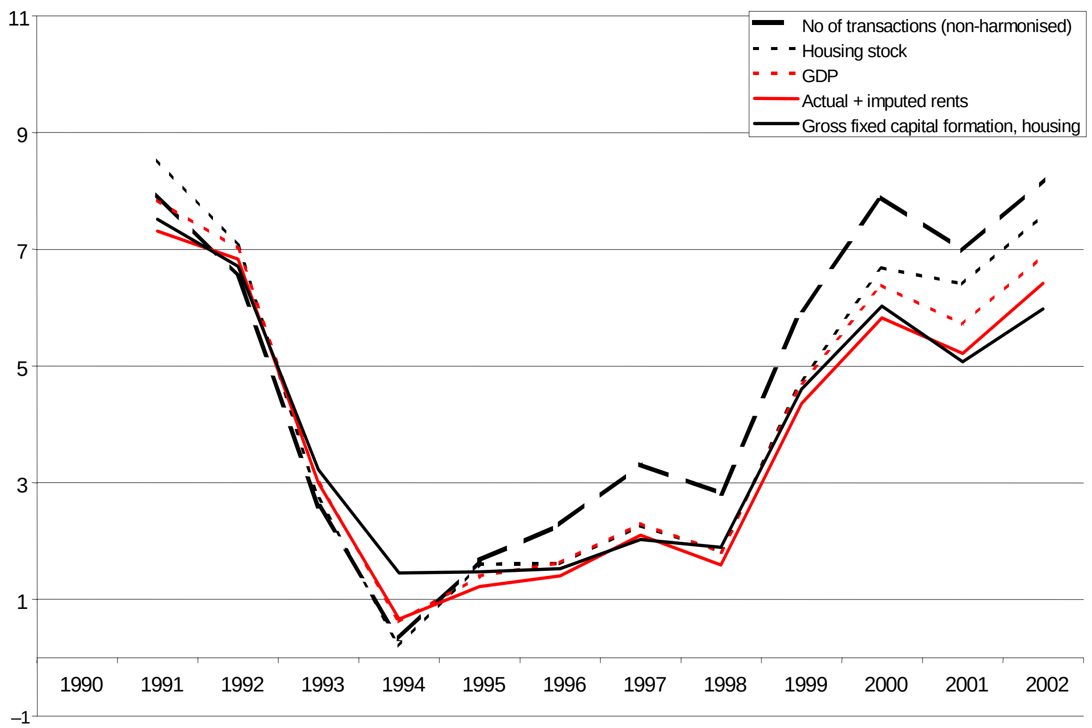
Table 3 shows the country shares in the euro area. For the more volatile data (transactions and gross fixed capital formation in housing), a three-year average was taken for the most recent available data; otherwise 2001 data are used with the exception of the housing stock, for which 2001 data are not yet available. The data show both marked differences and similarities in different parts of the table. Regarding their weight in the euro area aggregate, the most significant difference is between different weights for Germany, ranging from 18 to 39% in the euro area aggregate.

Graph 5 shows the results of applying these different weighting schemes to the same set of national data in order to calculate euro area totals. National contributions to the euro area figures for 1992 and 2002 are shown in Annex 3. The results are generally very similar, especially using GDP, actual and imputed rents and the housing stock weights. The aggregate weighted by the number of transactions is relatively similar until 1994 and then deviates and remains consistently higher than the other aggregates. This is mainly explained by the behaviour of the German data, which is similar to the euro area average until 1995 and then drops significantly below (the difference between the annual growth rates was 7 percentage points in 2002). As Germany has a particularly low share in the transaction weights, the transaction-weighted euro area aggregate is higher than all other aggregates. Also important is the effect of different weighting sets for Spain, because after l998 the annual increases are significantly higher than the euro area average.

Graph 5

Euro area residential property price indices using different weighting schemes

Annual changes, in per cent



Source: ECB.

The tables in Annex 3 demonstrate that there are, in some cases, considerable differences in the national contributions under different weighting schemes, but that the cancelling effect means the overall aggregate is often unaffected (eg in 1992). However, where the effects of divergent national growth rates and differences in the weights work in the same direction, as in 2002, the effects are more significant, leading to a difference of up to 2.2 percentage points.

It seems that the choice between the available weighting schemes is more important for the magnitude of the rate of change than the trend. However, as the differences in the magnitude of the rate of change can be significant, the question remains: which weighting scheme should be used in the euro area aggregate? Given the low quality of the data on the number of transactions, and given that this is a basic volume measure rather than the desired nominal measure, we conclude not to use these weights. Gross fixed capital formation in housing provides good-quality harmonised data; however, the fact that it applies only to new dwellings and excludes land prices means it is rather too far from the required measure. Moreover, it tends to be volatile. The remaining three measures produce the closest results, as shown in Graph 5. Both the housing stock and actual + imputed rents differ from the desired measure and, given that GDP falls between the two, we may pragmatically conclude that the existing GDP-weighted index is an acceptable solution given the available data.

6. Conclusions

The euro area residential property price index compiled by the ECB is a useful indicator for economic analysis. However, as an aggregate of non-harmonised national indicators it can only be regarded as an estimate of the general trend in price developments. There are substantial differences between the current national sources used and these differences can be assumed to have a greater impact on the resulting aggregate than those found in other non-harmonised euro area statistics. Moreover, the national data are often only broad proxies for the national price developments. In the absence of better quality harmonised indicators, it is difficult to precisely assess the reliability of the current index. Evidence from comparing available national sources suggests that the criteria used for selecting national components into the aggregate, namely breadth of geographical and market coverage, sophistication of quality adjustment, and reliability of source data, are correct. However, in many cases the choice is limited to series which fall considerably short of the targeted definition and quality requirements. For this reason the index may best be used to analyse trend developments, but both *smaller* short-term (annual) *changes* in the index and the *level* of the annual *growth rates* have to be treated with a considerable degree of caution. Work is also needed to increase the periodicity of the euro area index to quarterly, which requires higher-frequency data for Germany and Italy.

For the aggregation of the data into a euro area indicator, there is more than one variant which may provide a valid result. In practice, the choice of available weighting schemes is limited and in no case provides an ideal solution. For an inflation index nominal weights should be used, but whether they refer to the flow of transactions or the stock of dwellings depends on the final purpose of the index. Increased country coverage of national accounts balance sheets may provide an appropriate answer in the medium term. Simulations with available data suggest that a properly measured weighting scheme would produce quite different results depending on this decision, especially with regard to the relative share of new and existing dwellings in the overall index. Given the unsatisfactory characteristics of the alternatives, it is suggested to continue using GDP weights until a more appropriate harmonised data set becomes available.

Annex 1:
Overview of national series used in the ECB euro area residential property price indicator (overall index)

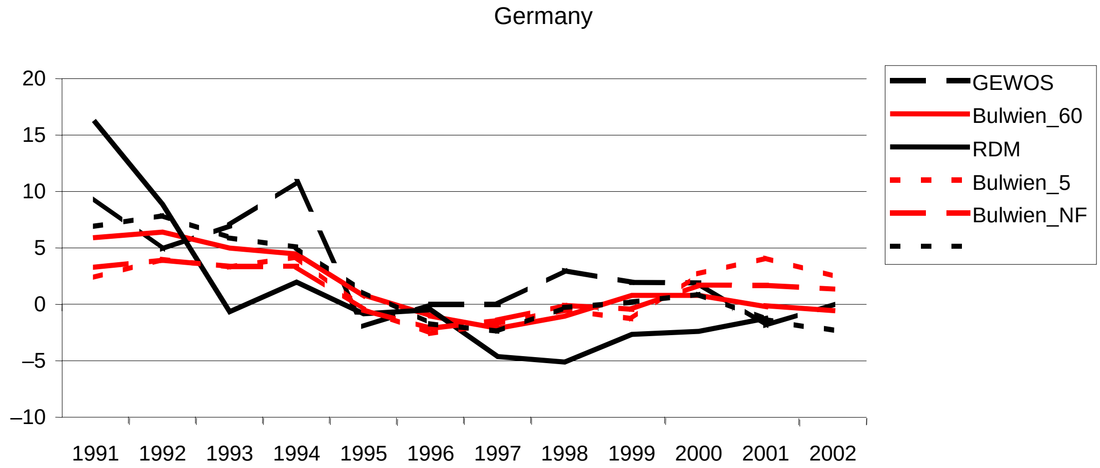
Country (GDP weight)	Frequency	Timeliness	Data source	Dwelling type	Geographical coverage	Cash/ mortgages	Quality adjustment	Regional weighting
BE (3.8%)	Quarterly	5-6 months	Mortgage bank	Existing small/ medium-sized dwellings	Whole country	Mortgages only	...	...
DE (30.3%)	Annual	3 months	Research institute/central bank	Separate series for new/existing terraced houses and flats	60 cities	Both	Flats: price per square metre; Terraced houses: only of about 100 square metres, medium to good areas	Population
GR (1.9%)	Quarterly	5 months	Research institute/central bank	All dwellings	Urban areas	Both	Price per square metre	Size of dwelling stock
ES (9.5%)	Quarterly	3 months	Government	All dwellings except subsidised dwellings	Whole country	Mortgages only	Price per square metre, subindices by postcode	Population
FR (21.5%)	Quarterly	5 months	Notary/NSI	Existing dwellings	Whole country	Both	Hedonic regression (surface area, number of rooms, bathrooms, age, garage, parking, size of plot and others)	Transaction values
IE (1.7%)	Quarterly	3 months	Government	New and existing dwellings (separate series)	Whole country	Mortgages only	None (unit values)	...
IT (17.9%)	Semiannual	1 month	Newspaper/ central bank	New and existing dwellings (separate series)	96 provincial capitals	Both	Price per square metre; according to proximity to city centre	Size of dwelling stock
LU (0.3%)	Annual	19 months	Central bank/ NSI	Dwellings built after 1944	Whole country	Both	None (unit values)	None

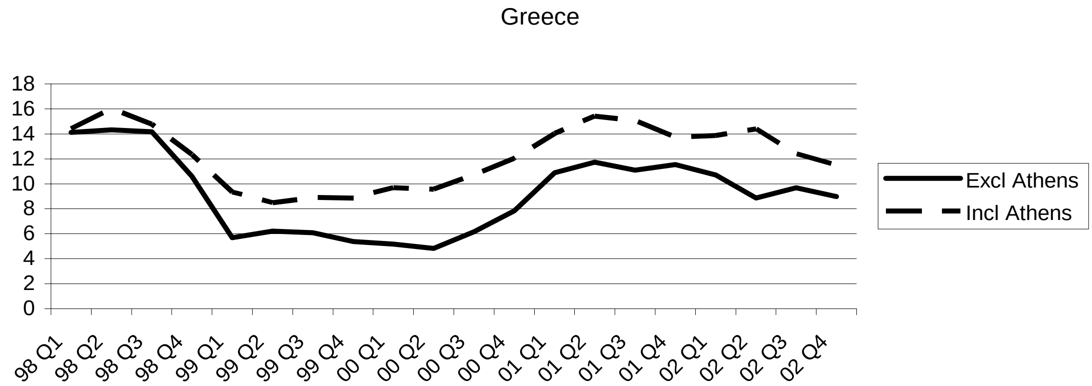
Annex 1 (cont): Overview of national series used in the ECB euro area residential property price indicator (overall index)

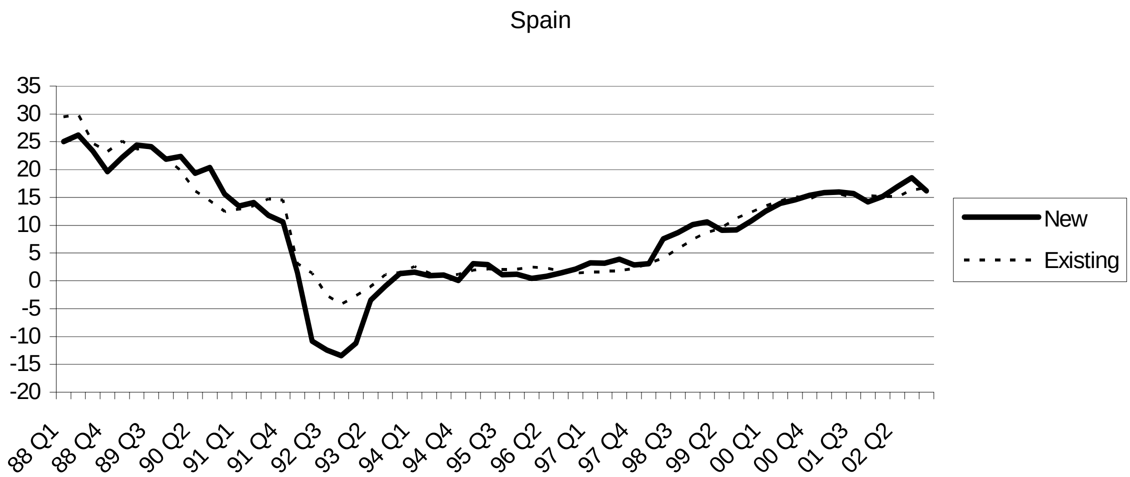
Country (GDP weight)	Frequency	Timeliness	Data source	Dwelling type	Geographical coverage	Cash/ mortgages	Quality adjustment	Regional weighting
NL (6.2%)	Monthly	1 month	Land registry/ central bank	Existing dwellings	Whole country	Both	None (unit values)	None
AT (3.1%)	Semiannual	1 month	Estate agents/ university	All dwellings	Whole country (since 2000), Vienna only (since 1987)	Both	Price per square metre	...
PT (1.8%)	Monthly	1 month	Real estate newspaper/ central bank	All dwellings	30 large/medium-sized towns	Both	Price per square metre	...
FI (2.0%)	Quarterly	1 month	Administrative data	Existing dwellings	Whole country	Both	Hedonic regression (floor size, age, number of rooms, location) and classification approach combined	Dwelling stock (number of houses per cell)

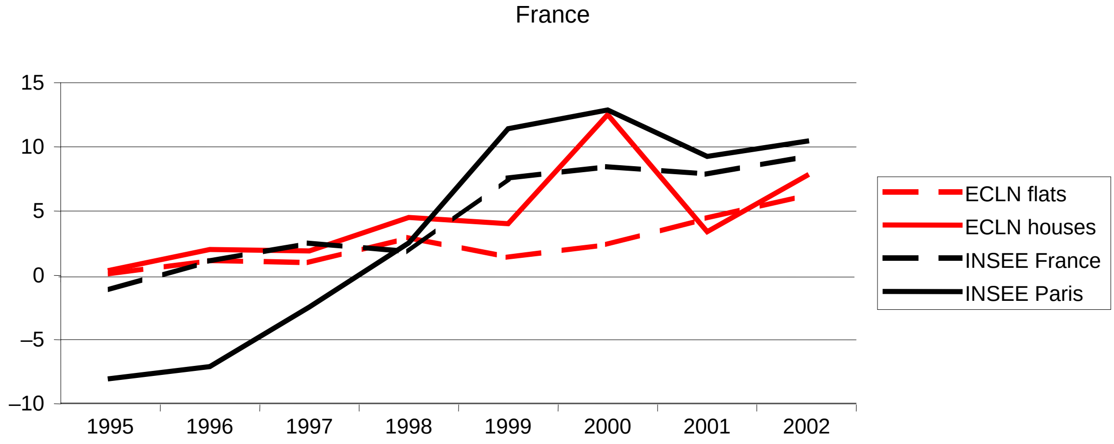
Annex 2:
Alternative national series

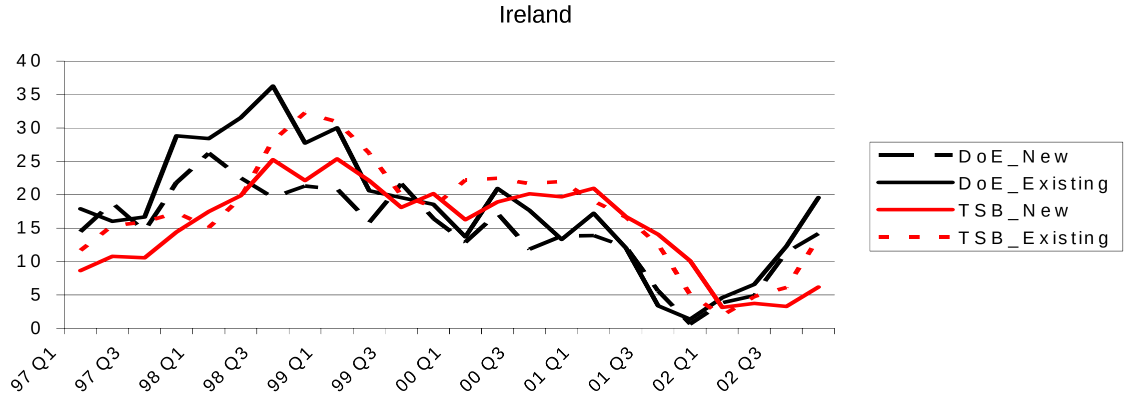
Annual changes, in per cent
(for series description see below)








France
15
10
5
0
–5
–10
1995
1996
1997
1998
1999
2000
2001
2002
ECLN flats
ECLN houses
INSEE France
INSEE Paris


Ireland
40
35
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25
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5
0
97 Q1
97 Q3
98 Q1
98 Q3
99 Q1
99 Q3
00 Q1
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01 Q1
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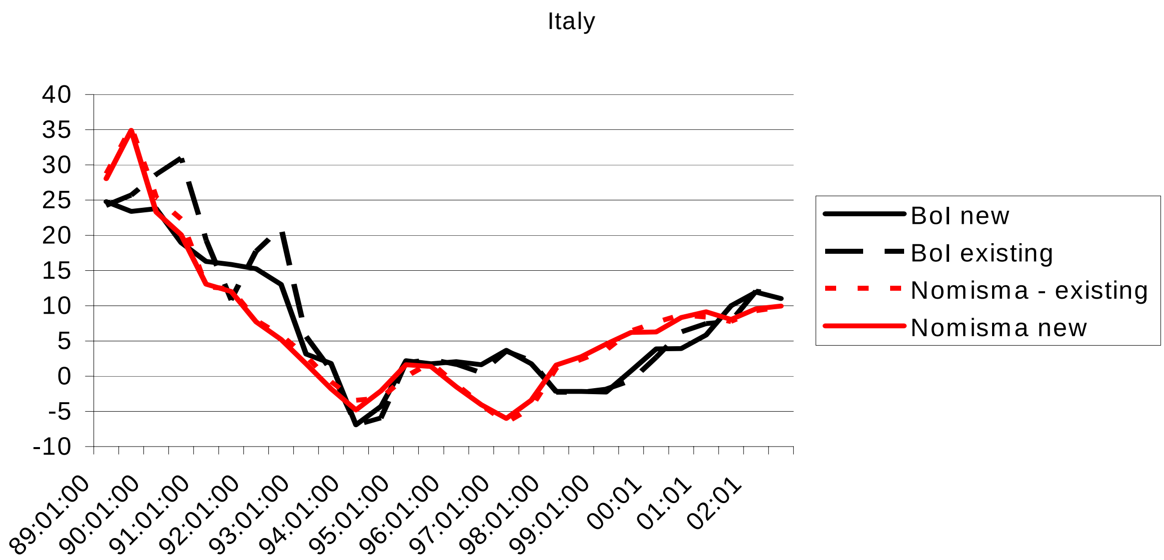
02 Q1
02 Q3
DoE_New
DoE_Existing
TSB_New
TSB_Existing


Italy
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92:01:00
93:01:00
94:01:00
95:01:00
96:01:00
97:01:00
98:01:00
99:01:00
00:01
01:01
02:01
BoI new
BoI existing
Nomisma - existing
Nomisma new

Description of the national series used above

Germany (from 1995, whole of Germany, to 1994, West Germany)

- Bulwien 60 - new and existing dwellings - average of 60 cities - series used in the ECB euro area aggregate, described in Annex 1. Source: Bulwien AG.
- Bulwien 5 - new and existing dwellings - average of largest five cities (Berlin, Hamburg, Munich, Cologne, Frankfurt). Source: Bulwien AG.
- Bulwien NF - new flats - average of 60 cities. Source: Bulwien AG.
- Bulwien EH - existing flats - average of 60 cities. Source: Bulwien AG.
- RDM - average of five largest cities, previously used in BIS *Annual Report*. Source: Ring Deutscher Makler (real estate federation).
- GEWOS - average prices for houses and flats, whole country. Source: GEWOS (Hamburger Institut für Stadt-, Regional- und Wohnforschung GmbH).

Greece

- Excl Athens - new and existing dwellings in 15 cities excluding Athens. Source: Bank of Greece.
- Incl Athens - aggregation of Excl Athens series, with a series from a private research institute for Athens. Source: Bank of Greece.

Spain

- New - dwellings less than one year old. Source: Ministerio de Fomento.
- Existing - dwellings older than one year. Source: Ministerio de Fomento.

France

- ECLN Flats - new flats excluding own construction. Source: Ministry of Equipment.
- ECLN Houses - new houses excluding own construction. Source: Ministry of Equipment.
- INSEE France - existing dwellings sold in whole of France. Source: INSEE/notaires.
- INSEE Paris - existing dwellings sold in Paris. Source: INSEE/notaires.

Ireland

- DoE New - new dwellings (all mortgage transactions). Source: Department of the Environment.
- DoE Existing - existing dwellings (all mortgage transactions). Source: Department of the Environment.
- TSB New - new dwellings (mortgage transactions financed by TSB Permanent. Source: TSB Permanent (mortgage bank).
- TSB Existing - existing dwellings (mortgage transactions financed by TSB Permanent. Source: TSB Permanent (mortgage bank).

Italy

- BoI New - new dwellings, 96 cities. Source: Bank of Italy based on data from Il Consulente Immobiliare.
- BoI Existing - existing dwellings, 96 cities. Source: Bank of Italy based on data from Il Consulente Immobiliare.
- Nomisma New - new dwellings, 13 largest cities. Source: Nomisma (private research institute).
- Nomisma Existing - existing dwellings, 13 largest cities. Source: Nomisma (private research institute).

Annex 3: Contribution of national data to the euro area aggregate under different weighting schemes

Table 1

Contributions to the annual percentage change for the year 1992

	National data (annual change, in per cent)	Weighting scheme used					
		No of transactions (EMF)	Housing stock (census data)	Actual + imputed rents	Gross fixed capital formation in housing	GDP (market exchange rates)	Population
DE	6.2	1.1	1.7	2.2	2.4	1.9	1.7
ES	–1.3	–0.2	–0.2	–0.1	–0.1	–0.1	–0.2
FR	2.5	0.6	0.5	0.6	0.4	0.5	0.5
IT	19.4	3.6	3.9	3.4	2.8	3.5	3.8
NL	8.4	0.8	0.4	0.4	0.6	0.5	0.5
Others	.	0.6	0.7	0.4	0.6	0.6	0.7
Euro area	.	6.5	7.1	6.8	6.7	7.0	7.0

Source: ECB calculations.

Table 2

Contributions to the annual percentage change for the year 2002

	National data (annual change, in per cent)	Weighting scheme used					
		No of transactions (EMF)	Housing stock (census data)	Actual + imputed rents	Gross fixed capital formation in housing	GDP (market exchange rates)	Population
DE	–0.2	0.0	–0.1	–0.1	–0.1	–0.1	–0.1
ES	16.6	2.2	2.2	1.1	1.6	1.6	2.2
FR	9.3	2.3	1.9	2.1	1.5	2.0	1.8
IT	11.9	2.2	2.3	2.0	1.7	2.1	2.2
NL	6.2	0.6	0.3	0.3	0.4	0.4	0.3
Others	.	1.0	0.9	0.9	0.8	0.8	1.0
Euro area	.	8.2	7.6	6.4	6.0	6.9	7.5

Source: ECB calculations.

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Experience with constructing composite asset price indices

Stephan V Arthur[1]

The Bank for International Settlements has variously published, over the past decade, papers where use is made of its aggregate asset price indices for over a dozen industrial countries. This paper explains the methodology used and recent changes in that methodology as well the extended country coverage.

Introduction

Following preliminary work done by the BIS in 1992, Borio et al published a paper exploring aggregate asset price fluctuations across different countries in 1994.[2] One of the objectives of the paper was to develop an aggregate asset price index for several of the major industrialised countries,[3] thereby summarising the information contained in the separate movements of the three asset prices - equities and residential and commercial real estate - exhibiting major fluctuations. The intention was that such an index would facilitate comparison of broad asset price movements over time and across countries, give some empirical content to notions of general asset price "inflation" and "deflation" and highlight patterns of behaviour that would otherwise remain undetected. The paper also provided a first analysis of the possible determinants of movements in the index as well as preliminary evidence on the usefulness of such an index as an input in the design of monetary policy. Their work has since become seminal and has spawned much research in other institutions. More recently, in work done within the Bank, the index of aggregate asset prices has been included in a set of indicators that attempt to predict financial crises. This note explains the original methodology used by Borio et al to construct aggregate asset prices and documents how the methodology has been adapted over time.

The aggregate asset price index

The aggregate asset price index (AAPI) was defined as being a weighted average of national price indices for equities and residential and commercial real estate, since these make up the majority of private sector wealth.[4] Although a simple (unweighted) average would have been a possibility,[5] a weighted average, where the weights represent estimates of the (normalised) shares of those assets in total private sector wealth, was seen to be more relevant.

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2 C E V Borio, N Kennedy and S D Prowse (1994): "Exploring aggregate asset price fluctuations across countries: measurement, determinants and monetary policy implications", *BIS Economic Papers*, no 40, April.

3 Australia, Belgium, Canada, Denmark, Finland, France, Germany, Japan, the Netherlands, Norway, Sweden, the United Kingdom and the United States.

4 For those countries where balance-sheet data are available, this amounts to over 80% of the total. Although private sector holdings of government and other bonds are not insignificant, their prices vary little, and would tend only to dampen an aggregate in which they were included. In addition, as their *price* (but not, of course, their *return*) plays no role in monetary policy, bond prices were excluded from an AAPI.

5 Indeed, as will be shown later, within a limited range, the weighting pattern used affects the aggregate index little.

The frequency of the three national price indices used varies considerably. Equity indices are available electronically on a daily basis[6] and, in several countries, several series can be, for one purpose or another, be considered "representative". Residential property prices are generally disseminated on a quarterly basis, although a few countries publish monthly data; several industrial countries, however, are still only able to provide lower-frequency data,[7] while data from emerging market economies, in particular, is often rudimentary and, almost by definition, annual. Commercial property prices are typically annual, but there are some isolated instances of quarterly availability; most data are collected and provided as "spin-offs" for business purposes and will vary greatly in coverage.[8] Annual national[9] balance-sheet information was used to establish the weighting pattern, so that Borio et al originally restricted their data to the same frequency. Recently, work has been done to construct, for those countries where data availability allows, a quarterly AAPI.[10]

Nominal and inflation-adjusted

An AAPI in nominal terms is only of limited use, and especially so when the inclusion of high-inflation countries or periods is considered. Consequently, the AAPI was deflated by consumer prices, and it is this inflation-adjusted AAPI which was used by Borio et al in their various papers, especially in the areas discussing monetary policy implications.

The equations

The nominal AAPI is a simple weighted average of the form:

$$\Sigma\, w(a_t)\, p(a_t) \qquad (1)$$

for a = 1, 2, 3, and $\Sigma w(a_t) = 1$, where p is the price index of asset a at time t and w the corresponding weight. The weights were allowed to vary over time to capture significant changes in the composition of the portfolio, but intervals of five years were taken to reduce noise. The inflation-adjusted AAPI is a simple variant of this equation, taking the form:

$$\Sigma\, w(a_t)\, p(a_t)/i(a_t) \qquad (2)$$

for a = 1, 2, 3, and $\Sigma w(a_t) = 1$, where i is the price deflator as measured by nationwide consumer (or retail) prices.

The individual components

Equity prices. Data availability for equities provided the least problem: more so was the "correct" choice of index. As, however, the long-term trends varied little between indices purporting to be "general" or "total" within a country, recognised indices were taken in favour of, possibly, lesser known ones.[11] The additional criterion of creating an index back to (at least) 1970 also governed, in several cases, the choice of index.

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[6] And, increasingly, on a tick-by-tick basis.

[7] For example, France, Germany, Italy and Japan.

[8] For example, commercial data providers like Investment Property Databank or private real estate associations like Jones Lang LaSalle.

[9] And, where this was not available, the UN System of National Accounts (see below).

[10] Annual wealth data do not prove to be a problem, since the distribution across asset classes changes only slowly and simple interpolation techniques can be used.

[11] Ie for the United States, Standard and Poor's 500 Composite rather than the Wilshire 5000.

Residential property prices. The above was equally true, but far less frequently, when a choice was possible for residential property prices. As the focus on the construction of an AAPI was, and is, to obtain an indicator for the whole economy, country-wide indices were used whenever possible and were given precedence if "splicing" (with, for example, a discontinued series) was required. This was and remains a challenge when trying to create such an index for additional countries, especially emerging markets, or when trying to "fine-tune" an existing index. In the case of residential real estate, nationwide indices were available for all countries except Germany,[12] since replaced.[13]

Commercial property prices. Country-wide commercial property price indices were, however, unavailable at the time for a number of industrial economies,[14] being based solely on data referring to the capital city. The problem was further exacerbated in that, for several countries, the data referred to a particular, and by nature volatile, subset: the (capital) value of prime property in the capital's centre. Although the situation has since improved somewhat, nationwide data now available indicate that a commercial property price index typically has 80% of the total drawn from property in that country's capital. Fortunately, the share of commercial property in total private sector wealth is only 5-20%, so that its influence on the AAPI was fairly minor. This, of course, is especially true as long as price developments in the three asset classes were more or less synchronised, and this was indeed the case for the period which Borio et al originally considered. However, almost immediately after publication of their 1994 paper, this co-movement largely disappeared (see Graphs 2 and 4) and would provide the basis for further research.

The weighting pattern

In order to calculate the weights, Borio et al used the private sector balance sheets in the national flow of funds accounts for Australia, Canada, Japan, the United Kingdom and the United States, and a combination of the data from the United Nations System of National Accounts (SNA) 1968[15] and the OECD Financial Statistics (Part 2) for Finland, (western) Germany and Sweden. They applied the same weighting pattern as Germany for Belgium, France and the Netherlands, and the Swedish weighting pattern for Denmark and Norway.

The calculation of the weights involved two steps: the first, and by far the most important (and difficult) was to identify and estimate the proportions of the three asset categories. The second was to eliminate any "double-counting" that may arise from the fact that listed companies themselves own commercial real estate, thus simultaneously changing both the price of equity and commercial property. It is difficult to obtain reliable estimates of the proportion (denoted by Borio et al as α) of total commercial property held by listed companies. Callen (1991)[16] had estimated this proportion to be 0.6 for Australia, while Borio et al found a value of 0.68 for the United States from flow of funds data. They assumed a similar value for the United Kingdom, one equal to the Australian ratio for Japan, and 0.5 for the other economies, where it was reasoned that their stock markets were rather less capitalised. Based on this proportion, a "net" commercial property weight was calculated, and the three components were normalised to unity. In the early part of the period under review, not all weights (largely those for commercial property) were available, so that only the two remaining components were normalised to unity (ie the weight for commercial property was set to zero). Co-movement of the indices, as mentioned earlier, supported this decision.

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[12] Where an unweighted average of prices in (west) Berlin, Frankfurt, Hamburg and Munich was calculated. In fairness, detailed documentation is not always available for other countries, so that similar restrictions may also apply elsewhere. In addition, both Australia and Italy construct an index from a relatively small number of cities, but both are, at least, weighted averages.

[13] By a series calculated by the Bundesbank, based on data, provided by Bulwien AG, from 60 cities.

[14] For example, Australia, Belgium, Finland, France, the Netherlands and Norway.

[15] Which they erroneously refer to as the Standardised National Accounts.

[16] T Callen (1991): "Estimates of private sector wealth", *Research Discussion Paper* 9109, Reserve Bank of Australia, October.

The results

Results obtained at the time can only be viewed in Borio et al's paper, as the country coverage has since been extended and the methodology slightly modified (see below). Graphs 1-4 in the Appendix illustrate the results of present-day calculations but differ little for the countries and period covered in 1994: Graphs 1 and 3 plot the AAPI in nominal and inflation-adjusted terms respectively, while Graphs 2 and 4 show, in addition, the individual asset classes for each country.

Statistical work done at the BIS since 1994

Changes to the equations. Following the significant increase in equity prices, and the equivalent expansion in the private sector's equity holdings, in most countries from around the mid-1990s, it became clear that an AAPI was going to be increasingly driven and overshadowed by its equity component. Not only would the relative price of equity increase, but also its weight in private sector wealth. It was therefore agreed that a geometric weighting scheme, which, unlike an arithmetic weighting scheme, was index-level independent, would be preferable and would "dampen" indices that appeared to be historically high due to the choice of base year.[17] Consequently, the nominal and inflation-adjusted indices now take the form:

$$\Pi w(a_t)\, p(a_t) \tag{3}$$

for a = 1, 2, 3, and $\Sigma w(a_t) = 1$,

which is equivalent to:

$$\exp \Sigma w(a_t) \ln p(a_t) \tag{4}$$

and:

$$\Pi w(a_t)\, p(a_t)/i(a_t) \tag{5}$$

for a = 1, 2, 3, and $\Sigma w(a_t) = 1$,

which is equivalent to:

$$\exp \Sigma w(a_t) \ln (p(a_t)/i(a_t)) \tag{6}$$

A further change was the use of the personal consumption deflator rather than consumer (or retail) prices, which was seen to be more relevant for private sector wealth. The differences were, however, minimal.

Changes to the individual components. Efforts have been made to expand the country coverage, which essentially requires research into property prices. To date, Italy, Spain and Switzerland have been added (qv Graphs 1-4) and work on Hong Kong SAR, Ireland, New Zealand, Singapore and South Africa are nearing completion.[18] The BIS is greatly interested in expanding its country coverage, especially for emerging markets, but is dependent on, especially, reliable property price data.

Preliminary work has also been done on calculating a quarterly AAPI to feed into a set of leading indicators to predict financial crises. However, certain assumptions have had to be made when interpolating the largely annual commercial property price data. Given that another problem with such data is cross-country comparability, a further avenue to explore would be to construct an AAPI consisting of only the two components equity and residential real estate. However, it is unclear at the moment whether such an index would remain sufficiently representative.

Changes to the weighting pattern. The final area in which work has been done since Borio et al's first publication is a review of the weights. First and foremost, the weights were extended to include a

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17 Borio et al used 1980 as the base year, but this has been since changed to 1985.

18 Although lack of data back to the 1970s will, however, result in shorter time series.

figure for the five-year period 1995-99.[19] Also, continued data “cleaning” revealed errors made in the original calculations affecting, especially, Japan. Of course, during a 10-year period, other changes to the base data[20] are inevitable, but these have had little effect; even the inclusion of former eastern Germany as from 1990 only led to a redistribution of 1 percentage point! Finally, for the additional countries, weights also had to be approximated by using those of other countries in the data set. The Table in the Appendix illustrates, for selected countries, the weights used by Borio et al and those in use at present. More work is certainly required in this area, but, since the AAPI is so dominated by the scale of price increases of its various components, applying weights intuitively makes little difference when compared with the results obtained when using the “correctly estimated” weighting pattern.[21]

Most recently,[22] the five-year weighting pattern has been replaced in favour of an annual weighting system (“moving weights”) where possible. This is clearly preferable to a stepwise change in the weights, as it eliminates the resulting “shocks” at the changeover year, and which have become increasingly apparent in recent times (see also footnote 19). Future work will need to evaluate - and find! - annual asset holdings of the private sector.

Empirical work done at the BIS since 1994

Asset prices, especially in discussions on monetary policy, have been frequently mentioned and analysed in papers either presented at the Bank (at, for example, various conferences) or published by its economists. Worthy of particular mention, however, due to their direct bearing on the subject are the following:

- The Conference on Asset Prices and Monetary Policy organised by Centre for Economic Policy and Research and the BIS in January 1998. The conference volume’s[23] foreword states, “The widespread liberalisation of financial markets in the 1980s has increased the interest of central banks in asset price developments in two ways. First, as the use of intermediate targets has become unreliable in many countries, central banks have sought other indicators to guide policy actions. A natural place to look has been various asset markets. Second, the greater role of asset prices in the monetary transmission mechanism, combined with their sustained volatility, has led to an increased concern that large changes in asset prices might disrupt economic activity and price stability as well as lead to financial fragility.”
- The paper by Borio and Lowe,[24] in which they argue that “… financial imbalances can build up in a low inflation environment and that in some circumstances it is appropriate for policy to respond to contain these imbalances. While identifying financial imbalances ex ante can be difficult, this paper presents empirical evidence that it is not impossible. In particular, sustained rapid credit growth combined with large increases in asset prices appears to increase the probability of an episode of financial instability.”

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[19] In reality, the same weighting pattern was used for the period 1995 to date, since a weighting scheme that would include 2000 data would have captured equity holdings at its peak. As they have since dropped sharply, such weights could therefore be considered as not representative for the period as a whole.

[20] For example, the introduction of the European System of Accounts (ESA) in the euro area.

[21] Such an argument is barely convincing to a statistician, however. It is, for example, extremely unlikely that the distribution of asset classes is similar within the German and French private sector; with an increasing country coverage, the situation will only become exacerbated.

[22] And since the IMF/BIS conference. Indeed, the graphs are the result of this most recent development.

[23] BIS (1998): “Asset prices and monetary policy: four views”, August.

[24] Claudio Borio and Philip Lowe (2002): “Asset prices, financial and monetary stability: exploring the nexus”, *BIS Working Papers*, no 114, July.

- The paper by Filardo,[25] in which he states, “The issue of monetary policy and asset prices has been receiving much attention not only because it is an interesting topic for macroeconomists but also because central banks have faced daunting challenges from large swings in various types of asset prices. To some extent, the achievement of a low, stable inflation environment has not simultaneously brought about a more stable asset price environment. The record over the past decade, in fact, has raised the prospect of asset price booms and busts as a permanent feature of the monetary policy landscape.”
- The paper by Borio and Lowe,[26] in which they argue, and demonstrate, “One important indicator that risk is building up is unusually sustained and rapid credit growth occurring alongside unusually sustained and large increases in asset prices (‘financial imbalances’). Building on previous work, we show that empirical proxies for financial imbalances contain useful information about subsequent banking crises, output and inflation beyond traditional two-year policy horizons.”

Concluding remarks

Work at the BIS, and elsewhere, has indicated that aggregate asset price indices could represent a welcome addition to the set of variables considered by policymakers from the perspective of both monetary and financial stability. The index developed and currently used is far from perfect, both in terms of methodology and data availability. Such indices could, of course, be further refined and better data on their individual components, particularly residential and commercial property, would help to make the indices more relevant.

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[25] Andrew Filardo (2004): “Monetary policy and asset price bubbles: calibrating the monetary policy trade-offs”, *BIS Working Papers*, no 155, June.

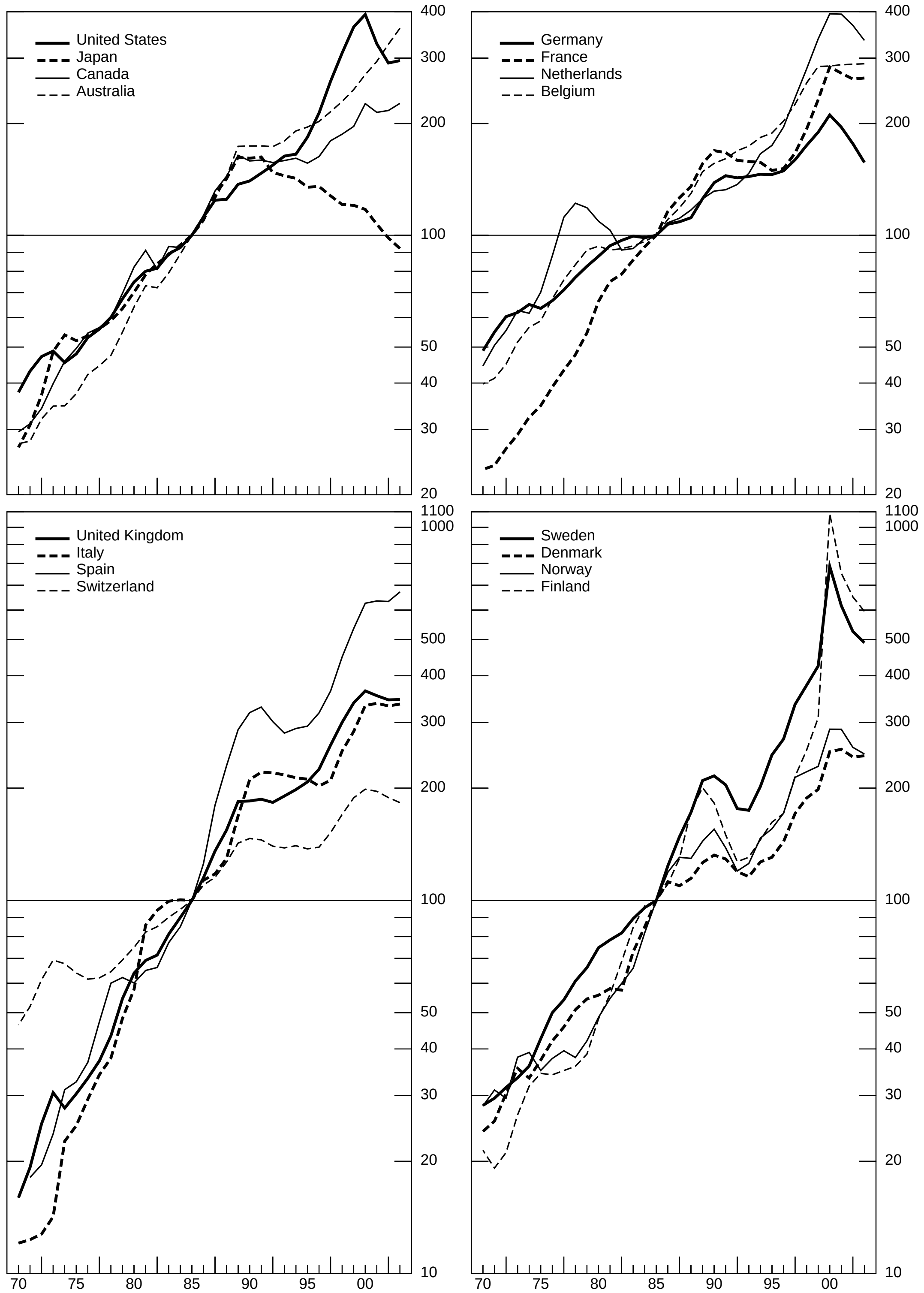
[26] Claudio Borio and Philip Lowe (2004): “Securing sustainable price stability: should credit come back from the wilderness?”, *BIS Working Papers*, no 157, July.

Appendix

Graph 1

Nominal aggregate asset prices

1985 = 100; semi-logarithmic scales

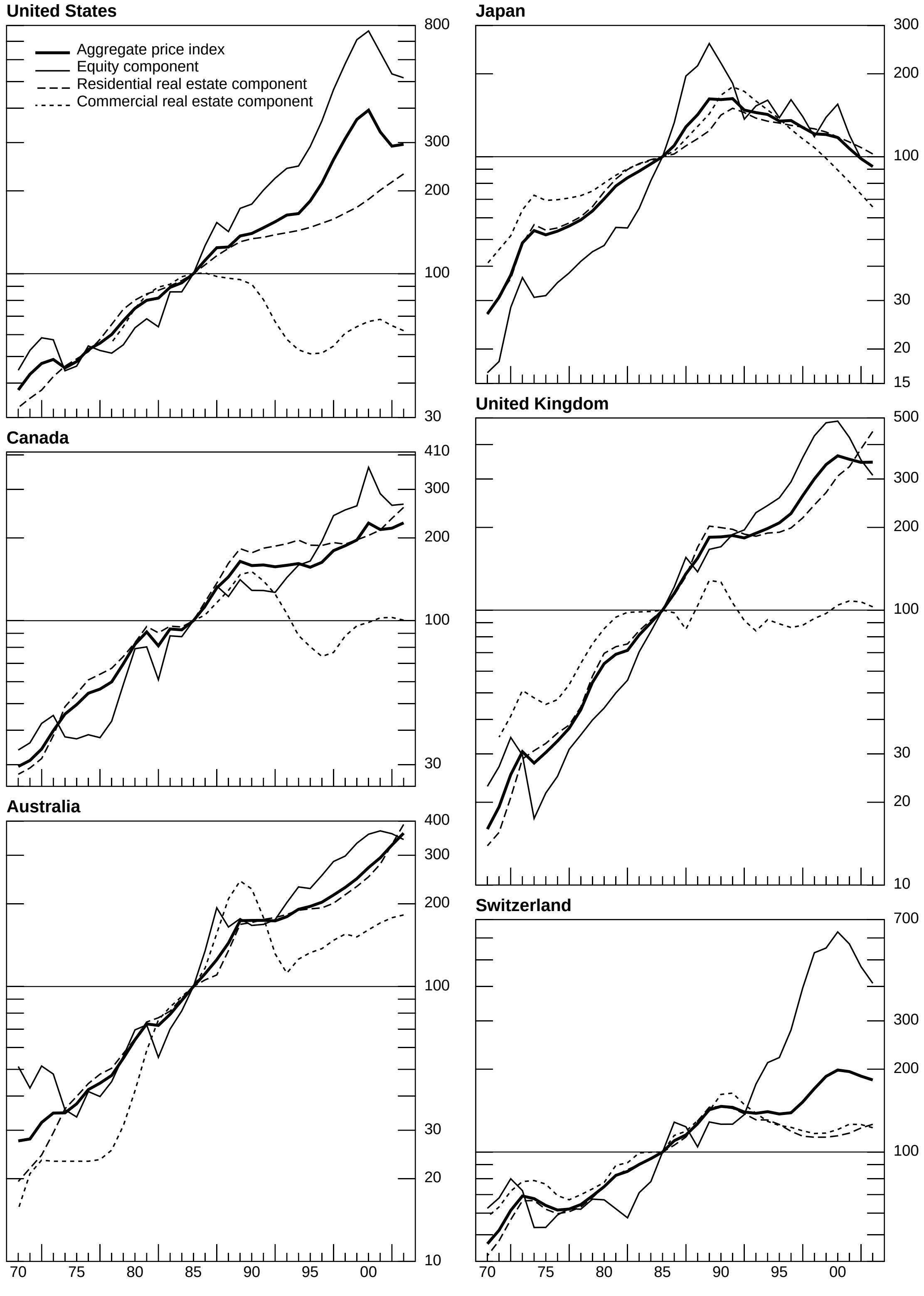


Note: For an explanation of the methodology and sources, see the notes to Graph 2.

Graph 2

Nominal asset prices: aggregate and components

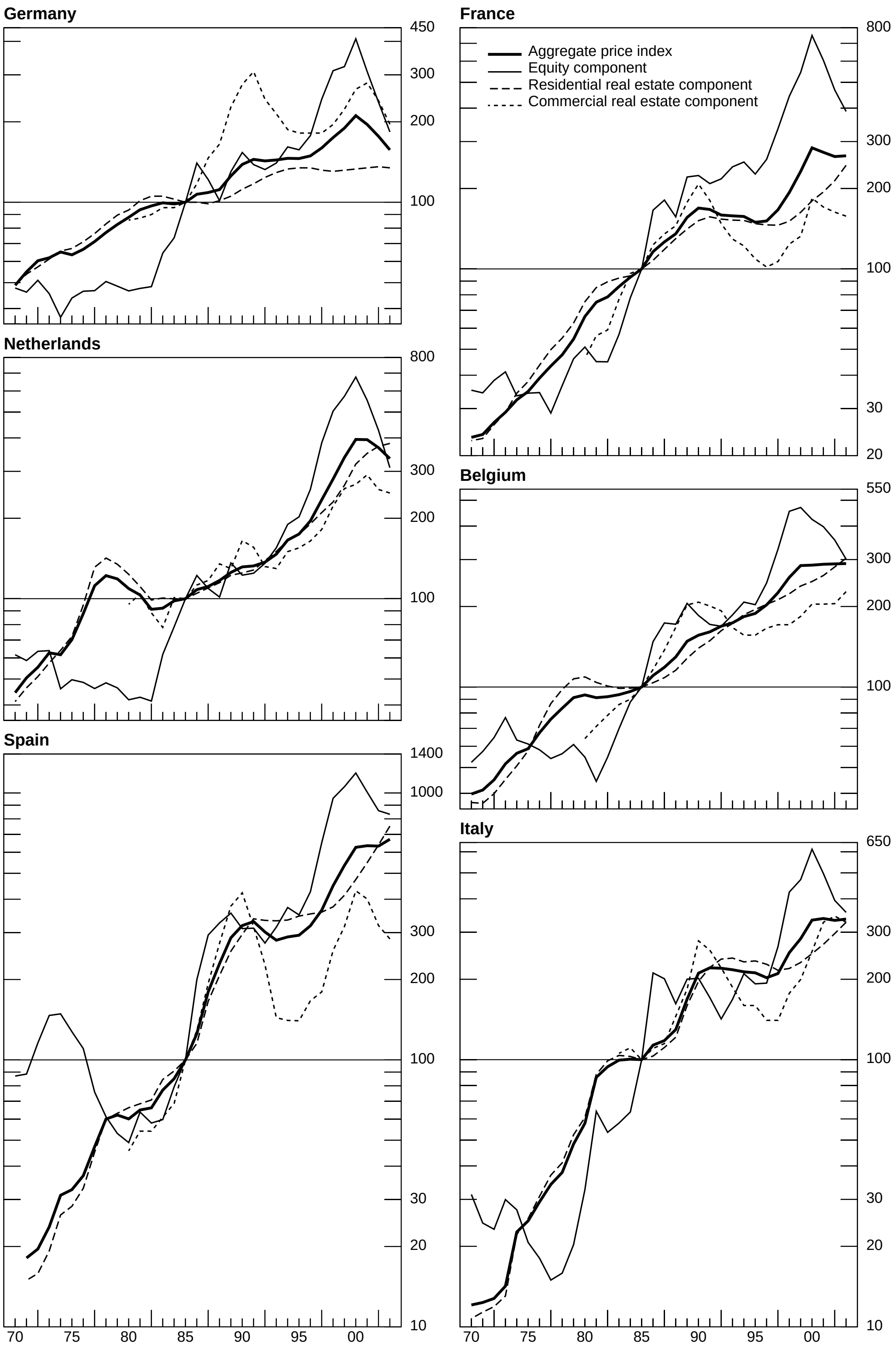
1985 = 100; semi-logarithmic scales



Graph 2 (cont)

Nominal asset prices: aggregate and components

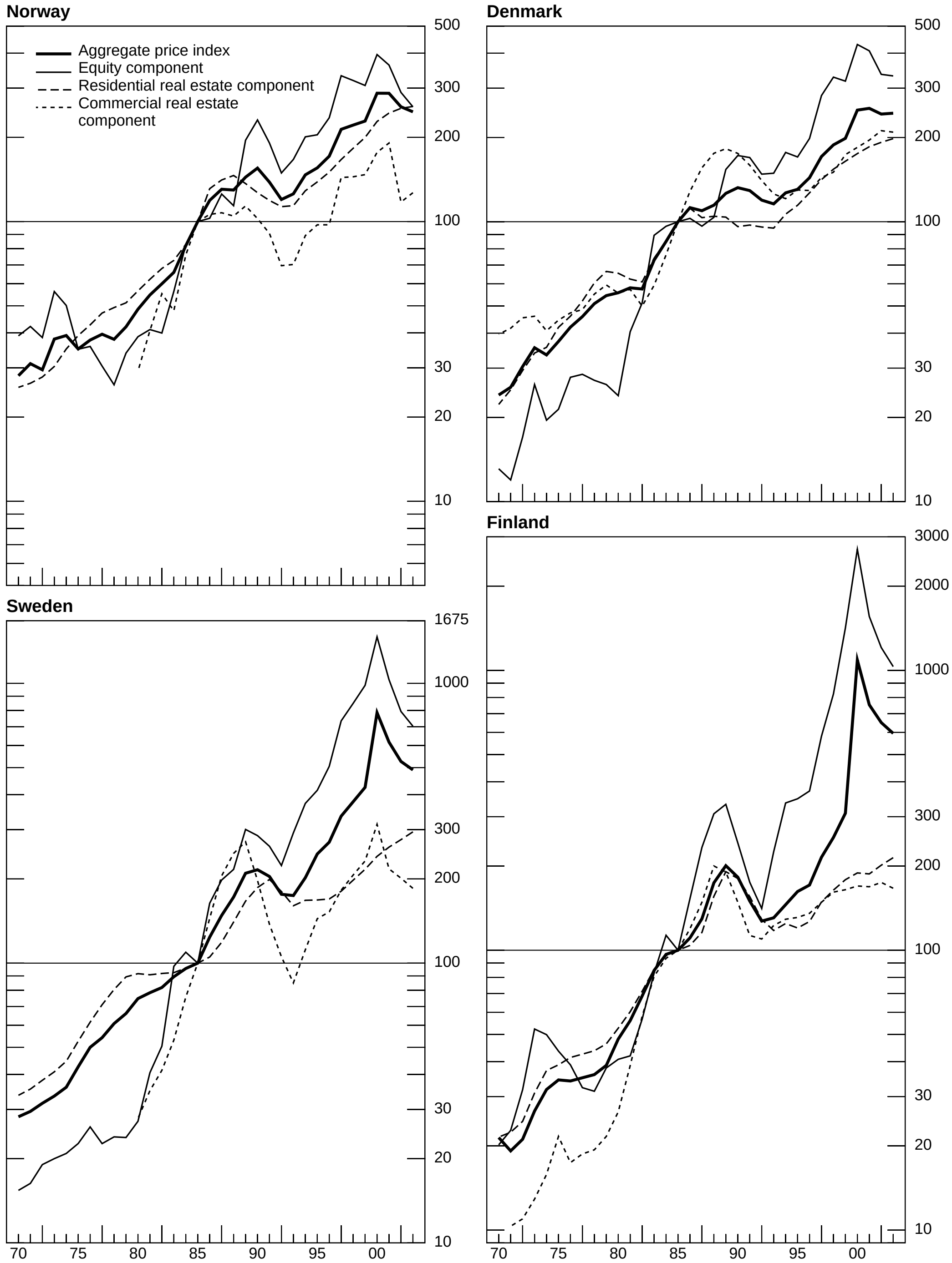
1985 = 100; semi-logarithmic scales



Graph 2 (cont)

Nominal asset prices: aggregate and components

1985 = 100; semi-logarithmic scales



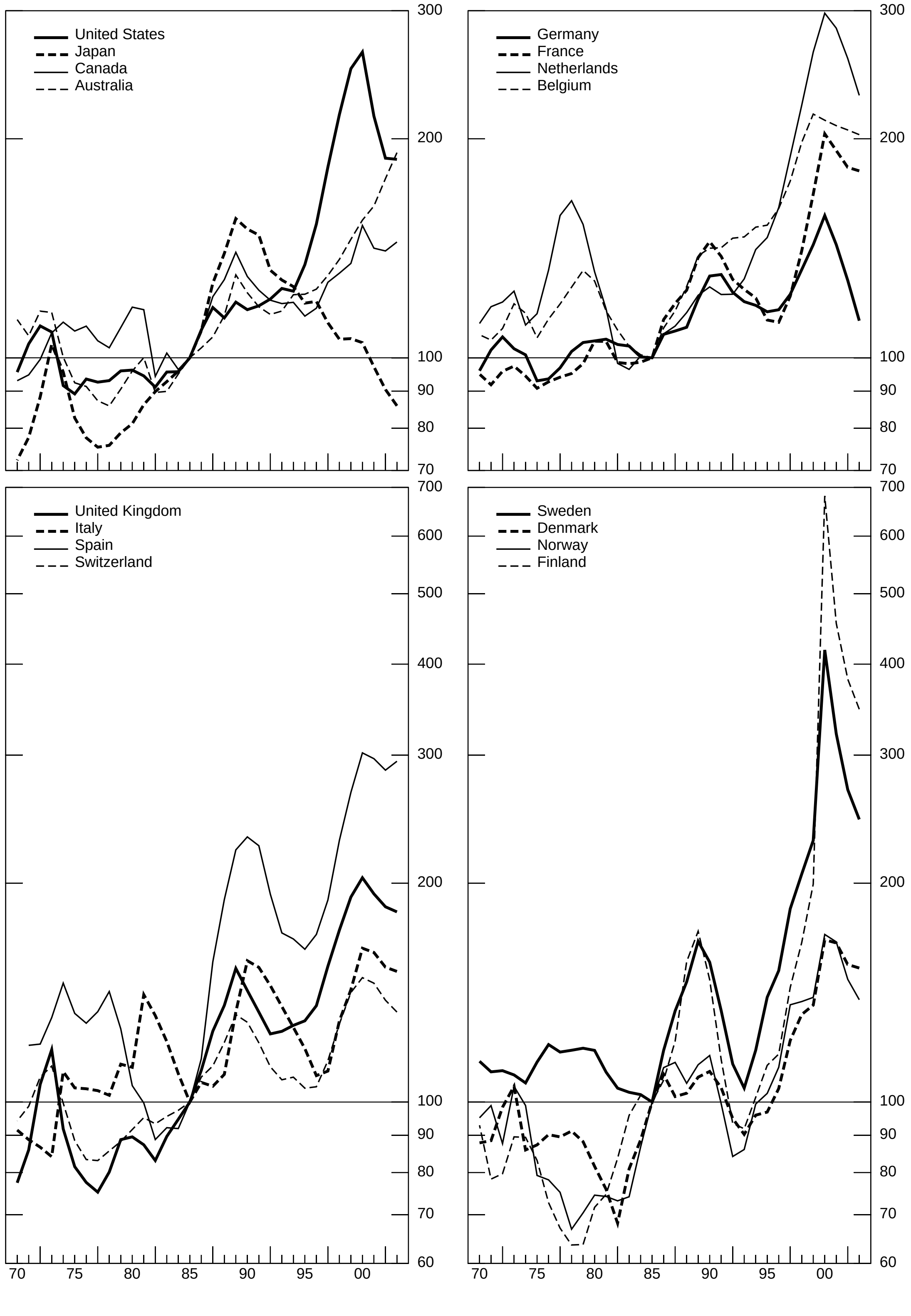
Notes: The aggregate price index is calculated as a weighted geometric mean of the three components. The weights are based, where available, on net wealth data, but in some cases are supplemented by the price change of each component. The calculation uses, where possible, moving weights; a five-year window, starting in 1970, is used where annual weights are not available. Where a component is not available, the geometric mean is calculated on the other two. For Belgium, France, Germany, the Netherlands, Norway and Sweden, the commercial real estate component is not shown in the 1970s as it is proprietary information.

Sources: Various private real estate associations; national data; BIS estimates and calculations.

Graph 3

Inflation-adjusted aggregate asset prices

1985 = 100; semi-logarithmic scales

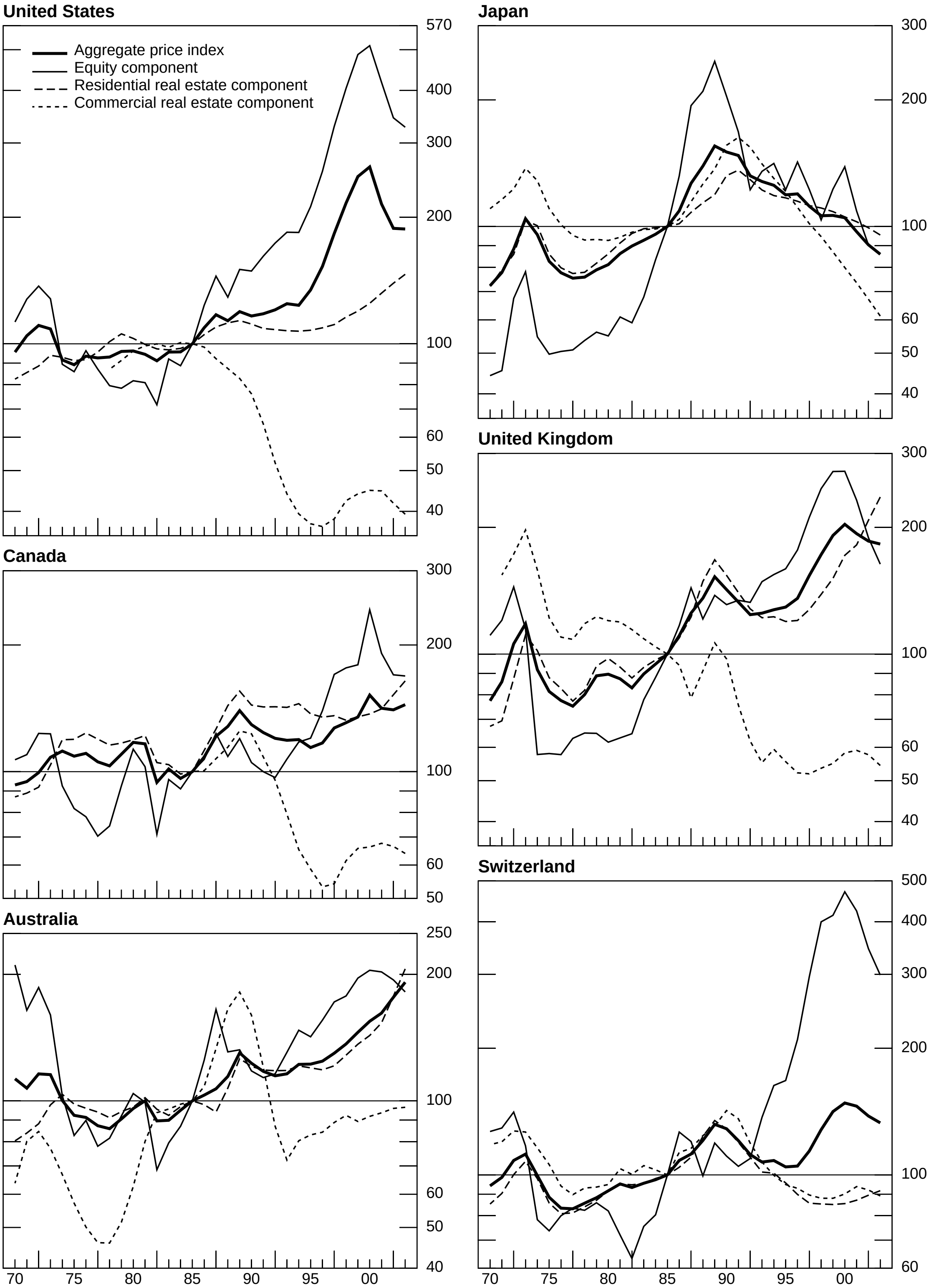


Note: For an explanation of the methodology and sources, see the notes to Graph 4.

Graph 4

Inflation-adjusted asset prices: aggregate and components

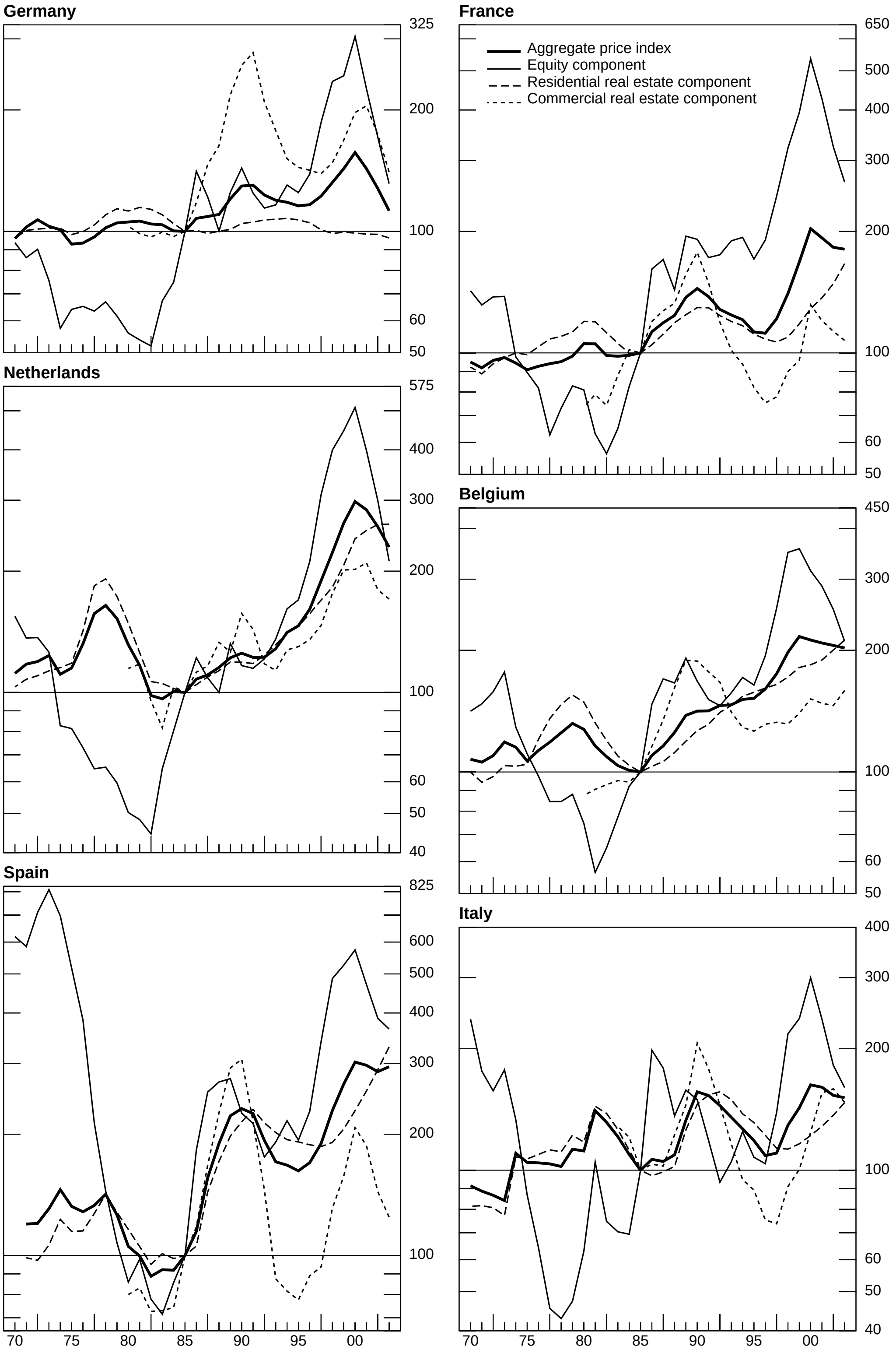
1985 = 100; semi-logarithmic scales



Graph 4 (cont)

Inflation-adjusted asset prices: aggregate and components

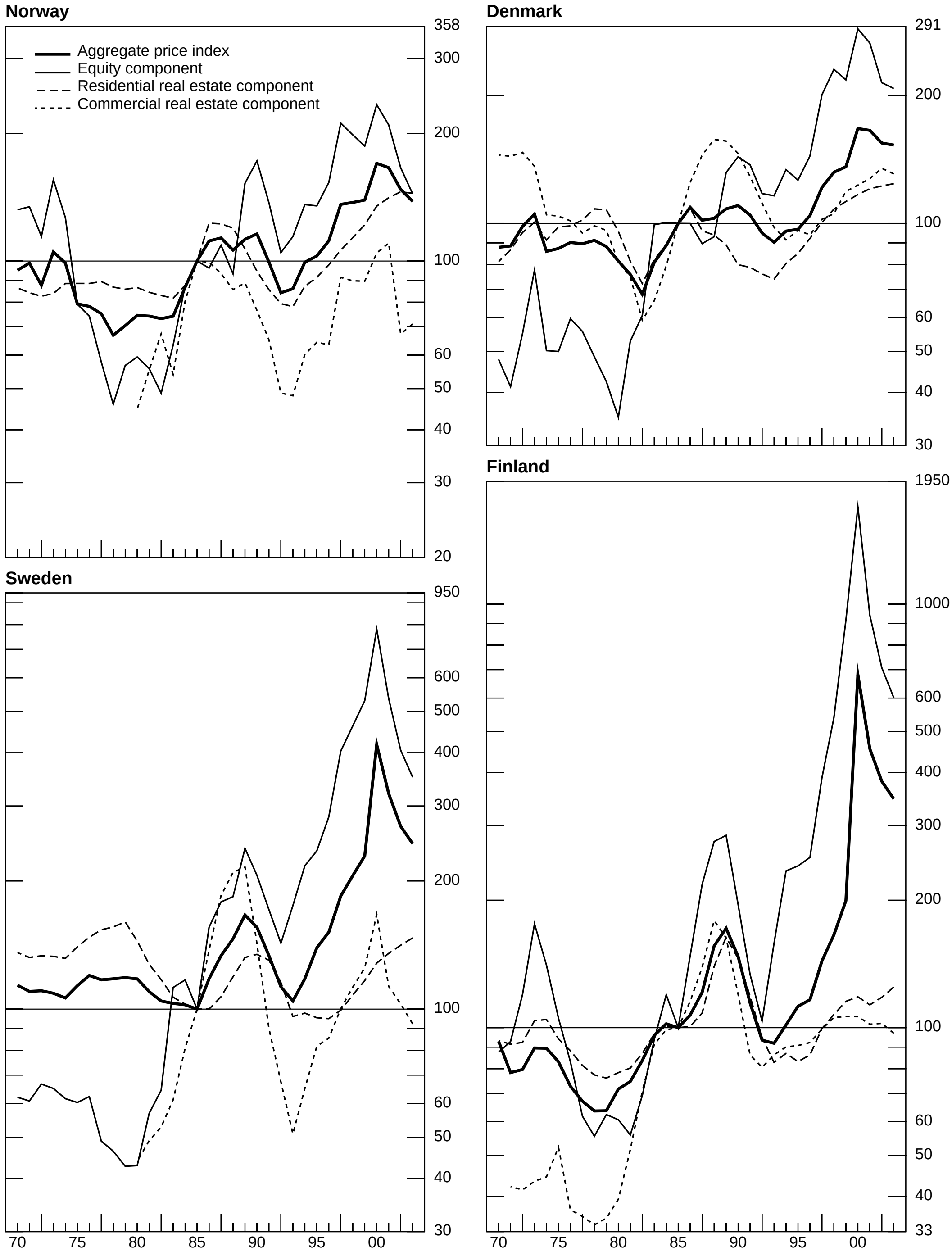
1985 = 100; semi-logarithmic scales



Graph 4 (cont)

Inflation-adjusted asset prices: aggregate and components

1985 = 100; semi-logarithmic scales



Notes: The aggregate price index is calculated as a weighted geometric mean of the three components. The weights are based, where available, on net wealth data, but in some cases are supplemented by the price change of each component. The calculation uses, where possible, moving weights; a five-year window, starting in 1970, is used where annual weights are not available. Where a component is not available, the geometric mean is calculated on the other two. For Belgium, France, Germany, the Netherlands, Norway and Sweden, the commercial real estate component is not shown in the 1970s as it is proprietary information. All indices are calculated as the nominal price indices deflated by the personal consumption deflator.

Sources: Various private real estate associations; national data; BIS estimates and calculations.

Table 1

Aggregate asset prices: a comparison of the weights

In percentages

Country	Borio et al (April 1994)				Arthur update (October 2000)			
	Period	Equity	Residential	"Net" commercial	Period	Equity	Residential	"Net" commercial
United States	1968-76	27	73	-	1972	45	45	10
	1977-82	25	68	7	1980	25	61	14
	1983-87	27	65	8	1985	26	62	13
	1988-92	31	61	8	1989	29	60	10
					1995	42	51	7
					2000	56	39	5
Japan	1960-77	5	74	21	1975	16	66	19
	1978-82	4	76	20	1980	16	66	18
	1983-87	21	62	16	1985	21	62	17
	1988-92	31	56	13	1988	31	56	14
					1995	23	59	18
					2000	18	62	19
Germany	1970-78	9	71	20	1974	8	72	20
	1979-82	8	75	17	1980	6	73	21
	1983-87	13	72	15	1985	11	70	19
	1988-92	15	69	16	1990[1]	11/12	69/68	20/19
					1995	16	66	18
					2000	32	53	15
United Kingdom	1968-76	30	70	-	1976	25	65	9
	1977-84	27	63	10	1982	27	62	11
	1985-92	34	59	7	1987[2]	34/33	58/60	8/7
					1995	46	47	7
					2000	49	46	5
Canada	1970-82	29	71	-	1976	18	56	26
	1983-87	34	66	-	1985	23	53	24
	1988-92	30	70	-	1989	24	56	20
					1995	30	53	17
					2000	37	48	15
Australia	1970-82	17	77	6	1970	37	56	7
	1983-87	19	75	6	1975	17	77	6
	1988-92	21	71	8	1980	19	76	5
					1985	19	75	6
					1990	21	71	8
					1995	25	69	6
					2000	28	67	5

[1] The first set of weights, and those prior to 1990, are for the former West Germany; the second set and those thereafter include the former East Germany. [2] The first set of weights, and those prior to 1987, are based on ESA 79; the second set and those thereafter on ESA 95.

Aggregation bias and the repeat sales price index

Anthony Pennington-Cross[1]

Introduction

A house price index is by definition a summary indicator of spatial and/or intertemporal house prices. House price indices provide a basis for measuring real estate values and their growth through time. But, all housing is not created equal. The attributes of the home (the square feet, number of baths, quality of materials, etc) as well as the location of the home add substantial heterogeneity to the value of housing in any location. As a result, any index will measure individual house prices with an error and is best thought of representing overall market conditions. This is even true for house price index estimates at a detailed level of geography such as census tracts or zip codes.

The objective of a house price index is to accurately describe the level or change in prices for a location. In the United States, house prices are typically reported for metropolitan areas or states. For instance, the National Association of Realtors (NAR) reports median house prices for a range of metropolitan areas. In addition, the Office of Federal Housing Enterprise and Oversight (OFHEO) reports a constant quality house price index for all metropolitan areas and states. The index attempts to hold quality constant by measuring the average growth in house prices using only multiple transactions associated with the same home.

Because housing is a local phenomenon and heterogeneous in space and across time, these measures of house prices provide a highly aggregated view of house prices. As a result there is substantial evidence of heterogeneous price appreciation and sample selection issues when estimating house price indices (Dreiman and Pennington-Cross (2004), Englund et al (1998), Gatzlaff and Haurin (1997)). In addition, housing is a unique commodity because it trades infrequently. This is in contrast to other markets such as commodities, stocks, and bonds which have active centralised markets that establish market clearing prices through multiple transactions each business day. There are even intraday markets that are used to promote transactions and non-business day pricing estimates. In the housing market, if a home sells only once a year it would be extremely unusual. In fact, it would be impossible, given the time required to sell a home, for a home to sell everyday. As a result, transactions are sparse relative to the outstanding stock of homes.

Both the NAR and OFHEO price indices are best described as transaction-based house price indices. The question examined in this paper is whether transaction-based house price indices differ from true or housing stock-based house price indices.

Motivation

Consider the following, stylised representation of the housing market. This presentation focuses on the importance of differences between transactions and the stock of housing and how these differences can impact house price estimates. In a region there are two cities, A and B, with housing stock of Q_A and Q_B. The total housing stock is $Q = Q_A + Q_B$. For simplicity assume that all homes are identical within each city and that the housing stock and housing quality are time invariant. Also assume that there is no noise or a stochastic process associated with house prices. House prices in City A and City B are P_{At} and P_{Bt} in each time period t. Therefore, the prices and their growth through time within

[1] The views expressed in this research are those of the author and do not represent policies or positions of the Office of Federal Housing Enterprise Oversight or other officers, agencies, or instrumentalities of the US Government. Anthony Pennington-Cross, Office of Federal Housing Enterprise Oversight, 1700 G Street, 4th Floor, Washington, DC 20052; e-mail: apennington@ofheo.gov or anmpc@yahoo.com; tel: 202-414-8937.

each city is the same for all houses. The only difference between the two cities is how much housing stock is in each city, the price of housing in each city, and the appreciation rate of house prices through time. The region's average or true house price is defined as:

$$P_t = (Q_A/Q) \times P_{At} + (Q_B/Q) \times P_{Bt} \tag{1}$$

Each city's price is weighted by the city share of the housing stock. The change in house prices over time can also be expressed as:

$$\Delta P_t = (Q_A/Q) \times \Delta P_{At} + (Q_B/Q) \times \Delta P_{Bt} \tag{2}$$

Note again that each city's price is weighted by the city share of the housing stock. ΔP_t can be viewed as an index.[2] In contrast, for an index based only on observed transactions, ΔP_{Tt}, a different weighting scheme applies. A transaction-based index can be represented as:

$$\Delta P_{Tt} = (Q_{TAt}/Q_{Tt}) \times \Delta P_{At} + (Q_{TBt}/Q_{Tt}) \times \Delta P_{Bt}, \tag{3}$$

where Q_{TAt} is the total quantity of city A's housing stock that transacted, Q_{TBt} is the total quantity of city B's housing stock that transacted, Q_{Tt} is the total amount of housing stock transacted and is defined as $Q_{TAt} + Q_{TBt}$, and ΔP_{Tt} is the transaction-based index. The transaction quantities are bounded by zero and the quantity of available housing stock. Therefore, $Q_{TAt} < Q_A$, $Q_{TBt} < Q_B$, and $Q_{Tt} < Q$. In contrast to the quantity of housing, which is held constant by assumption, the quantity of housing that transacts can also vary through time. The observed transactions, or prices, are not weighted by the share of the housing stock they represent, but instead by the share of total transactions. As a result, under certain conditions the transaction-based index can be the same or deviate from the true index.

$$(Q_A/Q) = (Q_{TAt}/Q_{Tt}) \quad \text{and} \quad (Q_B/Q) = (Q_{TBt}/Q_{Tt}) \Rightarrow \Delta P_{Tt} = \Delta P_t,$$

$$\Delta P_{At} = \Delta P_{Bt} \Rightarrow \Delta P_{Tt} = \Delta P_t \tag{4}$$

For example, if the propensity to transact equals the fraction of the housing stock in each city then the transaction and true index will be the same. In addition, if prices increase at the same rate in both city A and city B, regardless of the propensity to transact, then the transaction and true indices will be identical.

But, when city prices increase at different rates and the propensity to transact differs then the transaction index will diverge from the actual index. Assume that homeowners are more likely to sell their homes when prices are increasing. For example, if prices are increasing faster in city A than city B and the propensity to transact is also higher in city A then the true and transaction-based indices will deviate.

$$\text{If } \Delta P_{At} > \Delta P_{Bt} \quad \text{and} \quad (Q_{TAt}/Q_{Tt}) > (Q_{TBt}/Q_{Tt}) \Rightarrow \Delta P_{Tt} > \Delta P_t \tag{5}$$

In this scenario, using the transaction index, the price index will be estimated to be increasing at an artificially high rate. This is the source of the systematic bias in the transaction-based index. The opposite bias would be found if transactions are less likely to occur in higher appreciating locations. Supporting the first hypothesis, Genesove and Mayer (2001) found some evidence that homeowners do not like to sell their homes for a loss and are therefore less likely to transact when prices are down and more likely to transact when prices are up. This indicates that locations with robust housing markets may receive too much weight leading to a systematic upward bias in the transaction-based index. In contrast, Redfearn (2003) has found that transaction rates are sometimes positively and sometimes negatively correlated with house price movements in Sweden.

[2] As explained in the following sections, the index does not provide any information on the level of house price. Instead, for all locations, the index is normalised to one or 100 in the initial period and the growth rates derived from the resulting index.

Repeat sales models

The following section introduces a repeat sales model of house price appreciation rates to examine empirically the impacts of any systematic bias caused by using transactions to estimate average appreciation rates. This section will initially explain the repeat sales approach, which is implicitly a transaction-based index, and then introduces a new weighting scheme based on housing units to approximate the "true" or population wide price index.

Repeat sales models attempt to hold quality constant by examining only properties with repeat transactions to estimate average appreciation rates for particular locations. In this paper we include estimates at the state level. This will help to introduce a variety of appreciation rates across different cities within a single state. The house price index preserves the intuitively simple interpretation of any index. For example, if the index is 100 in state *j* in 2000 and increases to 105 in state *j* in 2001, the average house price in state *j* increased by 5% over the period 2000-01. The basic procedure dates back to Bailey et al (1963) and has remained essentially the same for over 40 years as is evidenced by Dreiman and Pennington-Cross (2004). Following the approach utilised by Case and Shiller (1987) and later modified by Abraham and Schauman (1991). It is assumed that the natural logarithm of price, P_{it}, of an individual house *i* at time *t*, can be expressed in terms of a market price index β_t and an individual house idiosyncratic deviation from the market index υ_t.

$$\ln(P_{it}) = \beta_t + \upsilon_t \tag{6}$$

The market index is expected to be correct on average so that $E(\upsilon_t) = 0$. This specification allows us to express the percentage change in price for house *i* which transacts in time periods *s* and *t* as:

$$\Delta V_i = \ln(P_{it}) - \ln(P_{is}) = \beta_t - \beta_s + \upsilon_t - \upsilon_s \tag{7}$$

Using D_{i_τ} a dummy variable that equals one if the price of house *i* was observed for a second time at time τ, -1 if the price of house *i* was observed for the first time at time τ, and zero otherwise the growth in house prices can be estimated by:[3]

$$\Delta V_i = \sum \beta_\tau D_{i_\tau} + \varepsilon_i, \quad \text{where } \varepsilon_i = \upsilon_t - \upsilon_s \tag{8}$$

Assuming $E(\varepsilon_i) = E(\upsilon_t) - E(\upsilon_s) = 0$, the parameters β_τ, $\tau = 0, 1, 2, \ldots, T$ for the market index can be estimated by ordinary least squares (OLS) regression.[4] Abraham and Schauman (1991) introduced the concept that the variance of the house prices around this estimated mean appreciation rate is likely to increase the longer it is between transactions. Therefore, OLS is not an efficient estimator because we cannot assume that the variance of the error term is constant. The squared deviations of observed house prices from the market index are given by:

$$\varepsilon_i^2 = (\Delta V_i - \sum \beta_\tau D_{i_\tau})^2 \tag{9}$$

It is assumed that the squared deviations of observed house price changes around β_τ will provide us with an estimate for the variance of the error term. The estimated variance of the error term will change for each combination of *s* and *t*.

$$E[\varepsilon_i^2] = A(t-s)_i + B(t-s)_i^2 + C \tag{10}$$

The expected values, from the estimate parameters *A*, *B*, and *C* and $t-s$, of the squared deviations, $E[\varepsilon_i^2]$, are used to derive the expected standard error, $E(se_i)$, which is defined as the square root of $E[\varepsilon_i^2]$. The expected errors are then used as the weights needed to obtain GLS estimates of the B_τ parameters in the following regression:

$$\Delta V_i / E[\varepsilon_i^2] = \sum \beta_\tau D_{i_\tau} / E[\varepsilon_i^2] + \varepsilon_i / E[\varepsilon_i^2] \tag{11}$$

[3] Note that the time period τ, which indicates the time period for which the index is estimated, is different from *t*, which was used previously to denote the time period of the second transaction.

[4] It is necessary to restrict one of the market index parameters to avoid perfect co-linearity among the explanatory variables. It is convenient to use $\beta_r = 0$, where *r* is the base period of the reported index.

This specification is estimated to derive house price indices. Index numbers for periods $\tau = 1, 2, 3, \ldots, T$ are given by:

$$I_\tau = 100e^{\beta_\tau^*} \tag{12}$$

where β_τ^* are the GLS parameter estimates of the market index.[5] The market index is a transaction based index because it only includes properties that transacted. If there are 1,000 observed repeat transactions then there are 1,000 observations in the estimation data set. Each observation is implicitly weighted equally. As hypothesised in the previous section, the propensity for a house to transact may be positively correlated with increasing house prices. If this is true, then transactions in locations with rising house prices represent less housing stock than transactions in locations where house prices are not increasing as much or declining. Therefore, the implicit equal weighting used to estimate the transaction-based market index is inaccurate and would bias the estimates from the true appreciation rate.

To create a housing-stock based or true market index, each observed change in house price (from the repeated observations) is weighted by the fraction of the housing stock in the neighbourhood. In this paper, the index estimated is at the state level and census tracts define the neighbourhoods. The US Census Bureau reports housing units in each tract in census years from www.census.gov, for download by county. The weights are defined using the 1990 and 2000 census tract housing units data. Because the transactions can span a considerable time period a decision rule is developed to assign the correct weight: (1) If both transaction are prior to 1991 then the 1990 census weights are used, (2) If both transactions are after 2000 the 2000 census weights are used, (3) If one of the transactions occurred during the years 1991 through 1999, then the median year of the period in which the loan was alive is used. The median year is used to identify the weight to be used from a straight-line spline of the 1990 and 2000 weights.

Results

Table 1 provides a graphical representation of the estimated annual appreciation rate for house prices for six representative states (California, Massachusetts, Maryland, Missouri, Nevada, and Ohio). The six states include locations where house prices have experienced large cycles (California and Massachusetts), locations where prices have been fairly stable through time (Ohio and Missouri), and a smaller state with a dominant and growing metropolitan area (Nevada). Some states such as Nevada or Missouri are dominated by one or two cities. In contrast, California includes a wide variety of cities with vastly different types of economies ranging from agricultural economies to high tech and financial economies. This heterogeneity should help to create deviations in house price appreciation rates and deviations in the propensity to transact. These are the conditions identified as ingredients that should make the transaction-based index deviate from the true index.

In contrast to the theory, the results provide very little evidence of any aggregation bias associated with the transaction based sample. For instance, in California there is almost no discernable difference between the index using transaction weights and the one using housing stock weights. Recall that one plausible hypothesis was that the propensity to transact should increase the more house prices are rising in a particular location. This should help to create a divergence of the transaction-based index and the housing stock based index if the propensity to transact is procyclical. But, in California there is almost no difference between the two indices, proving little support for the theory.

The same is true in Massachusetts, another location that has experienced a large run-up in house prices during the mid-1980s, price deflation and stagnation from 1988 through 1993 and modest inflation until the end of the time period. Again in this scenario, assuming heterogeneity in transaction propensities the indices should diverge. Instead, the transaction and housing stock indices are almost identical.

[5] If the restriction $\beta_1 = 0$ is imposed in estimation, then $I_1 = 100$.

The state of Maryland is substantially smaller, but is dominated by Washington DC suburban neighbourhoods and Baltimore. Again, there is almost no difference between the transaction and the housing stock based indices.

Ohio also experienced the run-up in house prices from 1985 through 1987, but the magnitude of the increases was much smaller than for Maryland, Massachusetts or California. In, contrast though, Ohio has not experienced any declining prices, but has roughly held at a 3% appreciation rate from 1990 through the end of 2000. Despite these different housing market experience the two indices are, again, almost identical.

In the two remaining states (Nevada and Missouri) the transaction and housing stock indices do diverge. In both states the peak of the run-up in house prices is over-stated in the transaction index. This is apparent in Nevada during in 1988 and 1989 and in Missouri 1986 as well as in 2000 for both states. Nevada is a unique state because the rapid growth of Las Vegas throughout the 1990s and the relative abundance of developable land in the desert. In contrast, Missouri's housing market is dominated by St Louis, which is a city that has experienced a steady decline in population. But the area still includes some major employers such as a several large mortgage corporations. The deviations are much larger in Nevada and are especially apparent from 1992 through 1994 when house price growth was moderating after larger increases in the late 1980s. In fact, the housing stock index smoothes the transaction index. The results in Nevada are not consistent with a procyclical propensity to transact theory. Instead they indicate that in Nevada the propensity to transact was higher in locations with faster increasing prices during the price run-up in the late 1980s. But during the price decline/stagnation of the early 1990s the propensity to transact was higher in neighbourhoods experiencing the worst declines in prices.

In summary, there is no consistent evidence supporting the need for focus on housing stock rather than transactions when creating a repeat sales house price index or the existence of a procyclical propensity to transact across cities.

Home owner negative equity

For an individual home, i, the probability of negative equity, π, can be calculated as follows:

$$\pi_{\tau,t-s} = \Theta((\log \mathrm{upb}_{t-s} - \log P_t)/(E(se_{t-s})) \qquad (12)$$

where $\pi_{\tau,t-s}$ is the probability that the property is worth less than the mortgage and depends on the τ, the current time period, as well as how long it has been since the last transaction ($t-s$), upb_{t-s} is the unpaid balance on the mortgage and depends on how long the borrower has been paying the mortgage, P_τ is the value or price of the home, $E(se_i)$ is the expected or estimated standard error from equation (10), and Θ is the cumulative normal density function (see Pennington-Cross (2004), Deng (1997), Deng et al (1994)).[6] Assume that the mortgage interest rate is fixed at 8% for the life of the loan, the term is fixed at 30 years, the home initial value is 100 dollars, and a 10 dollar down payment was made. In addition, the borrower is assumed to make all payments on time so that the unpaid balance is reduced on schedule through the 30 years. Lastly, to isolate the impact of new price index estimate from the impact of the standard error estimates assume that prices in all states are constant at 100.

Using these assumptions Figure 2 shows the difference between the transactions estimated π and the housing stock based π. For instance, if the transaction $\pi = 7\%$ and the housing stock $\pi = 8\%$ the percent deviation is 1%. For all states, except Nevada, the deviations reported for the first five years of the mortgages life is always negative and always less than 1%. In Nevada the deviations are positive and can exceed 3%. Therefore, while the dispersion of house prices around the mean is usually larger using the transaction index, the dispersion estimates are very similar in terms of overall magnitude. This leads to a slight overestimate of the probability that the borrower has negative equity. Again, in Nevada the results are the opposite.

[6] The expected variance is time varying as defined by the parameter estimates of A, B, C and the time between transactions ($t-s$).

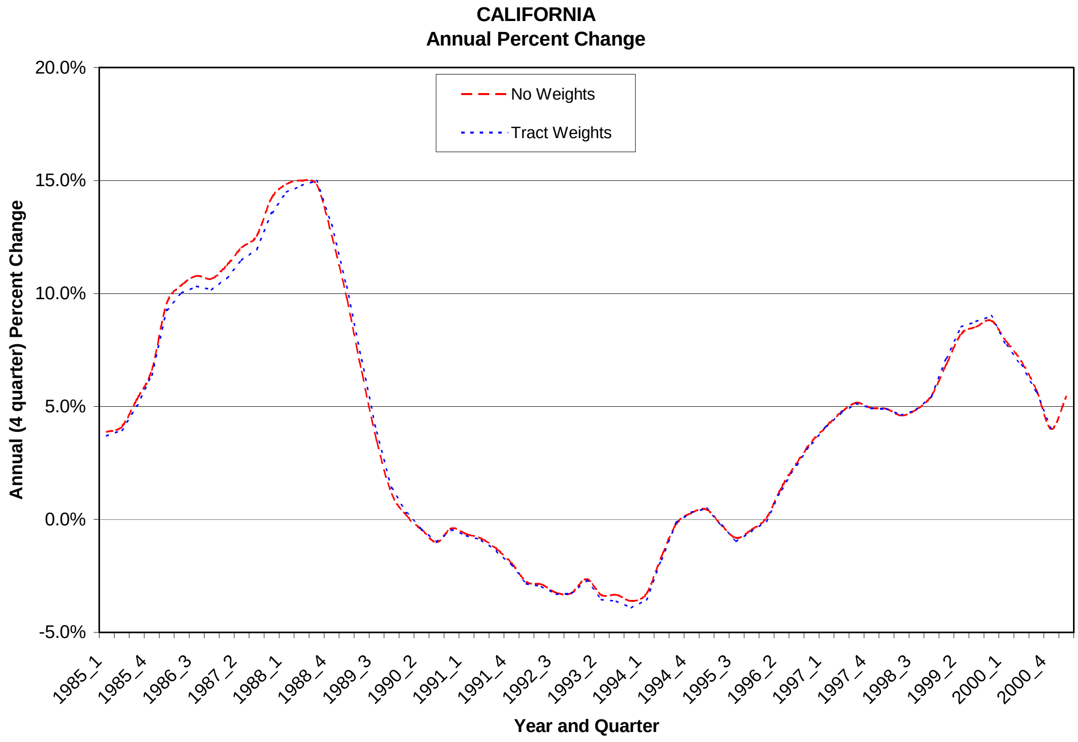
Conclusion

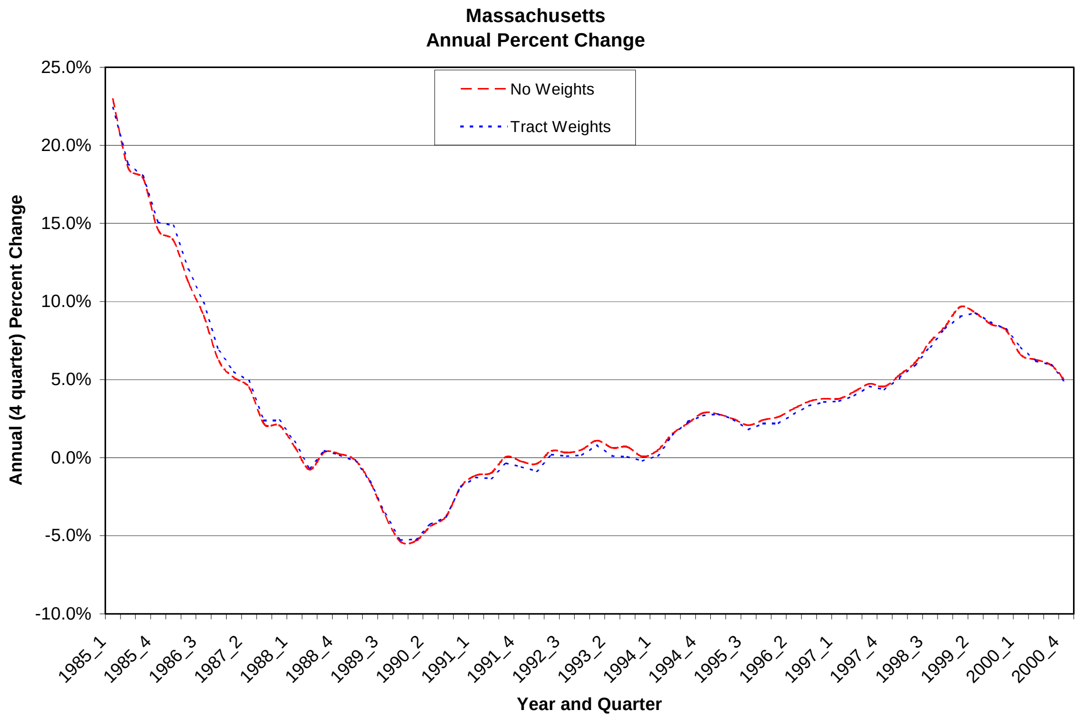
The construction of any price index must rely on actual transactions to create the index. By construction the index is an aggregate representation of individual prices. This aggregation contains a variety of property types and neighbourhood types. It is unlikely that all neighbourhoods experience the same appreciation rates or the same propensity to transact. As a result of this heterogeneity the construction of a transaction-based index may suffer from asymmetric appreciation and selection issues, which could bias the house price index.

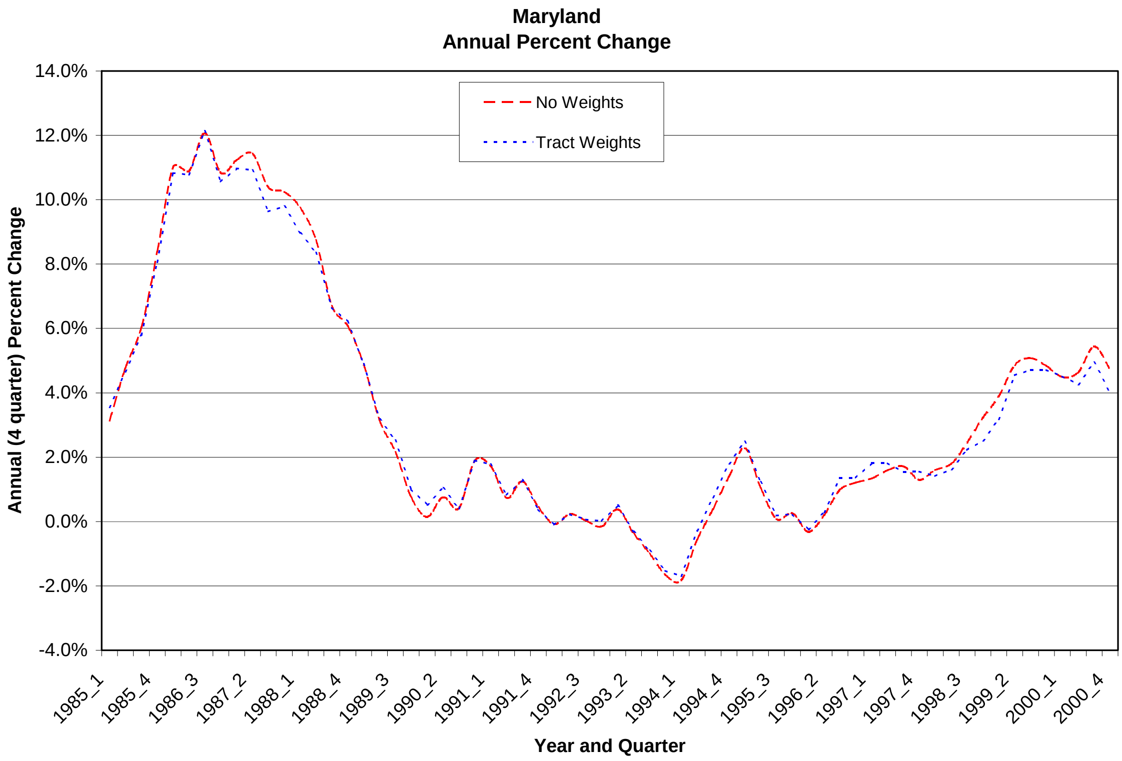
This paper examines whether any consistent bias can be found in the creation of a repeat sales price index at the state level. This is done by comparing a transaction-based index with a housing-stock-based index. The housing-stock-based index weights each observed repeat transaction by the amount of housing it represents. Therefore, the aggregate or regional index should reflect the true appreciation of house prices. But, the empirical results do not indicate any substantial revisions in the index nor do the results show any large differences on the dispersion of individual house prices around the mean appreciation rate. In particular, in large states and in states that have experienced strong housing cycles almost no discernable difference between the two indices is apparent.

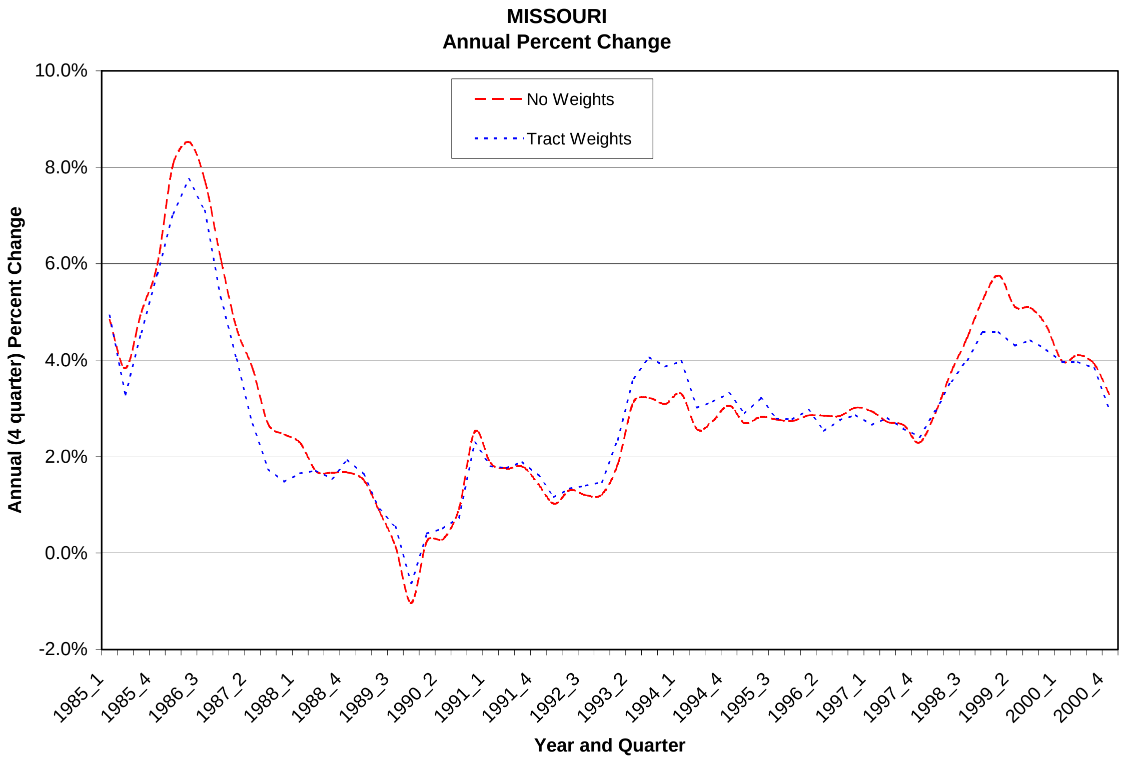
Figure 1

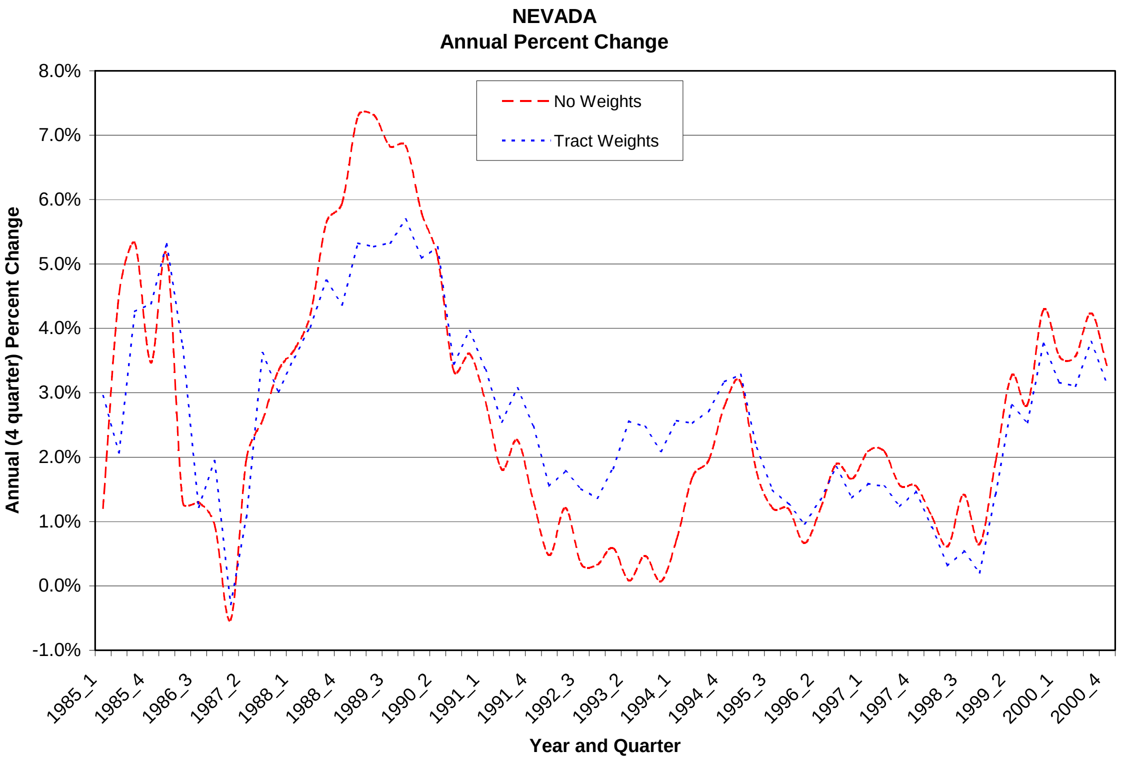
Index comparisons






Maryland
Annual Percent Change
No Weights
Tract Weights
Annual (4 quarter) Percent Change
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
-2.0%
-4.0%
1985_1
1985_4
1986_3
1987_2
1988_1
1988_4
1989_3
1990_2
1991_1
1991_4
1992_3
1993_2
1994_1
1994_4
1995_3
1996_2
1997_1
1997_4
1998_3
1999_2
2000_1
2000_4
Year and Quarter


MISSOURI
Annual Percent Change
No Weights
Tract Weights
Annual (4 quarter) Percent Change
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
-2.0%
1985_1
1985_4
1986_3
1987_2
1988_1
1988_4
1989_3
1990_2
1991_1
1991_4
1992_3
1993_2
1994_1
1994_4
1995_3
1996_2
1997_1
1997_4
1998_3
1999_2
2000_1
2000_4
Year and Quarter


NEVADA
Annual Percent Change
No Weights
Tract Weights
Annual (4 quarter) Percent Change
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
-1.0%
1985_1
1985_4
1986_3
1987_2
1988_1
1988_4
1989_3
1990_2
1991_1
1991_4
1992_3
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2000_1
2000_4
Year and Quarter

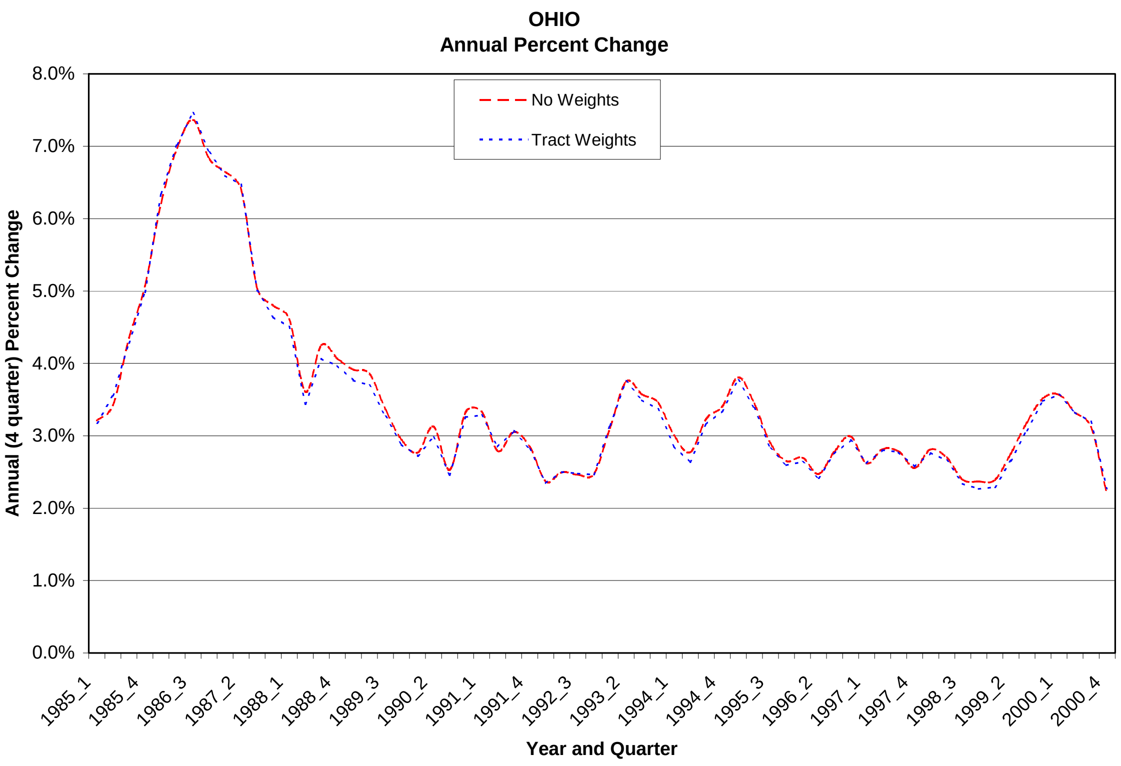
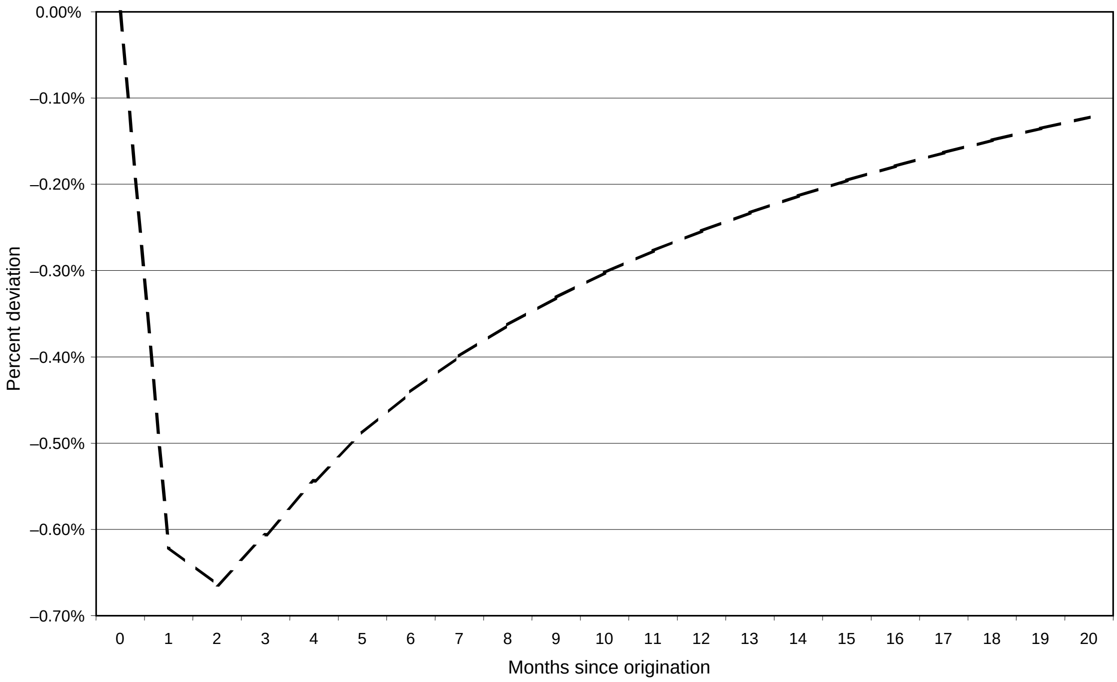

OHIO
Annual Percent Change
No Weights
Tract Weights
Annual (4 quarter) Percent Change
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
1985_1
1985_4
1986_3
1987_2
1988_1
1988_4
1989_3
1990_2
1991_1
1991_4
1992_3
1993_2
1994_1
1994_4
1995_3
1996_2
1997_1
1997_4
1998_3
1999_2
2000_1
2000_4
Year and Quarter

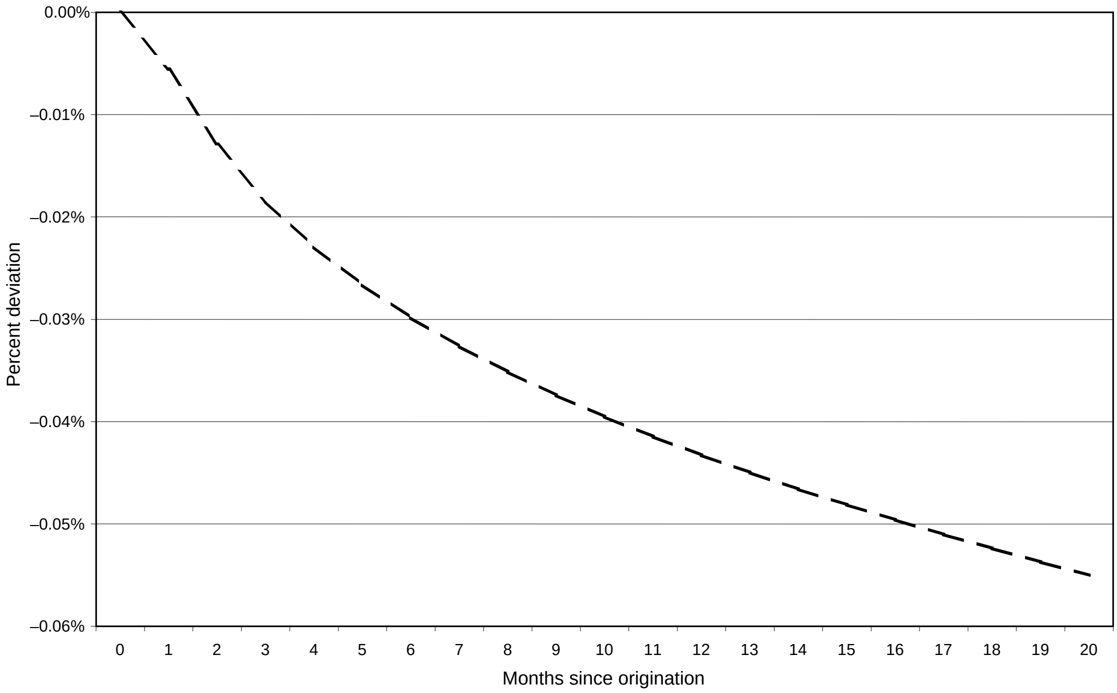
Figure 2

PNEQ deviations

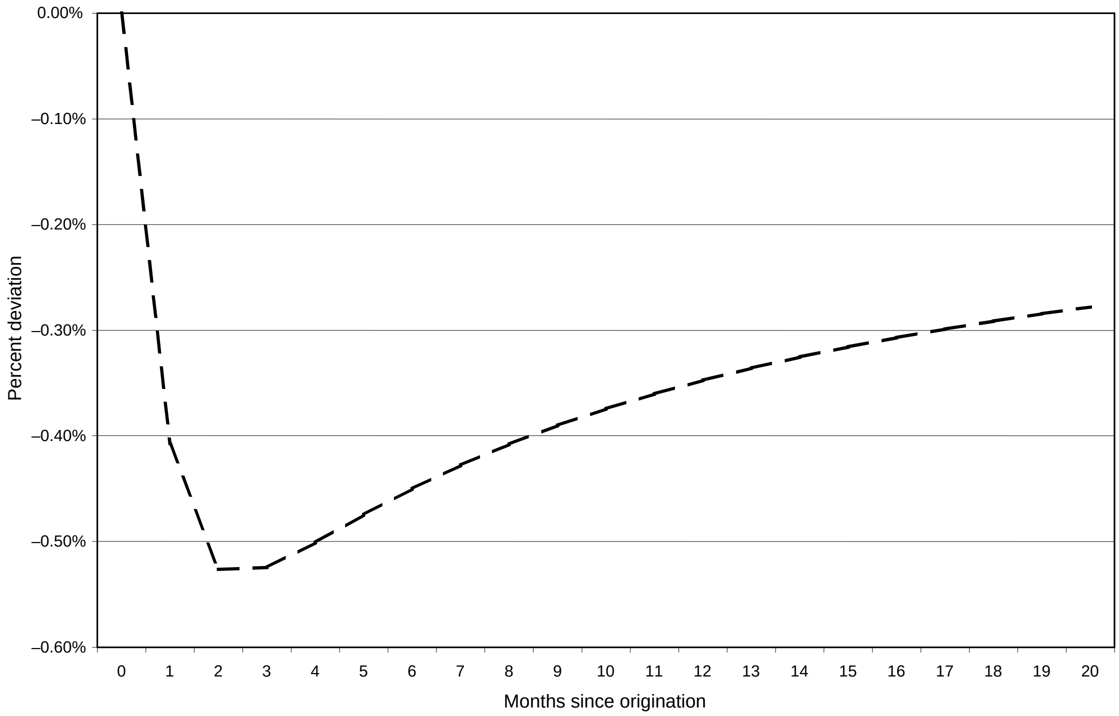
California - percent deviation from unweighted PNEQ, no house price growth



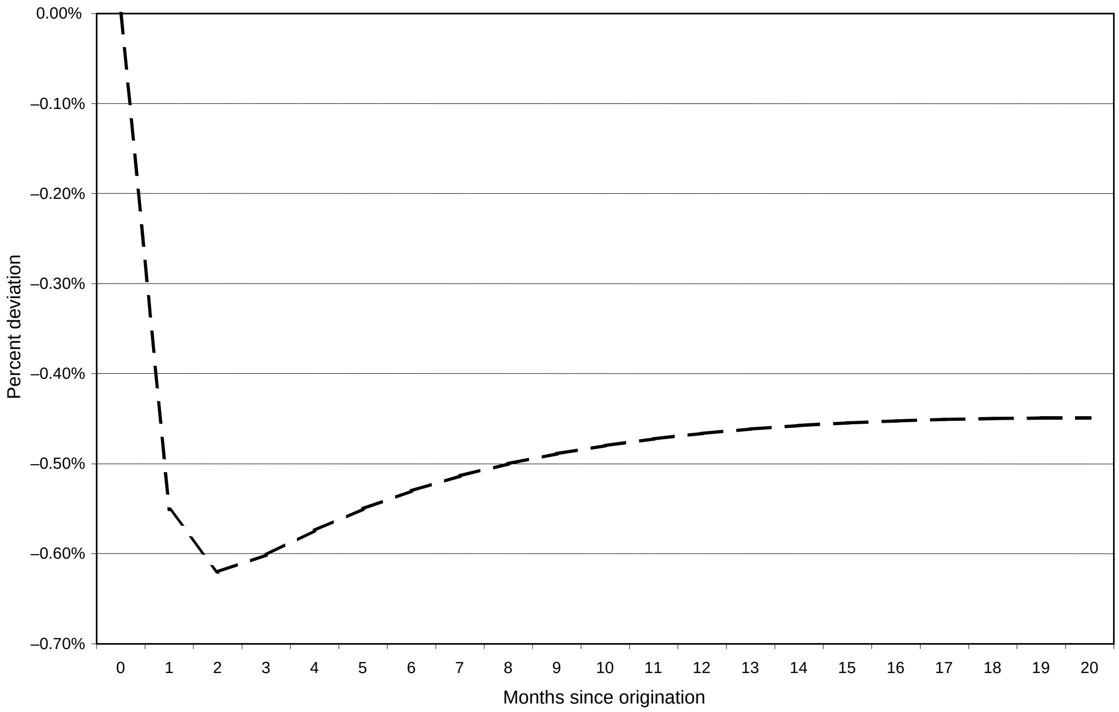
Massachusetts - percent deviation from unweighted PNEQ, no house price growth



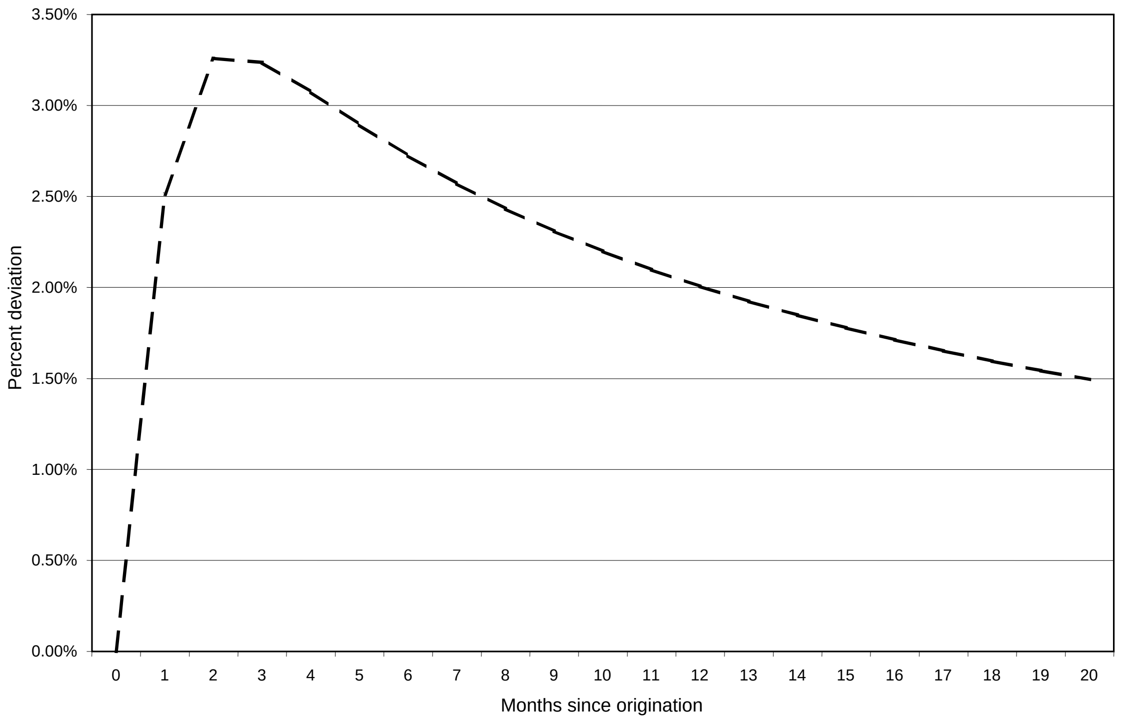
Maryland - percent deviation from unweighted PNEQ, no house price growth



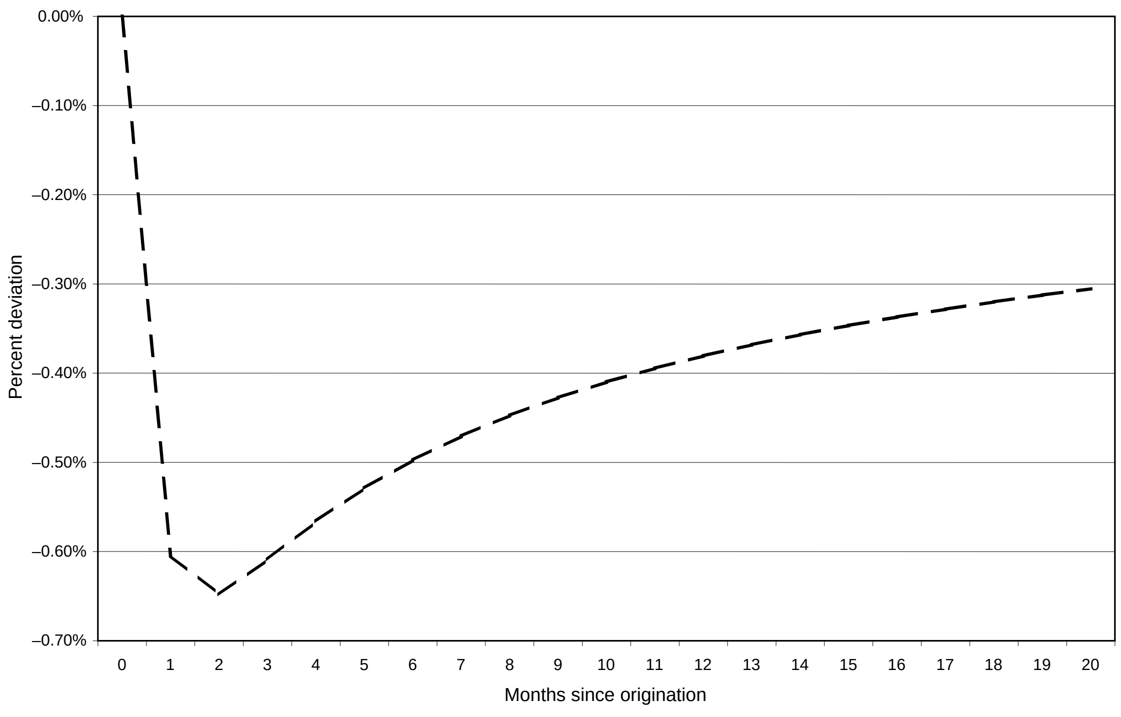
Missouri - percent deviation from unweighted PNEQ, no house price growth



Nevada - percent deviation from unweighted PNEQ, no house price growth



Ohio - percent deviation from unweighted PNEQ, no house price growth



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Comments on session "Aggregation issues", David Fenwick, Chair, with three papers:

1. Henning Ahnert and Adrian Page, "Euro area residential property prices: the aggregation of non-harmonised national data"

2. Stephan V Arthur, "Experience with constructing composite asset price indexes"

3. Anthony Pennington-Cross, "Aggregation bias and the repeat sales price index"

Robert J Shiller

The papers in this session impress on me how far we have come in the construction of real estate price indexes, but also about the distance we still have to go.

First, let me say that the progress in the construction of home price indexes, as revealed by the papers in this session, is stunning. When I first got involved in the construction of home price indexes in 1987, there were really no really good indexes available for any country, as far as Karl Case, my colleague, and I could determine. In the United States, there was the median sales price computed by the National Association of Realtors for major US cities, but at that time at least the median was often quite erratic through time. There was the Constant Quality Index produced by the Commerce Department, but it was a price for new homes only, and of course new homes tend not to be built in neighbourhoods with declining prices, and so this was an essentially biased estimate. In 1987, with only such data available, people hardly knew what the course of real estate prices were. There is always going to be uncertainty about the future, but in those days there was about as much uncertainty about the past: historical home prices were just not known accurately.

Now, looking at both the Stephan Arthur results and the Ahnert-Page results we can see a detailed account of what is happening to residential property prices. The Bank for International Settlements has done us all a great service by assembling its multi-country data set of asset price indexes for 13 countries. Until they had done this, the world had not seen the detailed international price data for residential properties, and the magnitude and covariability of these price movements were an eye-opener. The BIS data were of such news quality that the popular news magazine *The Economist* has gone to the sources that the BIS tapped and is giving much press to these indexes.

Stephan Arthur's computation of an aggregate asset price index (AAPI), and a plot of this total with its breakdown (in Graph 2) for 16 countries, gives us yet another powerful indicator of the wealth of nations, and new insights into the changes through time. The rather different behaviour across these components in the time paths reveals how much the stability of aggregate wealth in each country is the result of diversification across the three main asset classes, equity, residential real estate, and commercial real estate. The time paths of any one of the components differs a lot across countries, but the time path of the aggregate is fairly similar across all countries. (I only wish he had also included fixed incomes on these charts, which would have rounded out the remaining major asset class.)

The Ahnert-Page paper gives a good indication of the data and methods that underlie the European Central Bank (ECB) euro area residential property price indicator. They also show the remaining weaknesses in these indexes. Annex 1 reveals that for three of the 12 countries no quality adjustment at all is made, and for another five the quality adjustment is only based on square metres.

Regional weighting, for which Ahnert and Page (as well as Pennington-Cross) present a good theoretical case, is either not attempted at all or not defined in half of the countries. One might well surmise that regional weighting can make a great difference, if it is really done right. The Ricardian model of a city shows prices increasing like a rising pyramid on a plane, with prices zero in the undeveloped lands around the city, with the base of the pyramid expanding through time, and with the highest amount of sales occurring at the perimeter of the base of the pyramid, where prices stay near zero. While the Ricardian model is an extreme case, it does suggest that without regional weighting, a price index may show no increase even as the pyramid grows larger and larger.

It is fortunate that the results of Pennington-Cross suggest that such weighting was not so important in his examples. But, it is still possible that a more detailed study would show bigger effects. A spatial map of price levels would likely show irregular contours with some sharp peaks in urban areas.

Another problem for constructors of price indexes which ought ideally to be addressed is the resistance of sales prices to declines (downward rigidity). David Genesove and Christopher Mayer have shown, with some detailed data from the United States, that homeowners are reluctant to sell at a loss, apparently for psychological reasons related to the pain of regret. In down markets, the volume of sales drops dramatically, and so the sales in all regions can become unrepresentative of the actual prices that might be arrived at in actual markets.

There is also a fundamental distinction between new construction and existing homes. New construction goes on mostly in areas where land is not scarce, and only when price rises above construction cost. In those areas, there are forces to keep home prices in line with construction costs. Sales are biased towards new homes, tending to misrepresent the change in prices overall.

In the United States, Karl Case and I found a sharp distinction between states whose prices track the price of construction and states whose prices show wild departures from the price of construction. We concluded that states whose cities have an abundance of buildable land show very little price volatility, and the real estate market in those cities never becomes speculative. In contrast, states whose cities have little buildable land, and particularly in the glamorous cities within those states, a speculative sensitivity tends to infect the thinking of homebuyers, causing sometimes erratic moves in home prices. We see a hint of this in the Ahnert-Page data, that show the glamour city of Paris with much more volatile prices than France overall.

I was struck that, according to Ahnert and Page, none of the European data producers used the repeat-sales method. This seems most unfortunate, since the repeat-sales method would eliminate a number of problems, including the problem of excessive weight being given to new construction. Ahnert and Page dismiss this method because they say it demands a large amount of data. But, in fact, in our modern electronic age the volume of accessible data is growing by leaps and bounds, and the repeat-sale method ought to be considered for the future in Europe.

The original repeat-sales index idea is due to Baily et al (1963). The idea is to base price index construction exclusively on the change in price of individual homes. To construct a repeat-sales price index along lines outlined by Baily et al, one regresses change in log price between sale dates on time dummies, -1 for first sale period and $+1$ for second sale period except for the base period for which there is no dummy. Here, period refers to the unit of time, whether year, quarter or month. The estimated coefficients of time dummies become the log price index, and the log price index is zero in the base period by construction. For example, with four sales pairs, the first two of which were bought in period zero and sold in period one, the third in period zero and period two, and the fourth in period one and period two, we set up the regression model $Y = X\beta + \varepsilon$ where:

$$X = \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix}, \quad Y = \begin{bmatrix} p_{11} - p_{10} \\ p_{21} - p_{20} \\ p_{32} - p_{30} \\ p_{42} - p_{41} \end{bmatrix}$$

and where P_{ht} is log price of house h at period t, $t = 0, 1, 2$, and the coefficient corresponding to the first column of X is the log price index for $t = 1$ and the coefficient corresponding to the second column of X is the log price index for $t = 2$. This is essentially the method that Karl Case and I developed further, and that my firm Case Shiller Weiss, Inc, pioneered, and that is now used by Fannie Mae, Freddie Mac, and the Office of Federal Home Equity Oversight in the United States.

The repeat-sales method is very attractive because it solves the missing hedonic variables problem (so long as homes' characteristics are unchanging), and homes whose characteristics have changed in a major way can sometimes be excluded (as by accessing data on building permits).

The Ahnert and Page paper describes repeat-sales regression and hedonic regression as fundamentally different methods. But, in fact, they are both regression methods, and all regression methods are fundamentally related. It is just a matter of what one controls for in the regression. In fact, there is a natural hybrid between repeat-sales method and the hedonic method, as I described in my 1993 book *Macro Markets* and in a 1993 article. I defined there the hedonic repeat-sales method, which is an extension of the repeat-sales regression method. To create a price index using hedonic repeated measures method, one must regress the change in log price of house between sales on dummies for individual house and also on interactions of hedonic variables with dummies for individual house.

To continue the above example, suppose that we have for each of the four homes the hedonic variable s_{ht}, the square feet of floor space of home h at time t, which can change if new construction expands the house. We then set up the regression:

$$X = \begin{bmatrix} 1 & 0 & s_{11} & 0 \\ 1 & 0 & s_{21} & 0 \\ 0 & 1 & 0 & s_{32} \\ -1 & 1 & -s_{41} & s_{42} \end{bmatrix}, \quad Y = \begin{bmatrix} p_{11} - p_{10} \\ p_{21} - p_{20} \\ p_{32} - p_{30} \\ p_{42} - p_{41} \end{bmatrix}$$

This regression model takes account of all factors that are constant for a single house as well as allowing for square feet of floor space that changes through time for the house. From the estimated coefficients we can define a log price index for a standard house, for period one equal to the coefficient of the first column plus the coefficient of the third column times s, and for period two equal to the coefficient of the second column plus the coefficient of the fourth column times s, where s is the square feet of floor space for the standard house.

The perfection of our price indexes is very important because the home price indexes play many roles, going far beyond the role of detecting financial instability, as was emphasised in an earlier session in this conference. The desiderata for good indexes that reveal financial instability is that the indexes should capture national trends well, that the indexes should have associated with them some measure of earnings or rents so that a price-earnings ratio can be computed, and that indexes might be broken out between speculative glamour cities (where price bubbles tend to occur) and other areas. But, there are other purposes for price indexes and these other purposes suggest other desiderata.

An important application of real estate price indexes has been for automatic valuation models (AVMs) for homes. These models update past selling prices of individual homes with a real estate price index for its locale as a way of estimating the value of the homes. There is now great demand for AVMs, as the mortgage industry is going increasingly electronic and online, and so quick electronic access to home values is increasingly important. There is now a substantial industry which produces AVMs for sale to mortgage originators, home equity lenders, and others who have an interest in valuation of individual homes.

The desiderata for price indexes for use in AVMs are that the indexes should be finely disaggregated by region and by property type, as indeed price trends can differ significantly from one part of a city to another, and from one class of housing to another. Moreover, we do not want to purge the indexes from the effects of quality change in the homes, since the indexes are meant to compute the price of the houses with all the quality changes. On the other hand, we would ideally like to correct the indexes for the problem of downward rigidity of asking prices, and failure to sell homes whose prices have really declined.

Another very important use for real estate price indexes is in the settlement of financial contracts that allow the management of risks associated with real estate. The first such contract was a UK property futures market set up by the London Futures and Options Exchange (London Fox) in 1991. Although that market failed, successors are now succeeding. Also in London, City Index and IG Index set up index-based UK property futures markets in 2002. In 2003 Goldman Sachs launched certain real estate warrants in London that settle in terms of the Halifax residential property indexes. In the United States, there are several firms with plans to launch index-based futures markets in real estate: Hedgestreet.com, Realliquidity.com and Advanced e-Financial Technologies. A firm that I helped found, Macro Securities LLC, has been working with the American Stock Exchange to produce securities whose dividends depend on indexes, such as real estate price indexes. As these markets develop it will become increasingly possible to hedge real estate risks.

Designing indexes for use in contract settlement suggests different desiderata. When applied to contract settlement, it is important that the indexes be provided with great frequency and little time lag, and with great assurance that the index will be produced on time. The index should ideally not be revised after it is first announced, lest contracts be settled on erroneous values. The index construction method must be simple and replicable, and at the same time robust to criticism, so that market participants can have faith in the values. Since we will not have markets for every neighbourhood or property type, aggregate indexes are most important. Invulnerability to manipulation or early release of data to insiders have to be avoided.

I think that the progress that is being made in real estate price index construction as revealed by the papers in this session is an important beginning. But, with all the uses that will be made in the future for such indexes, and with all the improved electronic data transmission facilities, we have a lot more work cut out for us in the future.

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