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Remarks on the story of land prices, told by house prices

Risto PELTOLA, Mikko KORPELA, National Land Survey of Finland



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Summary

- There is an implicit land price in house prices. This implicit price can be used for two purposes: to calculate land price index and to value land value.
- **Temporal effect:** Land price indices, and the role of land prices in general house price appreciation, has recently been a field of intensive economic research related to analysis of housing markets and macroeconomic policy.
- For mass valuation purposes the **spatial effect** is important and useful.

Implicit land price in house prices can be used for two purposes

Temporal effect (of house price changes to land values)

- Can we calculate a land price index based on house prices?

Spatial effect (of house price differences to land values)

- Can we calculate land values based on house prices? How should we execute the latter task for mass valuation purposes in property valuation?



American Economic Review

The *American Economic Review* is a general-interest economics journal. Established in 1911, the AER is among the nation's oldest and most respected scholarly journals in economics.

No Price Like Home: Global House Prices, 1870-2012

Katharina Knoll

Moritz Schularick

Thomas Steger

AMERICAN ECONOMIC REVIEW
VOL. 107, NO. 2, FEBRUARY 2017
(pp. 331-53)

The main findings of Knoll et al

- From the last quarter of the nineteenth to the mid-twentieth century, house prices in most industrial economies were largely constant in real (CPI-deflated) terms. By the 1960s they were, on average, not much higher than they were on the eve of World War I.
- They have been on a long and pronounced ascent since then, giving rise to a hockey-stick pattern of house prices in the long run. While house prices have increased in all countries over the past 140 years, there is also considerable cross-country heterogeneity.
- While construction costs have flat-lined in the past decades, sharp increases in residential land prices have driven up housing values. More than 80 percent of the increase in house prices between 1950 and 2012 can be attributed to land prices.
- In the period from the late nineteenth to the mid-twentieth century residential land prices remained, by and large, constant despite substantial population and income growth.

Imputed land price index formula

According to Knoll et al notation, the land price index can be imputed as a function of house price and construction cost indices:

$$F(Z_t, X_t) = (Z_t)^\alpha (X_t)^{1-\alpha}$$

(1)

$$\frac{P_{t+1}^H}{P_t^H} = \left(\frac{P_{t+1}^Z}{P_t^Z} \right)^\alpha \left(\frac{P_{t+1}^X}{P_t^X} \right)^{1-\alpha}$$

and the imputed land price index can be traced out by employing

(2)

$$\frac{P_{t+1}^Z}{P_t^Z} = \left(\frac{P_{t+1}^H}{P_t^H} \right)^{\frac{1}{\alpha}} \left(\frac{P_{t+1}^X}{P_t^X} \right)^{\frac{\alpha-1}{\alpha}}$$

F= house, X = structures, Z = land

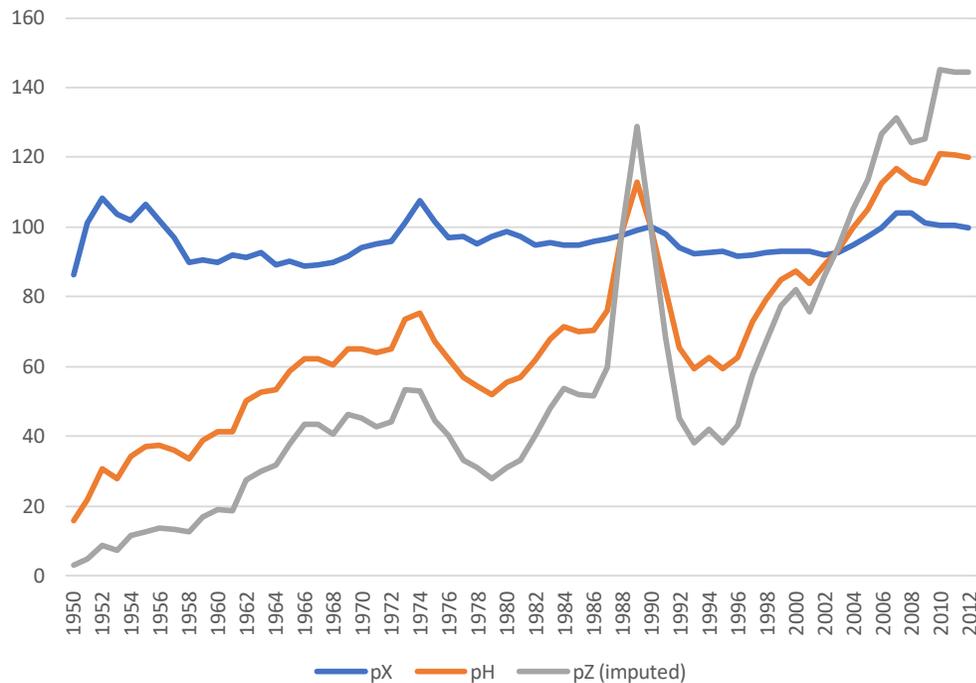
p^H = price of house, p^X = price of structures, p^Z = price of land

t = year, t+1 = next year

α = land share a house

Real house prices and construction costs, imputed land prices, Finland 1950-2012

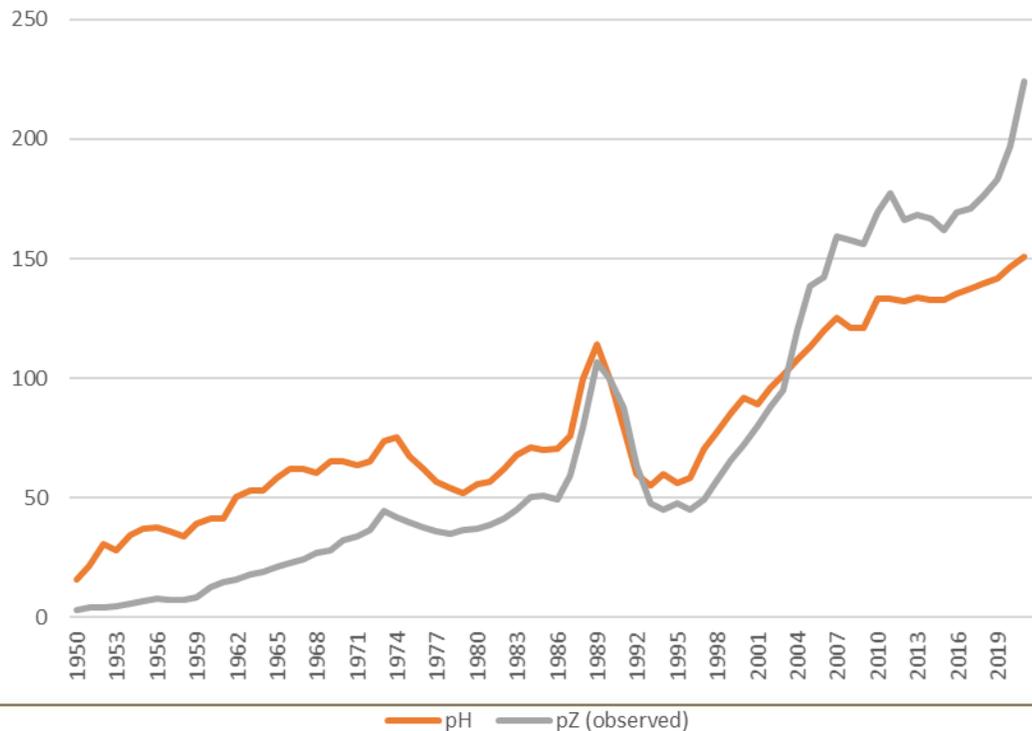
Figure 1. Real house prices, real construction costs and imputed land prices 1950-2012, Knoll et al



- Real construction cost are almost steady.
- Real house prices are rising.
- Imputed land prices are steeply rising.
- Land prices cause 96 % of house price appreciation.

Real house and land prices, Finland 1950-2021

Figure 5. Real house prices and observed real land prices 1950-2021

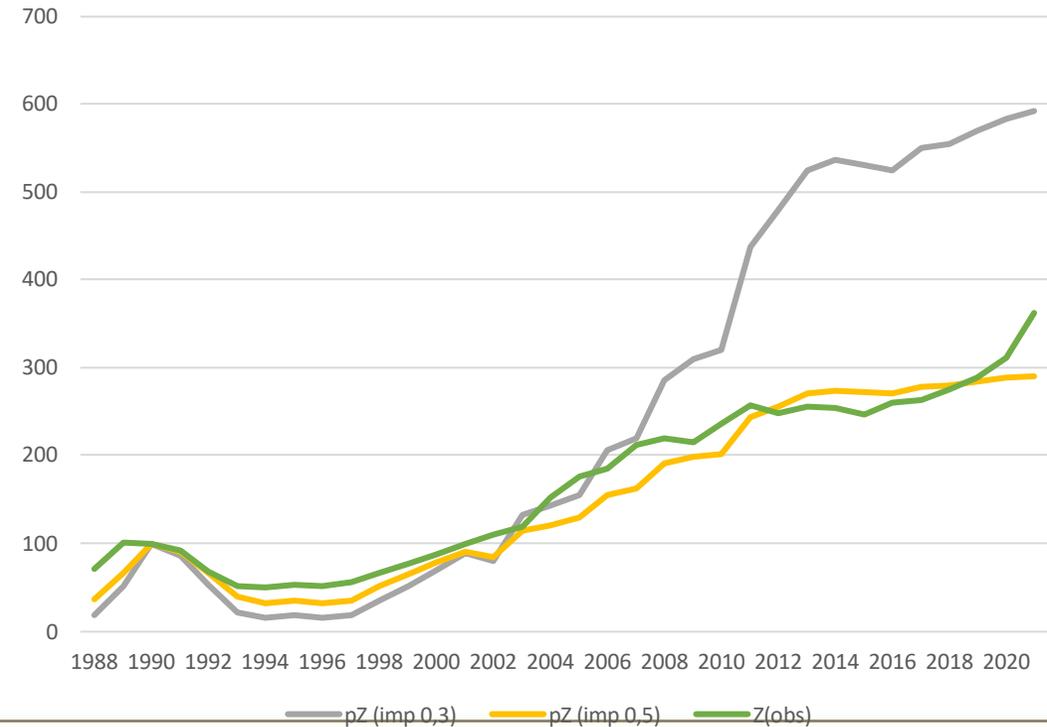


- This can be verified if we use observed land prices, instead of imputed ones.

Real and imputed land prices, Finland 1950-2012

- The problem is that imputed land prices are very sensitive to the land share assumption.
- Low land share (say 0.3) gives much steeper land value appreciation than high land share (say 0.5)

Figure 6. Real imputed and observed real land prices 1988-2021



Our critique to index approach of Knoll et al

Impressive, and elegant, as the Knoll et al study is, their treatment of land share seems elementary. The land share of a house prices is not endogenously calculated from the data, but must be given exogenously, artificially. They use $\alpha = 0,5$, and for robustness check also use $\alpha = 0,25$ and $\alpha = 0,75$.

All those numbers give similar results, we are told, which is a steeply rising land prices in the last ca. fifty years. As our simulation proves, this however is not true in the Finland data.

Generally, the land share must vary a lot depending on location and also between countries. Even more evident is that the land share must rise over time in all or most of the countries. The land share itself should be an essential object of research.

What is to be done?

- Whereas house prices are rather easy to observe and model, construction costs seem to be the weak link in the Knoll et al and some other economists' approach. Construction costs are usually unknown to a particular property, the information is to the parties involved only.
- There are problems in definition of those costs: are infra costs included or not? What about the costs of preparation of the lot, which can be high in case of poor or polluted soil? The demolition costs? The extra costs of a small lot in cramped built-up area? All these tend to be higher in expensive locations Finally, the depreciation is hard to measure.
- The crude level of construction costs can probably be measured for index calculation purposes

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SPATIAL EFFECTS: HOW TO CALCULATE A LAND VALUE OF A PARTICULAR LOT?

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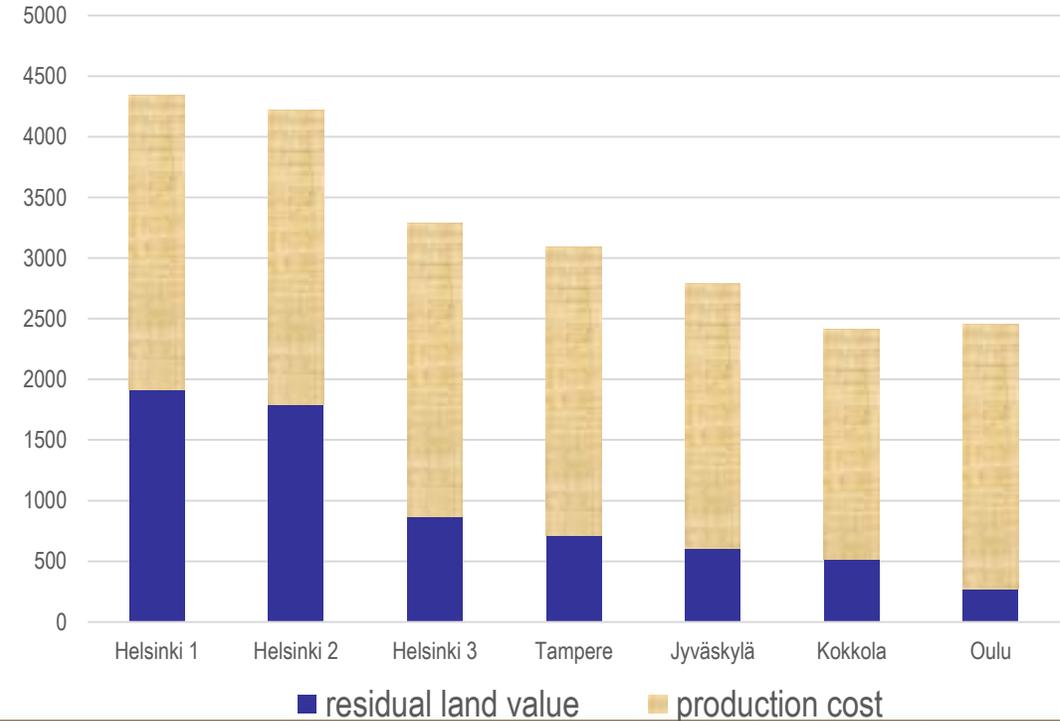
The valuation methods of urban residential land can be divided into three broad categories:

- a. direct comparison method
- b. residual method, based on house prices and construction costs
- c. land share method, based on house prices and observations of land prices The method in this article falls to the third category.

Land value as a residual

- The construction companies calculate their maximum bidding prices for land based on the difference of future selling prices of homes and construction costs.
- The residual method certainly plays a role in land valuation. That role is limited at best, when land under existing structures is concerned.

= House price minus construction costs



Land share method

- The construction costs and the residual is ignored.
- A modest and pragmatic approach: Land values can be imputed from house values, by comparing land and house prices and modelling this relationship.
- Imputing land values from house prices, aka. translating house prices to land values, essentially means calculating the land share of the residential property value, or the ratio of land values to house values.
- This mass appraisal of land has been used for the revaluation of 2 million land parcels in Finland for property taxation purposes.

Modelling the elasticity of land prices to house price variation

- A model of land value as a function of house price is specified and estimated.
- Data points with a pair of land and house price observations are needed. We chose taxation areas, 4000 of them in whole country. Median of constant quality land and house prices were calculated.
- Figures 11-12. show the plot of those median prices for those 1512 areas, where at least one sale of each type exists. Land median prices are based on both sales for lots for multi- and single-family houses.

Observed median housing and land prices

Figure 11. Observed median housing and land prices across the country, in zip code areas.

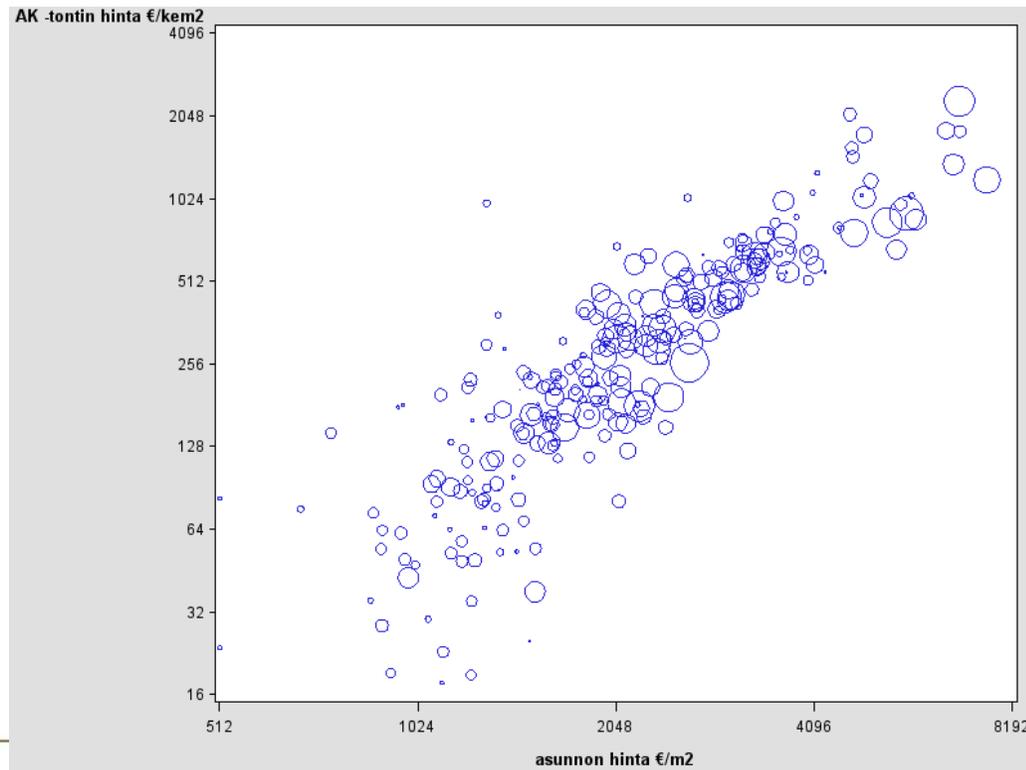
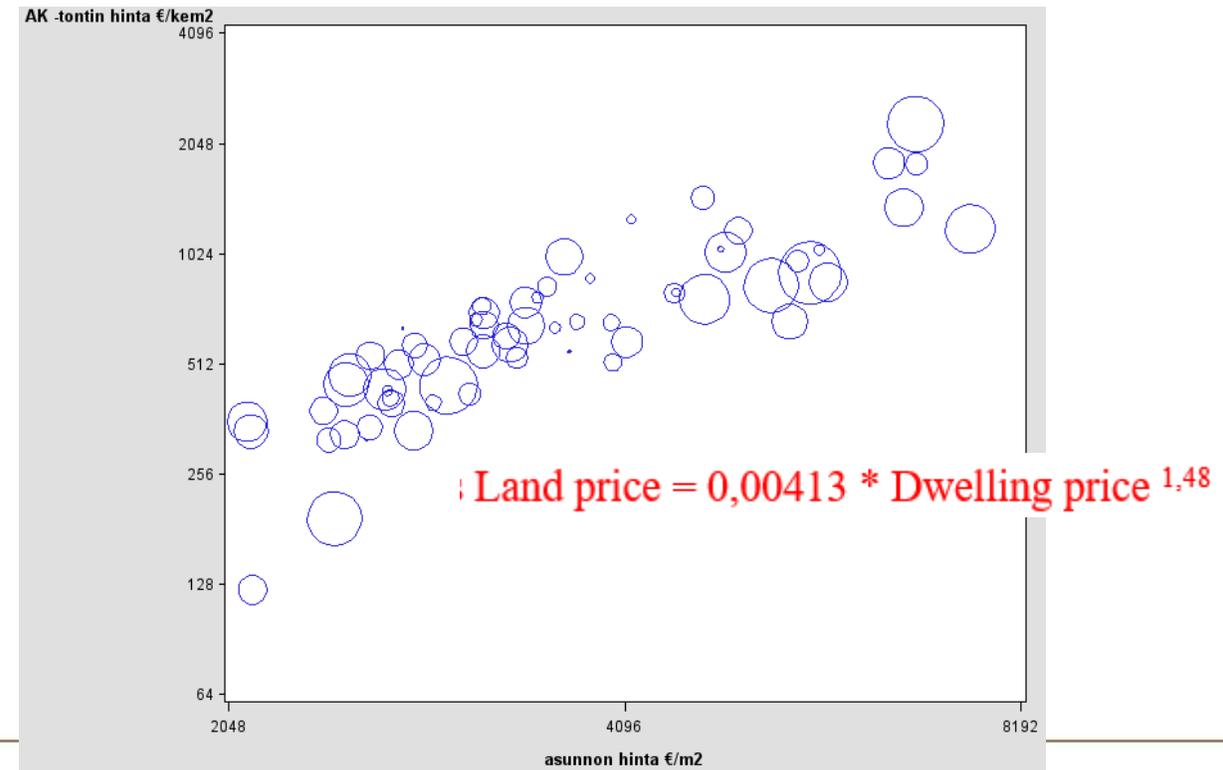


Figure 12. Observed median housing and land prices in the capital city, in zip code areas



- Three lessons can be noticed from the figure.
- 1) There is a strong correlation between land and dwelling prices, or rising trend in plots,
- 2) The slope of the trend line is steep on the left, but less so on the right. The slope, or elasticity, is more than three on the left, but perhaps below 1½ on right.
- 3) The correlation is not even close to perfect.
- The model for the capital city, is **Land price = 0,00413 * Dwelling price^{1,48}**
- Land price and land share values for different dwelling prices in Helsinki are given in figures 13-14 and in table 1.

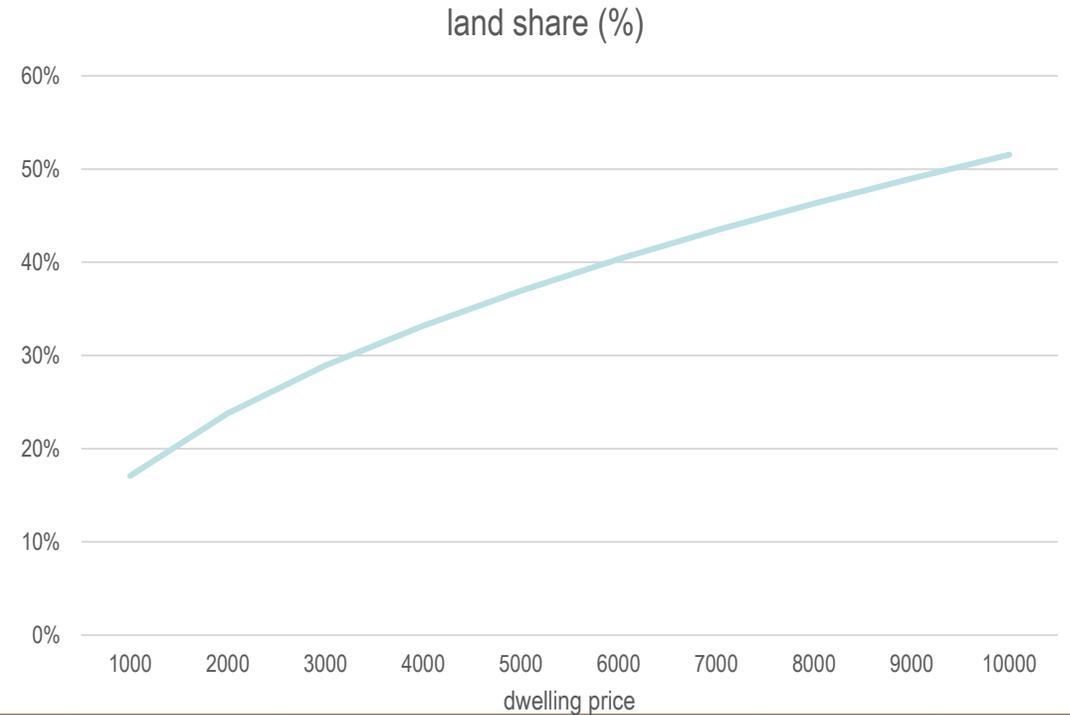
<u>dwelling price</u>	<u>land price</u>	<u>land share</u>
1000	114	17 %
2000	317	24 %
3000	578	29 %
4000	885	33 %
5000	1231	37 %
6000	1613	40 %
7000	2026	43 %
8000	2469	46 %
9000	2939	49 %
10000	3435	52 %

Land value and land share as a function of house price

Figure 13. Land value as a function of house price in the capital city



Figure 14. Land share as a function of house price in the capital city

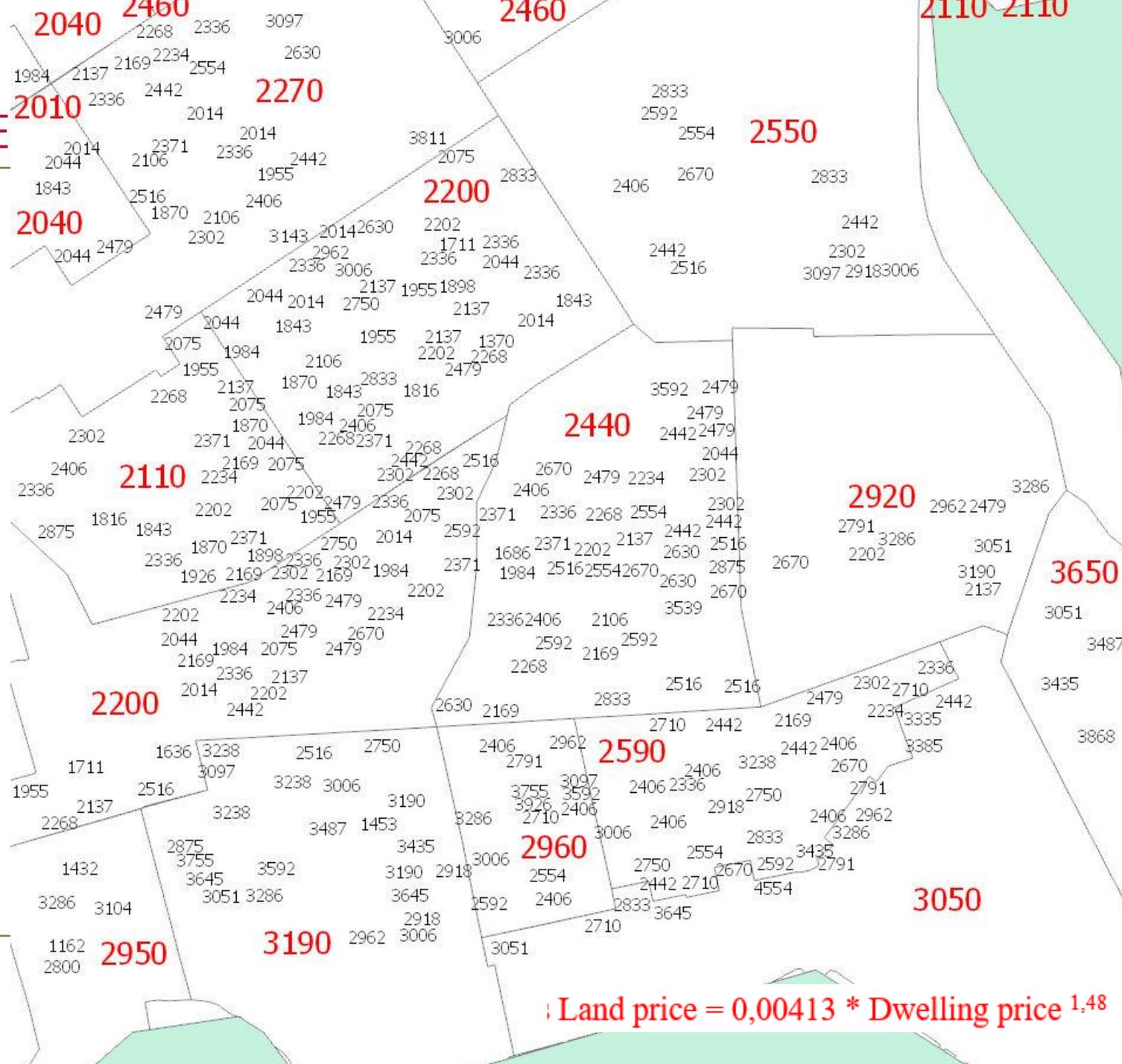


- The dwelling price statistics in Helsinki is based on 70.000 transactions on 10.000 properties, the dwelling prices are easy to model to get a constant quality price, so there is no reasons to doubt that dwelling prices would not reveal the rank order of locations in terms of their land value.
-
- Figures 15 and 16 illustrate, how dwelling prices were translated to land prices in the central, most expensive part of the capital city, in the most expensive part of the country using formula: $\text{Land price} = 0,00413 * \text{Dwelling price}^{1,48}$. Eventually these figures determine the tax base and cause the property owners an obligation to pay the property tax to the city of Helsinki.

A map of imputed land prices in 500 residential properties in the center of the capital city.

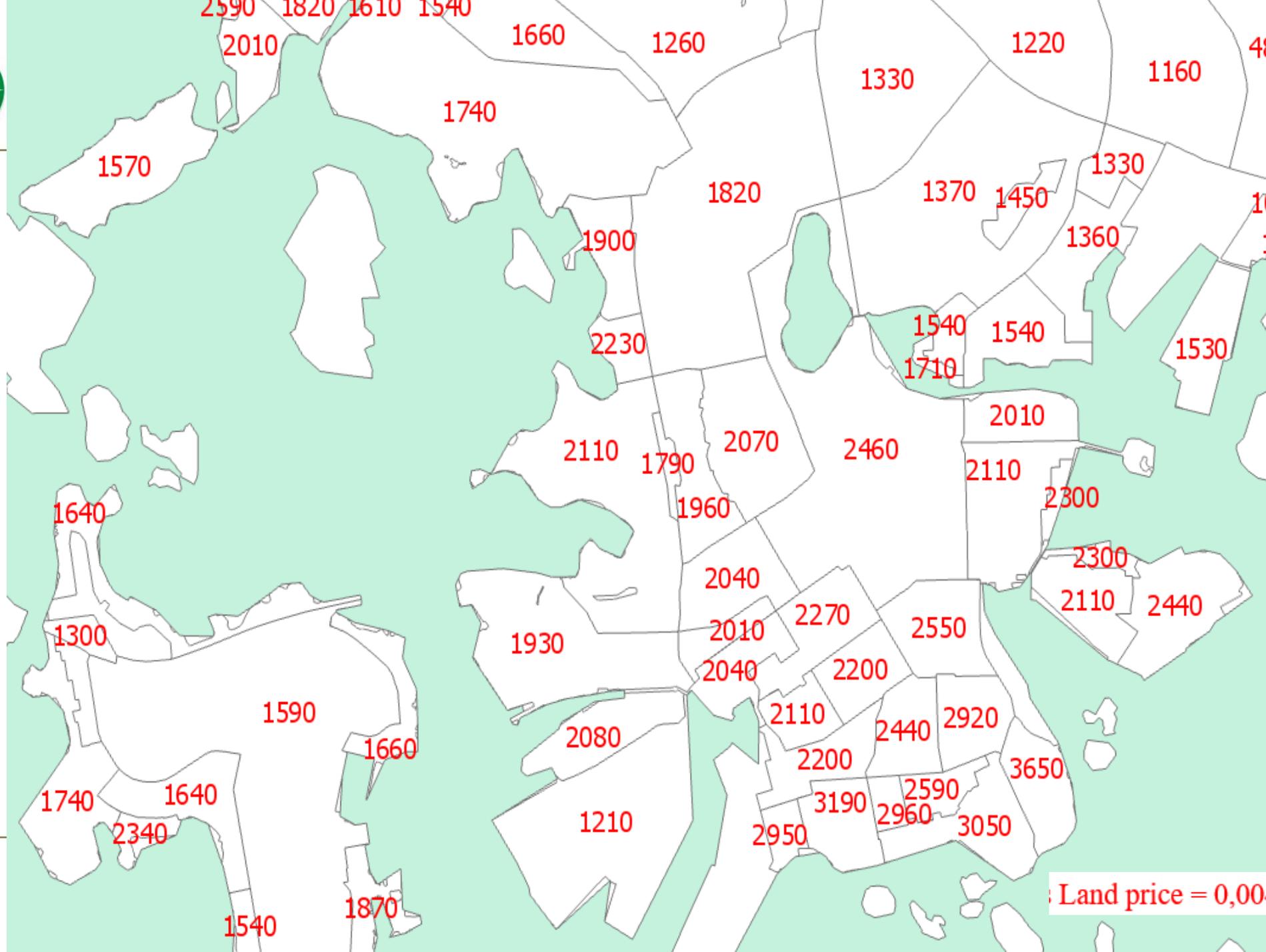
The map reveals the land value of ca. 500 residential properties with ca. 30.000 dwellings in 3 to 10 level buildings.

The red large numbers are medians of the data points in the area. The numbers are in euros/m² of building right. So a lot of 1000 m² and lot ratio of 4 has a building right of 4000 bm². If the unit taxation value is 2600 euros/bm², the taxation value is 10,4 million euros.



Land price = 0,00413 * Dwelling price ^{1,48}

Figure 16.
A map of median imputed land prices
in taxation areas



Lessons

- Translating dwelling prices to land values essentially means calculating the land share of the residential property value. The idea in this article, is to make the best use of dwelling price data, the numbers of which in larger cities are typically tens or hundreds times the number of land sales, and a thousand times in some locations.
- Modelling dwelling sales data offers a rank order of land values and amplify the information offered by precious few land sales. It provides a fundament and a framework to properly interpret land prices, and to calculate land values where no sales exist.
- In fact translating dwelling prices to land values may often produce more convincing and consistent land values than land sales prices, where unique and idiosyncratic factors often play a dominant role.
- **Thank you!**