

# Nasdaq OMX Valueguard-KTH Housing Index (HOX<sup>®</sup>) Methodology

## **Revision**

Version pA5, 2011-03-18 – Adding of the Nasdaq OMX Valueguard-KTH Housing Index (HOX<sup>®</sup>) for single family houses in Sweden.

Version pA4, 2010-05-20 - Adding of the Nasdaq OMX Valueguard-KTH Housing Index™ Flats Sweden and - Flats Medium Cities Sweden.

Version pA3, 2009-11-19 - Rules for the Construction and Maintenance of the Nasdaq OMX Valueguard-KTH Housing Index™, supporting condominium indexes for the three main cities in Sweden

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## Introduction

Nasdaq OMX AB (publ) and Valueguard AB, hereinafter referred to as the Index Owners, co-own the stock index Nasdaq OMX Valueguard-KTH Housing Index, with the ticker symbol HOX<sup>®</sup>, and has granted the Exchange and the co-operating Exchanges the right to use the indexes in the Nasdaq OMX Valueguard-KTH Housing Index family in connection with trading in and clearing of Contracts related to the Nasdaq OMX Valueguard-KTH Housing Index by the Exchange and the co-operating Exchanges in accordance with these Rules and Regulations. The Index Owners have appointed the Exchange to be the Nasdaq OMX Valueguard-KTH Housing Index provider. This also embraces the construction and adoption of the regulatory system for Nasdaq OMX Valueguard Housing Index, hereinafter called Nasdaq OMX Valueguard-KTH Housing Index Rules. The calculation of the indexes is done by Valueguard Index Sweden AB.

Nasdaq OMX Valueguard-KTH Housing Index has been constructed with the objective to be a consistent and reliable benchmark for the traded private real estate house and apartment markets, i.e. reflecting the price development of a typical single family house and/or condominium in a particular geographical area. The primary objective is that Nasdaq OMX Valueguard-KTH Housing Index should reflect the price development of a typical traded private single-family home for major metropolitan areas in Sweden for a start. Thus, the index family will consist of three index series, one reflecting the price development for condominium, one for single-family houses and one combined for single family homes.

This document describes the process and rules for how to calculate the Nasdaq OMX Valueguard-KTH Housing Indexes. It is aimed at users, investors and others interested in the construction and computation of such indexes.

### Partnership

These indexes are generated and published under agreements between Nasdaq OMX (publ), Valueguard AB, and Valueguard Index Sweden AB. The indexes are based on sales transaction data from the real estate brokers. The indexes are generated and published under agreements between Valueguard Index Sweden AB and Mäklarstatistik AB.

### Technology

The calculations of the indexes are all done according to an index specification developed by KTH Royal Institute of Technology under the supervision of Professor Mats Wilhelmsson, Center for Banking and Finance (CEFIN). The index specification is based on a so called hedonic price model. The index specification is fully owned by Valueguard AB and Valueguard Index Sweden AB and a patent application (U.S. Provisional Patent Application Atty Docket No. 0245-010) has been filed for the unique parts of the index specification.

## Terminology

### Naming convention

Nasdaq OMX Valueguard-KTH Housing Index is the name of the indexes. In the Swedish language the name to be used in writing is: “*Nasdaq OMX Valueguard-KTH boprisindex*” or the abbreviation “HOX Index”.

## Index Construction

### Introduction

The index is constructed by estimating a cross-sectional and time-series hedonic price equation of cooperative apartment prices in Sweden. A hedonic price equation is a regression of prices against attributes that determine these prices and time. The interpretation of regression coefficients is as estimates of the implicit (hedonic) prices of these attributes.

Following the literature, the hedonic price equation is equal to

$$Y_{i,t} = \beta_0 + X_{i,t}\beta_1 + TD_t\beta_2 + \varepsilon_{i,t} \quad i=1,\dots,N \text{ and } t=1,\dots,T$$

where Y is the dependent variable transaction price,  $\beta_1$  is a vector of regression coefficients associated with exogenous explanatory variables, X. The stochastic term  $\varepsilon$  is assumed to have a constant variance and normal distribution. We can decompose X into, for example, structural apartment and property attributes, as well as neighborhood attributes. The variable TD with subscript t is a dummy variable for each period and equal one for period t and zero otherwise. N is equal to the number of observations and T is equal to the number of periods (in this case months).

Hedonic price equations in which the dependent variable price appears in logarithmic form, with a number of monthly time dummy variables as independent variables, are estimated. The parameter estimates concerning the dummy variables have a percentage interpretation: when multiplied by 100, the estimated parameter on a dummy variable is interpreted as the approximate percentage change in the dependent variable. In a hedonic price index application, the exponential of the estimated time dummy parameters might therefore be interpreted as the approximate rate of growth in the mean price with respect to the mean price at the beginning. For further reading see the index product specification.

### Inclusion and Exclusion Criteria

The Nasdaq OMX Valueguard Housing Indexes are designed to measure the price development of a typical one family condominium, a single family house and a combined index for both condominiums and single family houses. Since the number of sales transactions is limited in Sweden a hedonic price equation has been used to calculate the indexes which gives robust index values also with limited number of sales transactions.

As a comparison, a repeated sales index, which is based on sales transaction pairs, identifies sales transactions for objects within a data set which have been sold twice during a period of time, the rest is

excluded, and thus a lot of transaction data is needed. The hedonic price equation, on the other hand, uses more information in each transaction, thus needing fewer transactions to produce an index.

The index is based on the real estate agent sales transactions and excludes new construction. However, it includes sales transactions from both condominiums and single family houses. It does not include the sales transactions from vacation houses, co-ops/apartments, multi-family rental dwellings, or other properties that cannot be identified as single-family.

### Composite index construction

A number of different methods can be used to develop a composite index from a number of regional index series. In order to calculate a composite index, the included regional indexes need to be weighted. The weights are based on both the stock and values of apartments in the different regions. The used housing stocks are figures from Statistic Sweden (SCB) with one year lag. Not all regions are included in the composite index. Instead the index includes the largest regions. The included regional indexes in the composite indexes are based on number of sales in the region. The regions are based on municipalities in the apartment indexes while the indexes for single family houses include the labor market regions of the largest cities and of larger regional centres.

### Index Family

The Nasdaq OMX Valueguard Housing Index family comprises indexes for condominiums, single family houses and combined indexes for both.

## Index Construction Process

### Data Input (Sources)

Sales transaction data is obtained from the real estate agent business systems, Capitex and SFD. One of the major data suppliers is Mäklarstatistik AB. The data is then inspected, complemented and cleaned.

Data is for instance complemented with missing (x,y) coordinate information and certain data attributes are compared to expected attribute values to identify missing or erroneous data.

The data for single family houses is complemented by register data from Lantmäteriet, the Swedish mapping, cadastral and land registration authority.

The index reflects the price development of a typical single family house and/or condominium in a particular geographical area. Even though, the price equation explains about 90% of the price variation of the data set, the index is based on approximately 50% of the total number of sales transactions, thus it could differ slightly from an index based on all sales transactions in theory.

### Detecting Outliers

Outliers can be a serious problem. In order to mitigate problems with outliers and measurement errors, we have, first, excluded all observations that deviate in value too much measured by a statistical

measure from expected value and second, down-weighted observations where the absolute value of the errors is high. For more detailed information, see the index product specification.

### Verification of the Index Values

The data input, data processes and index calculations are stored for future verification of index values in case a recalculation of the index series by an independent vendor is demanded.

## Index Dissemination

### Object Types

Condominiums  
Single family houses

### Geographical Areas

- The municipalities of Stockholm, Gothenburg and Malmö (condominiums)
- The labour market regions Stockholm (1a), Gothenburg (21a) and Malmö (19a) as defined by the Swedish Agency for Economic and Regional Growth (single family houses)
- Medium sized cities with the largest number of registered transactions (condominiums)
- The labour market regions in the category “Larger regional centres” as defined by the Swedish Agency for Economic and Regional Growth (single family houses)
- National Swedish composite indexes composed by the indexes above

### Dissemination

As of March 18, 2011 five index series are published for condominiums, here called NASDAQ OMX Valueguard-KTH Housing Index Flats. Five index series are published for single family houses. One index is a composite of both condominiums and single family houses. Indexes are distributed through Bloombergs and Reuters with the ticker symbols below.

#### Full Name

Full Name	Ticker
NASDAQ OMX Valueguard-KTH Housing Index Sweden	HOXSWE
NASDAQ OMX Valueguard-KTH Housing Index Flats Sweden	HOXFLATSWE
NASDAQ OMX Valueguard-KTH Housing Index Houses Sweden	HOXHOUSESWE
NASDAQ OMX Valueguard-KTH Housing Index Flats Stockholm	HOXFLATSTO
NASDAQ OMX Valueguard-KTH Housing Index Flats Gothenburg	HOXFLATGBG
NASDAQ OMX Valueguard-KTH Housing Index Flats Malmö	HOXFLATMLM
NASDAQ OMX Valueguard-KTH Housing Index Flats Medium Cities	HOXFLATMCSWE
NASDAQ OMX Valueguard-KTH Housing Index Houses Greater Stockholm	HOXHOUSESTO
NASDAQ OMX Valueguard-KTH Housing Index Houses Greater Gothenburg	HOXHOUSEGGBG
NASDAQ OMX Valueguard-KTH Housing Index Houses Greater Malmö	HOXHOUSEMLM
NASDAQ OMX Valueguard-KTH Housing Index Houses Medium Cities	HOXHOUSEMCSWE

### Index Base Value

100.00

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**Index Base Date**

2005-01

**Length of Index Series**

74 months (2011-03-18)

**Measurement Period and Updating Frequency**

New index values are calculated and updated monthly.

**Methodology**

Hedonic price index

**Calculation**

Valueguard Index Sweden AB

**Dissemination**

Nasdaq OMX (publ)

**Responsible for Index Specification**

Professor Mats Wilhelmsson (Centre for Banking and Finance/Cefin, KTH Royal Institute of Technology) and  
Dr. Han-Suck Song (KTH Royal Institute of Technology)

**Patent Application**

U.S. Provisional Patent Application No. 61/176.743.

**Read More**

More detailed information regarding the index construction it may be found in the Product Information document found at [www.valueguardindex.se/index](http://www.valueguardindex.se/index).

## Index Maintenance

**Revisions**

Each month when a new index value is calculated, only the last data point is added to the index series.

Although most sales transactions are available at calculation times of each index value, sometimes a number of sales transactions for an earlier period may not yet have been recorded at the time of index calculation. Normally, this has no significant effect to the index values. When this information becomes available it is included in the next month's calculation, however this will only affect the new month index value.

Historical index numbers will not be changed when the index is updated for a new period.

### Planned Revision Updates

Although the index series are calculated as accurate as possible, changes to the data set or the index specification due to changes of the data set or the availability of data sets may happen. A review of the index series for reasons of maintenance updates is normally carried out every 6 months, with cut-off dates end of June and end of December respectively. Planned revision updates are supervised by the Index Quality Forum and are informed about three months in advance.

### Index Composition Revision

Composition indexes is revised annually the first trading day in June and December based on previous six month sales transaction data with cut-off date end May and end November respectively. A decision to do an update of the composite index weights are supervised by the Index Quality Forum. An index composition revision is informed about three months in advance.

### Index Corrections

Even if the index calculation and dissemination of the index normally should have no malfunction, the correction procedures for incorrect or missing data input are:

- Corrected immediately as intraday change.
- Correction after closing time.

### Discretionary Adjustments

NASDAQ OMX may in cases described above make other adjustments than those stated if warranted by special circumstances and deemed essential for the index construction

### Publication of Index Revisions

All revisions of the index series and changes to these rules are always published in the revision history available at <https://indexes.nasdaqomx.com>.

Notice of any adjustment shall be given in an Index Announcement. Whenever possible, any such announcement shall be published not less than two Bank Days before it takes effect.

### Rounding off

Index Values and average prices shall be rounded off to two decimals. The Exchange information and Clearing Systems use a rounded Index Value with two decimals.

## Index Governance

### Index Quality Forum

Nasdaq OMX Valueguard-KTH Housing Index is under the supervision of an Index Quality Forum with representation from KTH Royal Institute of Technology, Nasdaq OMX, Valueguard Index Sweden, Mäklarstatistik AB and leading industrial companies. The Index Quality Forum will also supervise and make sure that processes are established to minimize the risk for manipulation of data and a policy for inside information is established before trading starts. Index Quality Forum is gathered twice a year or when necessary.



## Publishing Dates

The NASDAQ OMX Valueguard-KTH Housing Index will be published monthly, 9.00 AM Swedish time, publication at the same day as Mäklarstatistik.se publishes statistics. Publishing calendar is available at <https://indexes.nasdaqomx.com>

## Index Announcements

Information concerning Nasdaq OMX Valueguard-KTH Housing Index is provided by the Exchange through Index Announcements. Matters covered by such announcements will include various types of adjustments to the indexes as well as the reasons for such adjustments.

Index Announcements will be distributed by the Exchange via

[http://nordic.nasdaqomxtrader.com/newsstatistics/Market\\_Notices/STOCKHOLM\\_Market\\_Notices/](http://nordic.nasdaqomxtrader.com/newsstatistics/Market_Notices/STOCKHOLM_Market_Notices/).

## Website

More information regarding Nasdaq OMX Valueguard-KTH Housing Index can be found at [www.nasdaqomxnordic.com/bonds/sweden/mortgagerates](http://www.nasdaqomxnordic.com/bonds/sweden/mortgagerates).

More detailed information regarding the index, more detailed and complementing index series as well as information regarding index analysis products can be found at [www.valueguardindex.se/index](http://www.valueguardindex.se/index)

## Limits of Liabilities

Neither the Index Owners nor the Exchange is liable for loss or damage resulting from Swedish or foreign legislative enactment, actions of Swedish or foreign authorities, war, power failure, telecommunication failure, fire, water damage, strike, blockade, lockout, boycott, or other similar circumstances outside the control of the Index Owners or the Exchange. The reservation with respect to strikes, blockade, lockout and boycott also applies if the Index Owners or the Exchange adopts or is the subject to such conflict measures.

Neither the Index Owners nor the Exchange shall be responsible under any circumstances for loss of data, non-payment of profits or other indirect damage.

The Index Owners and the Exchange provide no express or implied warranties regarding the results that may be obtained as a consequence of the use of Nasdaq OMX Valueguard-KTH Housing Index or regarding the value of Nasdaq OMX Valueguard-KTH Housing Index at any given time. The Index Owners and the Exchange shall in no case be liable for errors or defects in Nasdaq OMX Valueguard-KTH Housing Index nor obligated to provide notice of, or publish, errors in Nasdaq OMX Valueguard-KTH Housing Index in any manner other than that set forth under Index Maintenance.

### **Changes in Conditions**

The Exchange retains the right to amend these rules.

### **Planned Revisions of Conditions**

The Exchange plans to complement these rules when new index series are made available. The rules may also be updated for clarification purposes or to meet additional requirements. To amend these rules for the current index series to become effective, the approval of the Index Ombudsman is required when the changes to the rules affect existing index series.

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