Government
Institute for
Economic Research

Working Papers 30

On the role of public price information in housing markets

Essi Eerola

Teemu Lyytikäinen

Working Papers 30 - April 2012

VATT WORKING PAPERS

30

On the role of public price information in housing markets

Essi Eerola
Teemu Lyytikäinen

Valtion taloudellinen tutkimuskeskus
Government Institute for Economic Research
Helsinki 2012

Essi Eerola, Government Institute for Economic Research (VATT), email: essi.eerola@vatt.fi

Teemu Lyytikäinen, Government Institute for Economic Research (VATT) and London School of Economics (LSE)/Spatial Economics Research Centre (SERC), email: teemu.lyytikainen@vatt.fi

The authors thank Elias Einiö, Greg Fischer, Heikki A. Loikkanen, Mika Kortelainen, Pauli Murto, Niku Määttänen, Elias Oikarinen, Henry Overman, Olli Ropponen, Tuukka Saarimaa, Marko Terviö, Janne Tukiainen and Juuso Välimäki for useful comments and discussions. Funding from the Academy of Finland through the Economics of Housing II project is gratefully acknowledged. Lyytikäinen would like to thank Yrjö Jahnsson foundation for financial support.

ISBN 978-952-274-020-5 (nid.)
ISBN 978-952-274-021-2 (PDF)

ISSN 1798-0283 (nid.)
ISSN 1798-0291 (PDF)

Valtion taloudellinen tutkimuskeskus
Government Institute for Economic Research
Arkadiankatu 7, 00100 Helsinki, Finland

Edita Prima Oy
Helsinki, April 2012

Cover design: Niilas Nordenswan

On the role of public price information in housing markets

Government Institute for Economic Research
VATT Working Papers 30/2012

Essi Eerola – Teemu Lyytikäinen

Abstract

This paper studies the impact of increased price information on the functioning of the housing market. We first study the implications of new information for market outcomes in a theoretical framework so as to disentangle the potential channels through which information may be important. The results suggest that increased information leads to higher prices. The time on the market, in turn, may become longer or shorter depending on which side of the market reacts more to the new information. In the empirical part of the paper, we utilize a Finnish policy intervention to estimate these effects. In July 2007, a website with detailed information about individual housing transactions was opened. The website covered only part of the country, which allows us to use the Differences-in-Differences method to estimate the effect of increased information. The results show that increased information on past transactions led to higher prices and shorter times on the market. In the light of our theoretical results, the empirical evidence therefore indicates that buyers react more to the new information than the sellers.

Key words: Housing prices, time on the market, information, learning, differences-in-differences

JEL classification numbers: R30, D83

Tiivistelmä

Tutkimme asuntojen hintatietojen julkistamisen vaikutuksia asuntomarkkinoiden toimintaan. Tutkimuksen ensimmäisessä osassa tarkastelemme yksinkertaisen mallikehikon avulla, millä eri tavoilla informaation lisääminen voi vaikuttaa asunnon ostajien ja myyjien käyttäytymiseen. Simulaatiotulosten perusteella voidaan odottaa, että yksityiskohtaisen hintatiedon julkistaminen nostaa asuntojen hintatasoa. Sen sijaan vaikutus asuntojen myyntiaikoihin riippuu siitä, reagoivatko ostajat vai myyjät enemmän uuteen informaatioon. Tutkimuksen toisessa osassa hyödynnämme suomalaista uudistusta hintainformaation hinta- ja myyntiaikavaikutusten estimoimiseen. Heinäkuussa 2007 ympäristöministeriö avasi nettipalvelun, jossa julkaistaan asuntojen hintatietoja. Palvelu kattaa vain tietyt kunnat, mikä tarjoaa hyvän mahdollisuuden palvelun vaikutusten arvioimiseen. Empiiriset tuloksemme näyttävät, että lisääntynyt informaatio aikaisemmista asuntokaupoista nosti asuntojen hintatasoa ja lyhensi myyntiaikoja palveluun kuuluneilla alueilla.

Asiasanat: Asuntojen hinnat, myyntiaika, informaatio, oppiminen

JEL-luokittelu: R30, D83

Contents

1. Introduction

In recent years, the importance of information structures on market outcomes has been increasingly recognized in the economics literature. One much discussed issue is related to the role of information in explaining price dispersion of identical products.[1] Another important research agenda relates to the value of information in decentralized trading where traders can learn from own experience. If information is valuable to the traders and determines the gains from trade, the distribution of information becomes an important policy issue.

Housing markets provide an interesting setting for studying the effect of information shocks. Because houses are spatially fixed and heterogeneous, there is no single market price for a housing unit. In contrast, the price of a house is determined in a bidding process between a seller and a buyer. One important determinant of this process is the outside option of the trading partners: What price would the seller expect to obtain if he does not trade with the current partner? How expensive does the buyer believe other similar houses on the market to be? The average price level in a city may give little guidance to the traders in this respect.

In this type of setting, more detailed information about past transactions of comparable houses is useful for the traders. One would therefore expect that revealing such information has important effects on housing market outcomes. This paper aims to evaluate these effects.

To this end, we first study the implications of new price information for market outcomes in a theoretical framework in order to disentangle the potential channels through which information may be important. This analysis builds on previous literature on learning from own experience, in particular, Mason and Välimäki (2007, 2011). The crucial elements of the analysis are that increased information 1) helps the sellers of houses in formulating beliefs about how much the buyers value his house and 2) helps buyers to visit the right house. [2]

In the second part of the paper, we study a Finnish reform which increased publicly available price information in the housing market and use the theoretical framework to interpret the empirical results. The reform was the following: In 2007, the Finnish Ministry of Environment opened a website publishing detailed information about individual housing transactions. Previously, only aggregate data on house prices were publicly available. The website covered only some parts of the country. This created a quasi-experimental setting which offers a

---

[1] For a general discussion and review of the literature, see e.g. Baye et al. (2006).

[2] Of course, learning could also be related to the quality of the house. See e.g. Taylor (1999) where time on the market is an indication of the quality of the house. The reform we wish to analyze, however, does not change the market environment in this respect.

possibility to obtain reliable estimates for the effects of increased information using the Differences-in-Differences (DiD) method.

We are not aware of any previous empirical papers studying the effect of increased price information on the market outcomes in housing markets. However, the effect of increased information about the quality of local amenities has been addressed in the literature. In this literature, the main question of interest relates to capitalization of local amenity values into house prices. For instance, Fiva and Kirkebøen (2011) study housing market reactions to the publication of information on school quality. If households care about school quality and if the publication of school quality provides new information to the households, prices are expected to increase in areas with high quality schools and vice versa. This is indeed what the authors find at least in the short run. Our research agenda is different from these types of analyses in that we wish to understand why and how information about the price of one house affects the price or sales time of some other house.

In our study, the identification strategy relies on geographical differences in the amount of information available to traders.[3] In this sense, our approach is similar to some other studies exploiting geographical variation in the amount of information. For instance, Jensen (2007) analyzes the price dispersion in a setting where fishermen in an Indian state Kerala must choose to land their fish to one of several markets without knowing the demand conditions in the different markets. He finds that by improving access to market information, the introduction of mobile phones improved arbitrage opportunities of the fishermen and resulted in reduced price dispersion across geographic markets. Svensson and Yanagizawa (2009) in turn study the effect of disseminating agricultural commodity price data in major market centers through local FM radio stations in various districts on farm-gate prices. They find evidence suggesting that better-informed farmers managed to bargain for higher farm-gate prices. In both these studies, increased information was clearly directed to one side of the market and the goods traded were homogenous. Our housing market experiment is different in that new information can be beneficial for both sides of the market. Thus, it is far less clear how increased information should affect the market outcomes. In particular, the process of selling and buying a house involves finding a trading partner and bargaining over the price and this often takes months. Therefore, the effects of the reform need not relate to prices alone but can also be reflected in sales times.

In order to study the effects of the reform, we simulate a model economy and compare the market outcomes before and after the reform. Regarding the behavior of the sellers, we observe the following: Because learning from own experience is asymmetric, not all sellers benefit equally from new information.

[3] Internet has been the source of increased information in many studies (see, e.g. Brown and Goolsbee, 2002).

To see this, consider first the situation after the reform. After the reform, the sellers possess more accurate information about the value of their house. In contrast, before the reform, some underestimate while others overestimate the value of their house. When entering the market, those who overestimate the value of their house, set too high prices. They are therefore more likely to stay long in the market and revise their price offers downwards. As a result, they effectively end up using market information even before the reform. For these sellers, the transaction prices are therefore relatively similar before and after the reform. The picture is completely different for those who underestimate the value of their house before the reform. Before the reform, they set too low prices, sell quickly and exit the market. Of course, quick acceptance reveals information about the value of the house. Unfortunately, if the sellers have only one house to sell, they have no possibility to use this information. After the reform, these sellers enter the market with higher prices which leads to higher price level.

Our simulation results suggest that increased information may lead to longer or shorter time on the market. This is because two opposing effects: First, as explained above, prices are higher after the reform. Other things equal, this leads to longer time on the market. Second, if the new information allows the buyers to visit the right house, the sellers meet, on average, buyers with higher valuations. Because of this efficiency gain, the houses sell faster. The overall effect on the time on the market depends on which of these two effects dominates.

In the empirical part of the paper, we study the effects of increased price information on house prices and time on the market. The effect on sale price is modeled through a standard linear regression model. The effect on sales times is estimated using duration models. Our empirical results clearly show that the reform increased prices. The results related to the time on the market are less conclusive but indicate that the reform led to somewhat faster sales. In the light of the simulation results, the empirical evidence therefore indicates that buyers react more to the new information than the sellers.

The rest of the paper is organized as follows: In the next section, we present the reform and institutional details related to the Finnish housing market. In section 3, we present a modeling framework and simulation results related to different scenarios. In section 4, we describe our data and present our empirical strategy and results. In section 5, we discuss the results, and section 6 concludes.

2. Reform and institutional setting

Statistics Finland publishes regional house price indices and average prices per square meter but, traditionally, sales prices of individual condominiums have not been publicly available.[4] The situation changed on the 1st of July 2007, when the Ministry of Environment opened a website which publishes individual sales prices of flats in apartment blocks and terraced houses in 13 biggest Finnish cities.[5] The website allows the user to search transactions by attributes including area (municipality, postcode, street)[6], the type of flat (apartment block or terraced house) and size of flat (number of rooms and square meters). If three or more transactions meet the search criteria, the website returns a list of transactions including following information for each transaction:

- Sales price and price per square meter (debt held by the housing company added)
- Floor design (e.g. 2 rooms, open plan kitchen, bathroom)
- Floor area (square meters)
- Agent's assessment on the quality for internal records not for marketing purposes (bad, satisfactory, good)
- Year of construction
- The storey of the flat and the number of storeys in the house (e.g. 4/5)
- Elevator (yes/no)
- Part of town

If less than three flats meet the criteria, the user is asked to run a less detailed search. The date of sale is not shown but the list is ordered by the date of sale. The returned list can also be sorted by other attributes. The data for the website are provided by the association of four biggest real estate agent companies (*Kiinteistömaailma, OP-Kiinteistökeskus, Huoneistokeskus* and *SKV Kiinteistönvälitys*).

The website increased substantially the amount of information available for trading partners in the cities it covers. We use the municipality of Vantaa as an example to give an idea of how the website improved the information available

[4] Single family detached houses are usually traded as real estate and so individual sales prices are available from the land registry, but information requests have to be made one by one and there is no centralized platform with information on multiple transactions easily available.

[5] The website is http://asuntojen.hintatiedot.fi/fi_FI/ and translates to houseprice.info.fi.

[6] In 2007, there were 416 municipalities and about 2000 postcodes in Finland. Population was 5.3 million.

for trading partners.[7] In December 2011, a search on two room flats in block houses in Vantaa returned 325 transactions. The search could be narrowed down to a smaller area by limiting the search to one of the 37 postcodes in Vantaa or even individual street (unless there were less than three matches). In the absence of the website, the best information publicly available would have been the average price per square meter in block houses in the whole municipality in the third quarter of 2011.

The website has been very popular. According to information provided by the Ministry of Environment, in 2008, there were on average about 1750 visits from about 1000 ip-addresses per day and the page is loaded roughly 10,000 times a day. In our data, there are about 70 transactions per day in the area covered by the website. The data cover only sales by the four leading real estate agents but their market share is believed to be close to 75 percent. Thus, there were approximately 15–20 visits per each house sold in the area covered by the website.

In Finland, most residential properties are sold through a real estate agency. The agency is responsible for marketing, viewing and all the paper work related to the transaction. Agency fees are typically between 2–4 percent of the sales price. The agency mediates offers made by potential buyers to the seller. Typically an offer made by the buyer leads to a bargaining process in which the seller makes a counter offer and the buyer can respond by accepting, rejecting or making a new offer. All offers made by both sides are binding in that they involve a deposit, which is lost if the offer is withdrawn.

A large share of the housing stock is condominium flats in apartment blocks and terraced houses. Except for single family houses, the legal structure for home ownership is a limited liability housing company. Homeowners own housing company shares which give them the possession of a specific apartment. The owner can occupy the flat herself or rent it out without restrictions on rent. The shares are treated as private property and can be used as collateral for mortgage loans.

[7] Vantaa is a municipality of roughly 200,000 people in the Helsinki Metropolitan Area north of Helsinki.

3. Model and simulated scenarios

3.1 Background

The data we will be exploiting contain detailed information about houses being traded but no information about the households involved in the transactions. Therefore, when building the model economy, we abstract entirely from issues related to how the characteristics of the households (say, wealth or labor market position) searching for a house or selling one affect the sales prices.[8]

In the analysis, we will make use of the modeling framework developed by Mason and Välimäki (2007, 2011). Translated into a housing market context, their model has the following features: Each seller has one house. Initially, the sellers do not necessarily know how much the buyers value the different attributes of their house.[9] Houses are of two types. Each buyer is characterized by a certain valuation for each house type. The valuations of the buyers form two valuation distributions. The situation we have in mind is one where the reform increases the information available to the buyers and thereby enables them to choose the houses they visit based on transaction prices. Therefore, for simplicity, we assume that before the reform, buyers are randomly allocated to the sellers. The seller makes a take-it-or-leave-it offer. Buyers are short lived and accept offers up to their valuation. If the offer is accepted, the seller exits the market. If not, he waits for the next buyer and makes a new take-it-or-leave-it offer. [10]

Increased price information potentially influences the housing market through both sellers and buyers. First, the sellers may have a more accurate understanding about the valuation distribution of the buyers they meet. Second, the buyers observe the price of the different types of houses. This allows them to compare the price levels and their own valuations of the different houses and choose sellers accordingly. As a result, the reform may help the buyers to sort to more suitable houses.

---

[8] Our model does not feature real estate agents. We discuss their role in Section 5.

[9] Merlo and Ortalo-Magné (2004) show that there is considerable variation in listing prices and sellers who seem to overestimate the value of their house end up staying longer in the market and revise their offers downwards.

[10] We wish to keep the bargaining process as simple as possible. The bargaining process in the housing market typically entails a buyer making an offer and both parties making counter offers or rejecting the offer. Our simple bargaining setting should be interpreted as the last offer of this process leading to either acceptance or rejection.

3.2 Model

3.2.1 Before the reform

There are two types of houses, 1 and 2, with different characteristics. Each buyer is endowed with a valuation, v, for both house types. The valuations are drawn from two valuation distributions with densities $f_1(v)$ and $f_2(v)$ and cumulative distribution functions $F_1(v)$ and $F_2(v)$. Since the buyers are randomly allocated to the sellers, given any take-it-or-leave-it offer, p, the probability that the offer is rejected is $F_1(p)$ and $F_2(p)$ for houses of type 1 and 2, respectively.

Before the reform the market works as in Mason and Välimäki (2007). Each seller knows the distributions described above but does not know from which distribution the valuations of potential buyers for his house are drawn. We denote by q the seller's subjective probability that his house is of type 1. Therefore, given belief q, and a price offer p, the seller expects the offer to be rejected with probability

$$F(q,p) = qF_1(p) + (1-q)F_2(p).$$

The response of the buyer to the offer reveals new information to the seller. Obviously, if the offer is accepted, the seller cannot use this information because he exits the market. If the offer is rejected, the seller can use the information contained in the rejection when setting his new offer. In that case, the next period belief of the seller is given by

$$q' = \frac{qF_1(p)}{qF_1(p) + (1-q)F_2(p)}. \tag{1}$$

It is useful to note that the above equation implies that if $F_2(p) - F_1(p) > 0$, the seller becomes more pessimistic about the value of his house over time.

The value function that describes the decision making problem of the seller when his belief is q can be written as

$$V(q) = \max_p \left[\left(1 - F(q,p)\right) p + F(q,p) \beta V(q') \right] \tag{2}$$

where β is the subjective discount factor and q' is determined by equation (1).

The first part of the value function says that the seller expects to sell the house in current period with probability $1 - F(q,p)$ with price p. The second part says that the seller expects the offer to be rejected with probability $F(q,p)$. In that case, the value function depends on his updated belief about the type of the house, q'.

In the absence of learning, price offers will always be higher in the dynamic game than in a one shot game. This is not surprising as having a possibility to sell tomorrow must be good news for the seller. However, it is not clear whether price offers are higher or lower with learning than without because the magnitude of the learning effect depends on the price offer.[11] The reason is as follows: The price set by the seller determines how much the seller will learn from rejection or acceptance. If the price offer is very low, all buyers accept it. If the offer is very high, all buyers reject it. That is, there exist low and high price offers which do not reveal any new information to the seller. In contrast, intermediate price offers allow the seller to learn from own experience.

3.2.2 After the reform

The reform makes public all sales prices. We will analyze the following three cases: 1) Both sides of the market use new information. 2) Only sellers use new information, and buyers are randomly assigned to sellers as before. 3) Only buyers use new information and sellers set prices as before.

Consider first the buyers. For them, increased information means that they now observe the price level of houses of type 1 and the price level of houses of type 2. Because they know their own valuation of the two different house types, new information can help them visit "the right house". We assume that the buyers are risk neutral and aim to maximize the expected net surplus from trade. Let us denote the average price level of type 1 and 2 houses before the reform by p_1^{pr} and p_2^{pr}, respectively. Then after the reform, a buyer visits a house of type 1 if

$$v_1 - p_1^{pr} > v_2 - p_2^{pr} \tag{3}$$

and house of type 2 otherwise.

Consider then the sellers. The reform allows them to obtain detailed information about the transaction prices of houses that are similar to their own. This means that the sellers are able to use the publicly provided price data to infer the type of their house.[12] In addition, if the buyers also use the new information in order to go and visit the house that gives them higher expected utility, the sellers can no longer treat the two distributions of valuations as independent.

[11] See Mason and Välimäki (2007) for more discussion on this issue.

[12] The assumption of full information after the reform may exaggerate the importance of the reform. We discuss the assumption in Section 5.

With full information about the type of the house, the sellers no longer learn from own experience in the market. The problem of a seller of type *i* house can be then written as

$$V_i = \max_p \left[\left(1 - H_i(p)\right) p + H_i(p) \beta V_i \right] \text{ for } i = 1,2 \tag{4}$$

where H_i is the cumulative distribution function of the valuations that sellers of type *i* house face. The optimal price offer of the sellers can be written as

$$p^*_i = \frac{\left(1 - H_i(p^*_i)\right)\left(1 - \beta H_i(p^*_i)\right)}{(1-\beta) h_i(p^*_i)} \text{ for } i = 1,2. \tag{5}$$

If the sellers only use new information, the buyers are randomly allocated to the sellers as before the reform and hence $H_i(p) = F_i(p)$.

3.3 Numerical analysis

In this section, we use the modeling framework to study the effects of an information shock on the housing market outcomes. In order to simulate the model, we need to pin down numerical values for the parameters of the model. In what follows, we first explain how we do that. After that we discuss how the reform affects the prices and time on the market in the model and discuss the reasons for these effects.

3.3.1 Calibration

We assume that half of the houses are of type 1 and half of type 2. Because each seller meets one buyer each period, the model period must be relatively short. We wish to interpret one period as one week and set the discount factor at 0.998. This discount factor implies an annual interest rate of 10%. This figure should be interpreted as incorporating costs related to staying in the market.

We also need to determine the initial distribution of beliefs for the sellers. We proceed as follows: We assume that all sellers with a house of type 1 (and type 2) have the same initial belief about the type of their house. We will formulate the initial distribution of beliefs so that all sellers initially make the same mistake. By initial mistake we mean the difference between the true type of the house and the state variable of the seller when entering the market. For instance, if initial mistake is 0.2 for all sellers, for an owner of type 1 house, $q=0.8$ and for an owner of type 2 house, $q=0.2$. Hence, the distribution of initial beliefs is such that 50% of sellers own a house of type 1 and for them $q=0.8$ and 50% of sellers own a house of type 2 and for them $q=0.2$.

We assume that the buyers' valuations are normally distributed. We choose parameters of the valuation distributions so that condition $F_2(p) - F_1(p) > 0$ is satisfied throughout. When this is the case, equation (1) implies that sellers become more pessimistic over time if the house fails to sell.

We normalize the valuation distributions so that we set the mean valuation of type 2 houses at $\mu_2 = 1$. We then choose the mean of the distribution for type 1, the variance of the distributions, and the initial mistake of the sellers so that the model replicates as closely as possible the distribution of the time on the market in the data before the reform.[13] In doing so, the aim is to minimize the sum of squared differences between the observed distribution and the prediction of the model. We proceed as follows: First, we determine from the empirical distribution the share of all trades for each week. We then determine, for a large number of the different parameter combinations, the corresponding distribution of times on the market in the model. This requires solving the problem of the sellers and simulating the market outcome for each parameter combination. Finally, we calculate, separately for each parameter combination, the weekly differences between the share of trades in the data and in the model, sum up the squared differences and choose the parameter combination which minimizes this sum.

This procedure leads us to choose the following parameter values: The mean of the distribution for type 1 houses is $\mu_1 = 1.04$. The variance is $\sigma_1^2 = \sigma_2^2 = 0.0011$. The initial mistake of the sellers is 0.46.

3.3.2 Housing market before the reform

In simulating the model we do the following: We first choose a grid for the state variable (probability that house is of type 1) and solve for the value function and the related policy function. The policy function allows us to pin down, using equation (1), evolution for the price offers conditional on not having sold the house.[14]

After having determined the evolution of the price offers, we simulate the market outcome. We first calculate the probability of trade for both types of houses. After that we determine the share of sellers that trade in each period. This allows us to further determine average price and average time on the market.

Figure 1 shows the frequency of different selling times in the data and in the model before the reform in the benchmark case where the initial mistake is 0.46.

---

[13] We target the distribution of time on the market and not prices because the model only features two types of houses and therefore the variation in prices cannot replicate the actual variation in prices. In addition, the price level in the model cannot be readily compared to that in the data.

[14] When solving for the sellers' problem, we check that the problem is concave.

This means that for owners of type 1 house *q=0.54* and for owners of type 2 house *q=0.46*.

The biggest differences between the distributions are related to the first two weeks. In the data, the share of houses sold increases rapidly during the first four weeks. In the model, in turn, underpriced houses sell well immediately during the first week. Therefore, after the first week the share of overpriced houses of all houses in the market is relatively high and as a result the number of trades goes down. The number of trades increases from the third week onwards as sellers revise the price offers downwards.

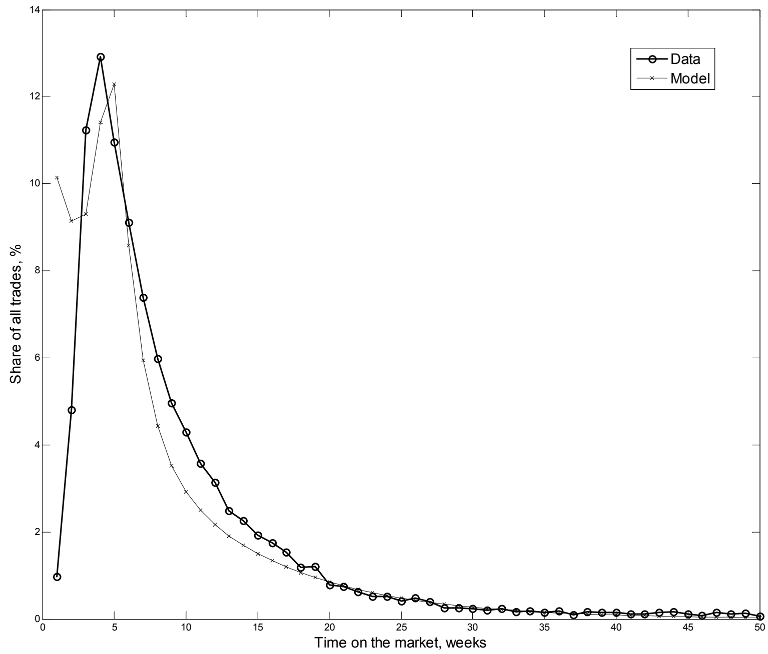

Figure 1. *Distribution of time on the market in the data and in the model before the reform.*

Figure 2 depicts the corresponding evolution of take-it-or-leave-it price offers over time. The figure shows that the offers decrease over time. When the seller is more confident that the house is of type 1, the offer is initially higher but the price offers converge as the seller becomes more pessimistic over time. Figure 2 also partly reveals an important feature of the model: ex ante identical sellers will end up selling at different prices and will experience different time on the market.

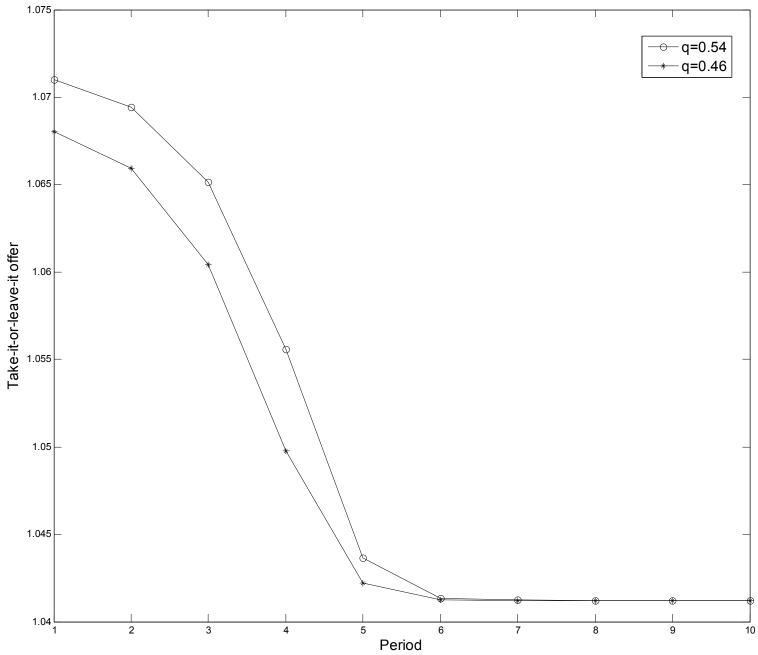

Figure 2. *The evolution of take-it-or-leave offers conditional on not having sold the house.*

3.3.3 Housing market after the reform

In this section we consider the changes in price level and distribution of selling times in the three different cases presented above. First, we consider the possibility that only sellers use the new information to make inferences about the market conditions. More specifically, we assume that after the reform, the sellers entering the market know the type of their house, that is, the initial mistake they make is zero. As a second step, we assume that sellers' behavior is not altered after the reform but buyers react to the new information. In this case, the distribution of the valuations of the two house types changes because the buyers visit the house which gives them higher utility in expected terms. The initial mistake of the sellers is the same as before the reform but the sellers take into account that the buyers' behavior has changed. Finally, as a third alternative, we consider the situation where both sellers and buyers react to the new information in the manner discussed above.

Table 1 shows the predicted changes in the price level as well as time on the market before and after the reform in the different cases.

Table 1. Predicted changes in average price level and time on the market in different scenarios.

	Change in price level, %	Time on the market, weeks	
		Before	After
Sellers learn	1	7,8	9,3
Buyers learn	1,3	7,8	6,7
Both learn	2	7,8	7,9

The table shows that average price increases in all cases. There are two distinct rationales for this. First, learning by the sellers before the reform is asymmetric. Because each seller has only one house, the possibility of using own experience for learning about the value of the house is limited to the case where the house does not sell. After a rejection, the seller always has the possibility to revise his offer. After an accepted offer, he can no longer revise his offer although he now has more information about the market situation. To see this, consider first the situation after the reform. After the reform, the sellers possess accurate information about the value of their house and take this into account when choosing prices. On average, those with better houses sell at higher prices. In contrast, before the reform, some underestimate while others overestimate the value of their house. When entering the market, those who overestimate the value of their house, set too high prices. They are therefore more likely to stay long in the market and revise the price offer downwards. As a result, they effectively end up using market information even before the reform. For these sellers, the transaction prices are therefore relatively similar before and after the reform. Those who underestimate the value of their house before the reform sell quickly and exit the market without much opportunity to use market information. After the reform, these sellers enter the market with higher prices which leads to higher price level.

The second reason for the increase in price is more efficient functioning of the market. This happens when the buyers use new information in order to infer which house type to visit. Even if the sellers' initial mistake does not change, the sellers take into account that they face, on average, buyers with higher valuations. As a result, they set higher prices than before the reform. Because of sorting, for any given price level, the offers tend to be accepted more quickly and therefore also the transaction prices are slightly higher.[15]

On average, houses may stay longer or shorter in the market depending on which side of the market uses the new information. First, if only sellers react to new

[15] The average price increases slightly also when the sellers do not realize that the buyers' behavior has changed after the reform. In that case, time on the market drops even more.

information the average price offers are higher but the valuations of the buyers the sellers meet are on average similar to those before the reform. These two things together imply that average time on the market must go up. Second, if only buyers react to new information, we observe a reduction in average time on the market. This is because of more efficient matching. When both learn, these two opposing effects are both present. In our benchmark case, these two effects roughly cancel one another and the average time of the market does not react much to the reform.

3.4 Sensitivity and discussion

In this section we study the how changes in the parameter values chosen affect the results shown in Table 1. We report the effect of the reform on the price level and time on the market in three alternatives cases. In all cases, we change one parameter value at the time while keeping others fixed at their benchmark level. The three parameters of interest are mean valuation of house type 1, the variance of the valuation distributions, and the initial mistake of the seller.

Table 2 is related to case where the degree to which the two house types differ (as represented by the difference in the mean of the valuation distributions) varies. The table shows that the degree to which the two house types differ has virtually no impact on the time on the market before and after the reform. However, a bigger difference in the means implies that price level reacts more to the reform.

Table 2. *Effects of the reform when the difference of the house types varies (benchmark μ_1=1,041).*

Large difference in means (μ_1=1,061)			
	Change in price level, %	**Time on the market, weeks**	
		Before	**After**
Sellers learn	1,4	7,9	9,2
Buyers learn	1,3	7,9	6,7
Both learn	2,4	7,9	7,9

Small difference in means (μ_1=1,021)			
	Change in price level, %	**Time on the market, weeks**	
		Before	**After**
Sellers learn	0,5	8,1	9,3
Buyers learn	1,1	8,1	7,1
Both learn	1,4	8,1	8,1

Table 3 shows the results in cases where dispersion in the buyers' valuations changes. The results indicate that changes in the variance of the valuation distributions do not have much impact on how the reform affects price level. However, a bigger variance leads to longer time on the market both before and after the reform.

Table 3. Effects of the reform when variance of the valuation distributions varies (benchmark σ^2=0,0011).

Large variance (σ^2=0,0013)			
	Change in price level, %	**Time on the market, weeks Before**	**After**
Sellers learn	1	8,3	9,9
Buyers learn	1,3	8,3	7,1
Both learn	2	8,3	8,4
Small variance (σ^2=0,0009)			
	Change in price level, %	**Time on the market, weeks Before**	**After**
Sellers learn	1	7,3	8,6
Buyers learn	1,2	7,3	6,3
Both learn	1,9	7,3	7,4

Finally, Table 4 shows that small changes in the initial mistake of the sellers are not important for the effects of the reform.

Table 4. Effects of the reform when the initial mistake varies (benchmark 0,46).

Large initial mistake (0,56)			
	Change in price level, %	**Time on the market, weeks Before**	**After**
Sellers learn	1,1	7,9	9,3
Buyers learn	1,3	7,9	6,8
Both learn	2,1	7,9	7,9
Small initial mistake (0,36)			
	Change in price level, %	**Time on the market, weeks Before**	**After**
Sellers learn	1	7,7	9,3
Buyers learn	1,2	7,7	6,6
Both learn	1,9	7,7	7,9

All in all, the results in Tables 2, 3 and 4 indicate that our findings are quite robust to changes in parameter values. In particular, the tables show that increased price information leads to a higher price level but may lead to shorter or longer time on the market depending on whether the sellers or the buyers react more to the reform.

It is interesting to note that there are several papers focusing on the potential effects of frictions in the housing market on housing market outcomes in a matching framework (see e.g. Wheaton, 1990 or Carrillo, 2012). Often these frictions are assumed to be related to incomplete information. Our analysis indicates that it may be misleading to assume that the effects of an information shock manifest themselves simply as more efficient matching. More detailed information about the market conditions can change the expectations of the traders in a manner that can overturn the potential effect on matching frictions.

4. Empirical analysis

4.1 Data

We use data on individual transactions provided by the Technical Research Centre of Finland (VTT). The VTT data are based on the same underlying data from the Real Estate Agents' Association as the website but covers the whole country and includes more detailed housing characteristics. The data exist from 1982 until June 2011 but we use data from 2003 onwards because of inconsistencies in key housing characteristics variables.

We have four years of data from the post-treatment period (July 2007 to June 2011). In order to facilitate the comparability of the post- and pre-treatment periods we use an equally long sample form the pre-treatment period (July 2003 to June 2007). In our main estimation, we employ a sample which covers apartment blocks in Helsinki area within 5 kilometers of the boundary of the area covered by the website. Sample construction is discussed in more detail in Section 4.2.1. Table 5 provides summary statistics for the sample used in the estimation. The choice of the width of the bands around the treatment area boundary and the length of the time period are, of course, somewhat arbitrary. We test for the robustness of our findings to different alternatives to these choices when discussing the results.

The outcome variables used in the empirical analysis are sale price and time on the market. Price is defined as the transaction price to which we add the apartment's share of possible debt held by the housing company. Average price is 114,000 euros. Time to sale is calculated as the difference between the listing date and the date of sale. Average time on the market is 55 days. Dwelling characteristics are used as control variables. The design and spaciousness of the dwelling is captured by floor area and the number of rooms (bed rooms and living rooms). We allow for a non-linear effect of the age of the house by including a dummy variable for newly built houses and the age of the house and its square. Dummies for good and bad condition measure the quality of the apartment. The excluded category is satisfactory condition. We also include a dummy for a vacant unit and monthly maintenance charge.

Unfortunately, the data do not contain information about listing prices or possible revisions of listing prices and rejected offers. Nor do they include any information about the seller or the buyer. This means that we cannot study the potential effect of listing price on market outcome as in Merlo and Ortalo-Magné (2004). Nor can we analyze the effect of the reform on the distribution of listing prices.

The data include the address of the house, which allows us to geo-locate most transactions in Helsinki area. We use the coordinates of the addresses to calculate the distance to the closest address on the other side of the boundary in which transactions took place in the period of our analysis. We refer to this measure of distance as distance to the treatment area boundary, even though it is strictly speaking not based on the distance to the boundary. Distance to transactions is a more relevant measure of distance for our purposes than distance to the boundary.[16]

Table 5. *Summary statistics.*

	Mean	Std. Dev.
Price (€ 1,000's)	114.3	42.6
Time to sale (days)	55.2	54.5
Treatment area	0.43	0.50
Treatment time	0.54	0.50
Rooms	2.28	0.83
Floor area (m2)	59.62	17.05
New (1/0)	0.066	0.25
Good condition (1/0)	0.61	0.49
Bad condition (1/0)	0.02	0.13
Vacant (1/0)	0.96	0.19
Age	25.65	13.60
Maintenance charge (€/m^2)	2.87	0.82

4.2 Empirical strategy

In this section, we explain the methods we use in the estimations. We test for the effect of increased price information on house prices and time on the market. The effect on sale price is modeled through a standard linear regression model. The effect on sales times is estimated using duration models. In both cases, we will exploit the feature of the reform that it only covered certain municipalities and therefore increased information related to transactions in certain geographical areas only.

4.2.1 Treatment and control groups

The nature of the policy experiment fits very well to Differences in Differences (DiD) estimation. For instance, we essentially do not have to worry about anticipation effects. In addition, the fact that the website covers only part of the country and excludes single family homes offers several possibilities. Firstly, we could use some or all of the 13 cities covered by the website as the treatment

[16] Moreover, there were inaccuracies in the GIS municipality boundary files available to us.

group and the excluded cities as the control group. Secondly, single family units could be used as a control group for apartment blocks and row houses in the treated areas. Thirdly, we could compare the difference in prices and sale times of single family units and other units in the treated and control areas through triple differencing. However, exploring the data suggested that the prices and sale times evolved very differently in different cities. This is not surprising as the developments in each housing market area depend on the interplay between local demand and supply conditions. There are large differences across cities in the developments of the relative prices and sale times of single family units and other units as well, which seemed to invalidate the triple differencing approach using house type as an additional margin of differencing.

The identifying assumption behind DiD estimation is that in the absence of the treatment the outcome variable (conditional on the control variables) would evolve similarly in the treatment and control groups. Hence, ensuring that the treatment group and the control group are comparable is crucial for reliable estimation. We argue that our best hope of obtaining reliable estimates of the impact of increased information with the available data is to focus on the market for flats in apartment blocks in the Helsinki Metropolitan Area (HMA). The website covered four core municipalities (Helsinki, Espoo, Kauniainen and Vantaa) of the Helsinki Metropolitan Area and the rest of the area was excluded. The semi-urban area reaches beyond the core municipalities and we have reasonably dense data on transactions inside and outside the area covered by the website. This allows us to further facilitate the comparability of the treatment and control groups by limiting the estimating sample to 5 kilometer bands just inside and just outside the boundary of the treatment area. The underlying demand and supply conditions are likely to develop very similarly on either side of the treatment area boundary within these narrow bands. A similar strategy has been used in a housing market context by Dachis et al. (2011) who study the effect of real estate transfer taxes on the number of house sales and house prices.[17] Figure 3 shows municipalities in the Helsinki area. Municipalities covered by the website are indicated with gray.

We drop from the data flats that were on the market when the website was opened. This ensures that the whole bidding process of transactions in the treatment group was affected by the increased information. Listing prices of flats that were on the market when the website was opened were set before the reform. Assuming that these flats are part of the treatment group could bias our results.

[17] Dachis et al. (2011) utilize the introduction of the real estate transfer tax in Toronto as the source of temporal variation in taxes and limit the sample to a 5km bands around the municipality boundary.

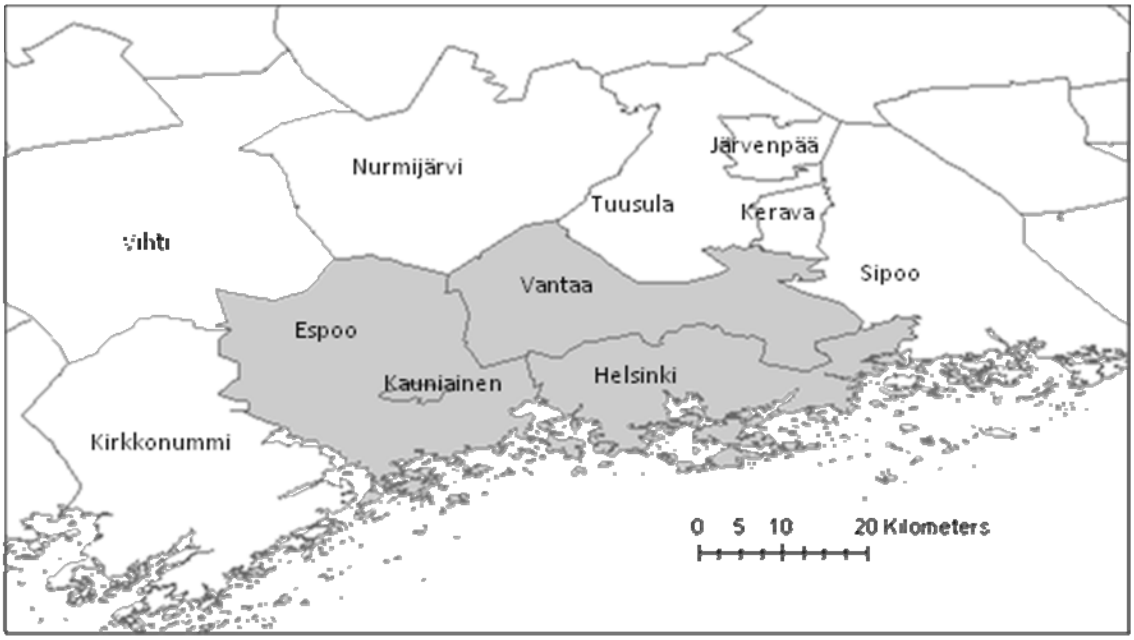

Figure 3. Municipalities in the sample area.

Table 6. Averages by treatment area before and after treatment.

	Treatment area		**Control area**	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Price (€ 1,000's)	101.0	124.6	103.2	124.6
Time to sale (days)	63.3	53.0	58.6	48.7
Rooms	2.24	2.28	2.26	2.31
Floor area (m2)	59.50	59.94	59.22	59.80
New (1/0)	0.088	0.023	0.126	0.030
Good condition (1/0)	0.639	0.590	0.560	0.671
Bad condition (1/0)	0.017	0.016	0.012	0.023
Vacant (1/0)	0.964	0.958	0.978	0.955
Age	23.58	26.54	24.69	27.15
Maintenance charge (€/m^2)	2.77	3.19	2.56	2.95
N	822	1128	1260	1280

Table 6 shows average price, sale time and dwelling characteristics in the treatment and control groups before and after the opening of the website in July 2007. Pre-treatment averages are reassuringly similar in the treatment and control areas. In both areas mean house price was slightly over 100,000 euros in the pre-treatment period and average time on the market was around 60 days. In the post-treatment period prices were about 20% higher and sale times were shorter than before the treatment. Most dwelling characteristics are stable over time or develop very similarly in the treatment and control areas. However, the share of flats in good condition decreases in the treatment area from 64% to 59% and increases in the control area from 56% to 67%. This suggests that controlling for dwelling characteristics is important.

4.2.2 Housing prices

Our empirical strategy is based on the comparison of housing transactions with similar structural characteristics on different sides of the treatment area boundary before and after the treatment took place. Our base model uses the DiD approach in a standard linear regression model

$$Y_{it} = \beta_t + \beta_1 Treat\_time_{it} + \beta_2 Treat\_area_i + \beta_3 (Treat\_time_{it} * Treat\_area_i) + \beta_4 X_i + \mu_p + u_{it} \tag{6}$$

where Y_{it} is the (log of) sale price of unit i in time t. Dummy *Treat_time* gets value one if the transaction took place after the website was opened in 1 July 2007 and zero otherwise. Dummy *Treat_area* indicates transactions in the treatment area. The interaction of the treatment time and treatment area indicators marks the transactions in the treatment area after 1 July 2007. The parameter of interest is β_3 which gives the average effect of the treatment on Y. The identifying assumption under which β_3 has a causal interpretation is that $Treat\_time_{it}*Treat\_area_{it}$ is uncorrelated with the error term u_{it}. We believe that this assumption is likely to hold when we include a detailed set of control variables in the model. Vector X includes a detailed set of housing attributes. Transactions are grouped quarterly and we include quarter fixed effects to control for shocks that affect both the treatment and control areas. In addition, we include postcode fixed effects μ_{ip} to control for area characteristics that do not change over time. Standard errors are clustered at the postcode level (21 clusters) to account for serial correlation in the error term within postcode.[18]

4.2.3 Time on the market

A linear DiD model may not be appropriate when the response variable comes in the form of a duration. Crucially, for our purposes, OLS cannot accommodate explanatory variables that change value over time. Therefore, we model the effect of price information on sales times through a Cox's proportional hazard model with time varying covariates discussed by Wooldridge (2002), among others. The model is written as

---

[18] Simulations in Bertrand et al. (2004) indicate that cluster robust inference works reasonably well when the number of clusters is reasonably large. In their simulation, with 20 clusters the rejection rate of a true null hypothesis of no effect is 5.8% at the 5% significance level.

$$Pr\left(Sold\ at\ duration\ d\ \mid\ not\ sold\ before\ d\right)$$
$$= h_0\left(d\right)\exp\left(\beta_t + \beta_1 Treat\_time_{it} + \beta_2 Treat\_area_i + \beta_3\left(Treat\_time_{it} * Treat\_area_i\right) + \beta_4 X_i + \mu_p\right) \quad (7)$$

where the hazard rate of a unit getting sold at duration *d* conditional on being on the market until *d* is a function of the baseline hazard $h_0(d)$ and the exponential function of other determinants of sales time. In order to introduce time varying covariates (*Treat_time* and quarter dummies), we split the spells by quarter. We use the Cox (1972) partial maximum likelihood estimator for the β parameters that does not require estimating $h_0(d)$. The semi-parametric proportional hazard model allows us to study how the opening of the website shifted the hazard function without restrictive distributional assumptions. The coefficients are approximate semi-elasticities of the hazard rate with respect to the covariates. Again, we control for dwelling characteristics, postcode fixed effects and common quarterly shocks. Standard errors are clustered at the postcode level to account for serial correlation in the error term within area.

4.2.4 Internal and external validity

A potential caveat of DiD estimation using data across the treatment area boundary is that in addition to the channels identified in Section 3, our estimates may be affected by factors specific to the empirical set-up. On one hand, potential information spill-overs from the treatment area to the control area could work against finding an effect for increased information. On the other hand, increased information within the treatment area could affect entry to the market. In particular, the treatment could displace demand for housing from the control area to the treatment area. It could for example be that buying in areas with more detailed information is considered less risky, which could make the treated area more attractive. The displacement effect might bias the price effect estimates upwards and sale time estimates downwards. The possibility of cross-border effects implies that one should be cautious when generalizing the empirical findings to a situation where information increases in the whole housing market area. However, we think that the potential cross-border effects are likely to be of second order importance compared with the mechanisms found in Section 3.

A further concern regarding the validity of our DiD strategy is that the treatment area boundary coincides with municipality borders. Place based government policies coinciding with the opening of the website could contaminate the results if they affect differently the treatment and control groups. We are not aware of significant policy changes that could be expected to capitalize into housing prices. We argue that changes in municipal taxes and services are not an important endogeneity issue. For example, the negative house price effect of an increase in local taxes can be expected to be counteracted by improved services.[19] These potential issues notwithstanding, we argue that DiD estimation based on the comparison of similar flats on either side of the boundary provides a convincing test of the effect of increased information in the housing market.

4.3 Results

4.3.1 Increased information and sale price

Table 7 shows the results for price. The dependent variable is the log of sale price. The first column shows the simple DiD estimates when we only control for quarter fixed effects. The coefficient on the interaction term is positive but insignificant. In the second column, we add dwelling characteristics. In this case, the treatment effect estimate rises to 6% and becomes and significant at the 1% level. All the dwelling characteristics, except the dummy for new flats, are statistically significant and have expected signs: Price increases with the number of rooms and floor area. Good condition increases price by 7%, bad condition decreases price by 10% relative to satisfactory condition and vacant flats are about 3% more expensive. Age and price have a U-shaped relationship. Maintenance charge has a negative effect on price. In the third column, where we add postcode dummies (21 postcodes), the coefficient on the interaction term decreases to 4.4% but remains highly significant. Taken at face value, the coefficient implies that publishing information on past transactions led to a 4% increase in the average price. In the fourth column, we allow for different linear trends in the treatment and control areas. The treatment effect estimate reduces slightly to 3.4% and is still significant at the 5% level. The interaction term of quarter and *Treat_area* is 0.001 and the t-test supports the common trends assumption. Therefore, column (3) is our preferred specification.

[19] In the theoretical framework of local taxation and service provision developed in Brueckner (1979 and 1982), the local government should set the level of public expenditures such that the capitalized tax needed to finance a further rise in services would just offset the capitalized willingness to pay for them.

Table 7. Increased information and sale price.

Dep. Var ln(price)	(1)	(2)	(3)	(4)
Treat group	-0.046	-0.034		
	[0.070]	[0.029]		
Treat time	0.043	0.060***	0.044***	0.034**
* Treat group	[0.025]	[0.017]	[0.010]	[0.014]
2 rooms		0.046*	0.057***	0.057***
		[0.024]	[0.020]	[0.020]
3 rooms		0.129***	0.150***	0.150***
		[0.041]	[0.030]	[0.030]
4 rooms		0.211***	0.229***	0.228***
		[0.048]	[0.036]	[0.036]
5 rooms or more		0.388***	0.352***	0.352***
		[0.046]	[0.051]	[0.052]
Ln(floor space)		0.458***	0.439***	0.440***
		[0.050]	[0.033]	[0.033]
New		0.013	0.022	0.021
		[0.027]	[0.019]	[0.019]
Good condition		0.066***	0.071***	0.072***
		[0.006]	[0.005]	[0.005]
Bad condition		-0.100***	-0.090***	-0.090***
		[0.018]	[0.013]	[0.013]
Vacant		0.026	0.029**	0.029**
		[0.015]	[0.012]	[0.012]
Age		-0.022***	-0.022***	-0.022***
		[0.003]	[0.002]	[0.002]
Age^2		0.000***	0.000***	0.000***
		[0.000]	[0.000]	[0.000]
Maintenance charge/m^2		-0.016**	-0.008**	-0.008**
		[0.006]	[0.003]	[0.003]
Quarter				0.015***
				[0.001]
Treat group				0.001
*Quarter				[0.001]
Quarter fixed effects	YES	YES	YES	YES
Postcode fixed effects			YES	YES
N	4490	4490	4490	4490
R-squared	0.156	0.873	0.913	0.913

Standard errors clustered at postcode level in brackets

* p<0.1, ** p<0.05, *** p<0.01

Note: main effect of Treat time absorbed by quarter dummies in (1)-(4)
and main effect of Treat droup absorbed by postcode dummies in (3)-(4)

Figure 4 shows the development of quarterly price difference between the treatment and control areas after controlling for dwelling characteristics. The line shows the coefficient on the treatment area dummy interacted with quarterly time dummies. The dashed line indicates the treatment period and the grey area is the 95% percent confidence interval. Quarterly price differences are imprecisely estimated and volatile due to sampling error but there is, nevertheless, a clearly visible upward shift coinciding with the opening of the website. As suggested by the final specification of Table 7, where we control for different trends, there is no apparent trend in the price difference. The strong and persistent increase in the price difference when the website was opened increases the confidence in the reliability of the regression estimates in Table 7.

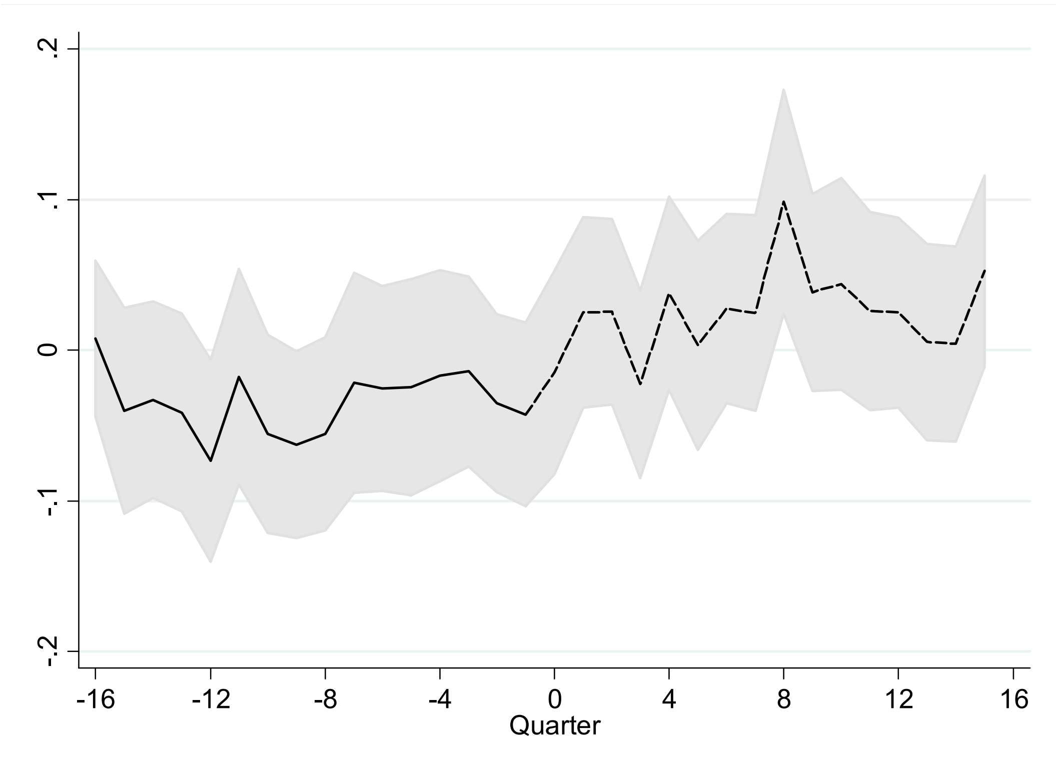

Figure 4. *Price difference between treatment and control areas.*

Our main estimates in Table 7 used an eight year window around the introduction of the website and 5km bands around the treatment area boundary. We next test the robustness of the results to these choices in Tables 8 and 9.

Table 8 reports the treatment effect estimates with 2, 4, 6 year windows using otherwise the same specification as in the third column of Table 7. The estimates vary between 3.2% and 4.8% and are statistically significant. Thus the choice of the time window does not affect our results on the price effect much.

Table 8. Increased information and sale price – robustness to time window.

Dep. Var ln(price)	2 years	4 years	6 years
Treat time* Treat group	0.032**	0.034***	0.048***
	[0.012]	[0.012]	[0.010]
N	1158	1672	3330
R-squared	0.91	0.907	0.909

Controls: Quarter fixed effects, house characteristics and postcode fixed effects
Standard errors clustered at postcode level in brackets
* p<0.1, ** p<0.05, *** p<0.01

Finally, Table 9 shows the results when we change the sample criteria regarding the distance to the treatment area boundary. The price effect estimate is consistently positive but seems to decrease as we expand the sample area further away from the boundary. With the 10km distance threshold, the estimate becomes insignificant. We argue that the specifications with narrower distance bands give more reliable results than the 10km band. The DiD assumption of similar price developments in the treatment and control group in the absence of the treatment is less likely to hold as we expand the sample area. The 5km distance threshold is our preferred specification because it gives a sufficient sample size for precise estimation while being narrow enough to ensure comparability.

Table 9. Increased information and sale price – robustness to distance threshold.

Dep. Var ln(price)	2km	4km	6km	8km	10km
Treat time* Treat group	0.050	0.052***	0.031**	0.022*	0.013
	N.A.[a]	[0.013]	[0.015]	[0.011]	[0.010]
N	837	2569	5131	7508	11695
R-squared	0.91	0.927	0.908	0.909	0.893

Controls: Quarter fixed effects, house characteristics and postcode fixed effects
Standard errors clustered at postcode level in brackets
[a] Standard error not shown for the 2km band due to insufficient number of clusters
* p<0.1, ** p<0.05, *** p<0.01

Altogether, Tables 7–9 provide evidence that the opening of the website boosted housing prices. Our preferred estimate (column 3 of Table 7) suggests that the effect is around 4%. The magnitude should, however, be regarded as approximate. Even if differential trends in the control and treatment areas are rejected by the significance test, controlling for differential trends reduces the point estimate. Moreover, the estimates are somewhat sensitive to the width of the distance band around the treatment area boundary and the width of the time window.

4.3.2 Increased information and time on the market

Table 10 reports the Cox proportional hazard model results for time on the market. Note that a positive coefficient indicates a higher probability of the flat being sold, conditional on not being sold before, which translates into a shorter time on the market. In the first column, without control variables, the coefficient on the interaction term is small and insignificant. However, adding housing attributes in the second column increases the coefficient to 0.23 and it becomes highly significant. The results do not change in the third column where we add postcode fixed effects. The coefficient increases slightly when we allow for different trends (fourth column) and the standard error increases. Again, the interaction of *Treat_area* and quarter is small and insignificant, which supports the common trends assumption.

The estimates in our preferred specification (column 3) indicate a roughly 24% increase in the sale hazard in the treated area relative to the control area. Figure 5 illustrates what this implies for sale times by showing the estimated survival function with and without the treatment when all other variables are set to their means. The treatment reduces the share of flats still on the market after 50 days from roughly 45% to around 35%.

In Figure 6 we examine how the proportionate difference in sale hazard between the treatment and control areas evolves over time. Housing characteristics are controlled for. Dashed line indicates the treatment period and the area around the line is the 95% confidence interval. The line is somewhat volatile but, as in Figure 4, there is a visible upward shift in sale hazard when the website is opened.

Table 10. *Increased information and sale time.*

Cox proportional hazard estimates	(1)	(2)	(3)	(4)
Treat area	-0.095	-0.266**		
	[0.180]	[0.105]		
Treat time	0.022	0.230***	0.238***	0.281**
* Treat area	[0.117]	[0.073]	[0.066]	[0.136]
2 rooms		0.150*	0.147*	0.148*
		[0.080]	[0.079]	[0.080]
3 rooms		0.104	0.088	0.089
		[0.135]	[0.138]	[0.140]
4 rooms		0.145	0.106	0.109
		[0.192]	[0.200]	[0.202]
5 rooms or more		0.143	0.164	0.17
		[0.276]	[0.272]	[0.272]
Ln(floor space)		-0.768***	-0.727***	-0.729***
		[0.186]	[0.185]	[0.188]
New		-1.202***	-1.225***	-1.225***
		[0.145]	[0.132]	[0.131]
Good condition		0.103***	0.089***	0.088***
		[0.031]	[0.032]	[0.032]
Bad condition		0.199***	0.229***	0.229***
		[0.069]	[0.073]	[0.073]
Vacant		0.478***	0.432***	0.431***
		[0.126]	[0.130]	[0.128]
Age		0.031***	0.028***	0.028***
		[0.008]	[0.007]	[0.007]
Age^2		-0.001***	-0.001***	-0.001***
		[0.000]	[0.000]	[0.000]
Maintenance charge/m^2		-0.119***	-0.114***	-0.115***
		[0.021]	[0.022]	[0.022]
Quarter				0.209**
				[0.083]
Treat area				-0.003
*Quarter				[0.008]
Quarter fixed effects	YES	YES	YES	YES
Postcode fixed effects			YES	YES
N	4437	4437	4437	4437
Log-likelihood	-32693	-32317	-32272	-32272

Standard errors clustered at postcode level in brackets

* p<0.1, ** p<0.05, *** p<0.01

Note: main effect of Treat time absorbed by quarter dummies in (1)-(4) and main effect of Treat area absorbed by postcode dummies in (3)-(4)

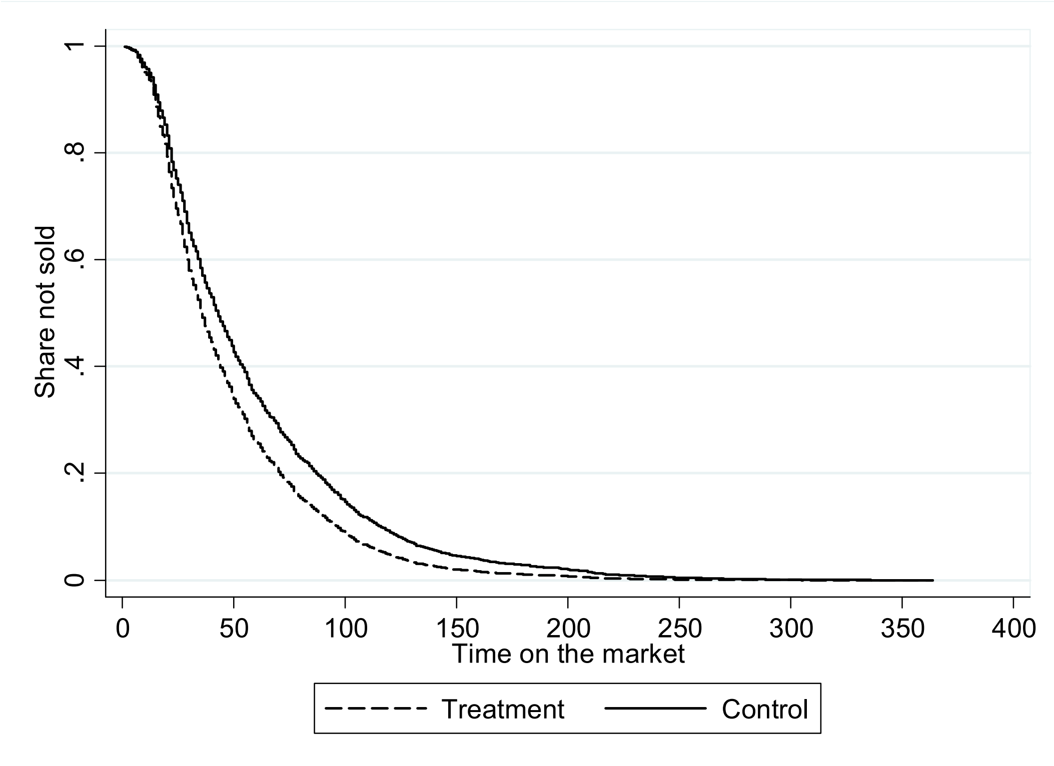

Figure 5. *Survival functions after the reform in treatment and control areas.*

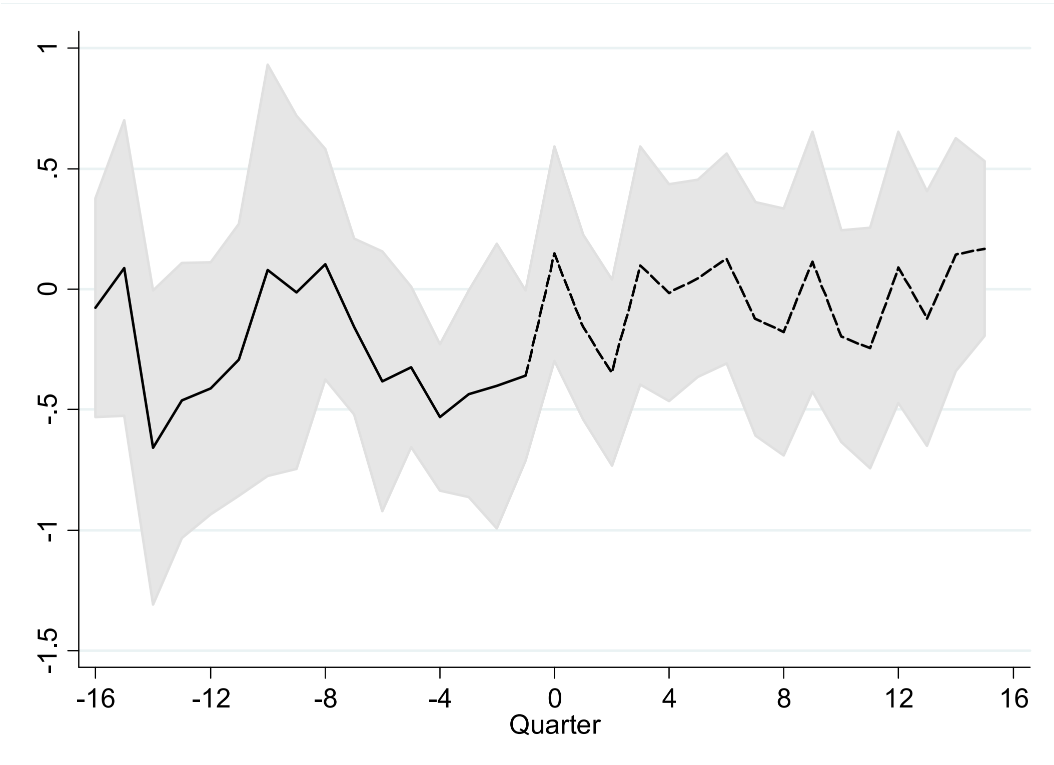

Figure 6. *Proportionate difference in sale hazard between treatment and control areas.*

We next consider the same robustness tests as above in the estimation of price effects while retaining otherwise the specification as in the third column of Table 10. Table 11 shows the results for varying time windows. The estimates are similar to the results with an 8-year window in Table 10. All coefficients are positive and significant and the magnitude varies around the 0.24 estimate obtained in Table 10 using an 8-year window.

Table 11. Increased information and sale time – robustness to time window.

Cox proportional hazard estimates	2 years	4 years	6 years
Treat time* Treat group	0.342***	0.240***	0.183**
	[0.104]	[0.068]	[0.077]
N	1282	2299	3449
Log-likelihood	-7216	-14694	-23541

Controls: Quarter fixed effects, house characteristics and postcode fixed effects
Standard errors clustered at postcode level in brackets
* p<0.1, ** p<0.05, *** p<0.01

Table 12 shows the results for alternative distance thresholds. The estimates are consistently positive and significant implying that better information on past transactions led to a shorter time on the market. The time on the market estimates are less sensitive to the distance band used than the price effect estimates.

Table 12. Increased information and sale time – robustness to distance threshold.

Cox proportional hazard estimates	2km	4km	6km	8km	10km
Treat time* Treat group	0.229	0.287***	0.206***	0.150***	0.167***
	N.A. [a]	[0.077]	[0.066]	[0.057]	[0.042]
N	836	2548	5079	7328	11457
Log-likelihood	-4681	-17118	-37670	-57027	-94281

Controls: Quarter fixed effects, house characteristics and postcode fixed effects
Standard errors clustered at postcode level in brackets
[a] Standard error not shown for the 2km band due to insufficient number of clusters
* p<0.1, ** p<0.05, *** p<0.01

All in all, Tables 11 and 12 indicate that our results on the sale times are not very sensitive to changes in the time period nor the geographic area analyzed. The results show that the opening of the website led to a significant decrease in the time on the market.

5. Discussion

The discussion in Section 3 shows that when price information is increased in the market, there are several potential channels through which the behavior of individual traders and, as a result, market outcomes could be affected. Concerning the effect on prices, the prediction is clear: regardless of who reacts to the new information, average price in the market is expected to increase after the reform. This is indeed what happens after the Finnish reform: we find clear evidence that prices increased in the treatment area when detailed information became available.

Regarding the sale time, the prediction of Section 3 is much less clear cut. When sellers obtain new information, they, on average, set higher prices. This would, other things equal, lead to longer time on the market. However, if the new information helps buyers self select to visit the right houses, the matching process in the market becomes more efficient. This in turn would, other things equal, lead to faster sales. These two opposing effects may well cancel one another. Our empirical results show that the time on the market becomes shorter after the reform. The empirical evidence therefore suggests that buyers react more to the new information than the sellers.

We aimed to keep our modeling framework simple so as to focus on the role of information. One potentially important missing ingredient in the model is the role of real estate agents. As mentioned above, the data we use contain trades completed by real estate agents. Unfortunately, the data do not contain information about the identity of the real estate agent which rules out more detailed study of the potential behavioral responses by the real estate agents.

One possible explanation for why buyers react more to new information than sellers could be that sellers who use real estate agents are less likely to search for new information or to have full control over the price setting. If the decisions on listing prices are much affected by the agents, we would most likely observe less reaction in the behavior of the sellers than in the behavior of the buyers. Indeed, there is evidence suggesting that real estate agents do not necessarily use their information advantage in the best interest of their clients. For instance, Levitt and Syverson (2008) find that homes owned by real estate agents sell at higher prices and stay longer on the market than other comparable houses. In addition, greater information asymmetry, measured by the heterogeneity of the housing stock, seems to lead to higher distortions.[20]

[20] Rutherford et al. (2005) also find that real estate agents earn higher selling prices on their own homes. Their focus is on the effort exerted by the agent. Hendel et al. (2009) compare the performance of two competing platforms: an established platform offering a bundle of services available from real estate

6. Conclusions

We analyze the implications of a reform which increases the publicly available price information in the housing market. Housing market is characterized by experimentation and price bargaining between a potential seller and a buyer. In such an environment sellers and buyers are likely to use their own experience in the market so as to update their beliefs about the market conditions. More detailed price information may complement this learning process.

Our theoretical analysis focuses on the different channels through which public information may affect market outcomes. The prediction of the model is that increased price information unambiguously leads to higher prices. The effect of increased price information on time on the market is less clear. This is because the behavioral responses of the sellers and the buyers are likely to influence the time on the market to opposing directions and the total effect depends on which channel dominates.

Our empirical analysis uses Finnish data to study how the opening of a website with detailed information on past transactions affected housing prices and sales times. Our empirical strategy is based on the comparison of transactions in the same housing market area on either side of the boundary of the area covered by the website. The empirical results show that increased information had a positive effect on price and a negative effect on time on the market.

---

agents and a newly established no-service platform. They find no support for the hypothesis that listing the house on the platform offering real estate agent services delivers a higher sale price.

References

Baye, M. R. – J. Morgan – P. Scholten (2006): Information, Search, and Price Dispersion, in (T. Hendershott, ed.): *Handbook on Economics and Information Systems*, Elsevier.

Bertrand, M. – E. Duflo – S. Mullainathan (2004): How Much Should We Trust Differences in Differences Estimates? *Quarterly Journal of Economics*, 119(1), 249–275.

Brown, J. R. – A. Goolsbee (2002): Does the Internet Make Markets more Competitive? Evidence from the Life Insurance Industry, *The Journal of Political Economy* 110(3), 481–507.

Brueckner, J.K. (1979): Property values, local public expenditures and economic efficiency, *Journal of Public Economics* 11, 223–245.

Brueckner, J.K. (1982): A test for allocative efficiency in the local public sector, *Journal of Public Economics* 19, 311–331.

Carrillo, P. E. (2012): An Empirical Stationary Equilibrium Search Model of the Housing Market, *International Economic Review* 53(1), 203–234.

Cheng, P. – Z. Lin – Y. Liu (2010): Home Price, Time-on-Market, and Seller Heterogeneity under Changing Market Conditions, *Journal of Real Estate Finance and Economics* 41, 272–293.

Cho, I.K. (1990): Uncertainty and delay in bargaining, *The Review of Economic Studies* 57, 575–595.

Dachis, B. – G. Duranton – M.A. Turner (2011): The effects of land transfer taxes on real estate markets: evidence from a natural experiment in Toronto, *Journal of Economic Geography,* forthcoming.

Hendel, I. – A. Nevo – F. Ortalo-Magné (2009): The Relative Performance of Real Estate Marketing Platforms: MLS versus FSBOMadison.com, *American Economic Review* 99(5), 1878–98.

Fiva, J.H. – L.J. Kirkebøen (2011): Information Shocks and the Dynamics of the Housing Markets, *Scandinavian Journal of Economics* 113(3), 525–552.

Jensen, R. (2007): The Digital Provide: Information (Technology), Market Performance and Welfare in the South Indian Fisheries Sector, *Quarterly Journal of Economics* 122(3), 879–924.

Levitt, S. D. – C. Syverson (2008): Market Distortions When Agents Are Better Informed: The Value of Information in Real Estate Transactions, *The Review of Economics and Statistics* 90(4), 599–611.

Mason, R. – J. Välimäki (2011): Learning about the arrival of sales, *Journal of Economic Theory* 146(4), 1699–1711.

Mason, R. – J. Välimäki (2007): Learning and Smooth Stopping, HECER Discussion Papers, No. 200.

Merlo, A. – F. Ortalo-Magné (2004): Bargaining over residential real estate: evidence from England, *Journal of Urban Economics* 56, 192–216.

Rutherford, R. C. – T. M. Springer – A. Yavas (2005): Conflicts Between Principals and Agents: Evidence from Residential Brokerage, *Journal of Financial Economics* 76, 627–665.

Taylor, C.R. (1999): Time-on-the-Market as a Sign of Quality, *The Review of Economic Studies* 66(3), 555–578.

Svensson, J. – D. Yanagizawa (2009): Getting the prices right: The impact of the market information service in Uganda, *Journal of the European Economic Association* 7(2-3), 435–445.

Wheaton, W. (1990): Vacancy, Search, and Prices in a Housing Market Matching Model, *Journal of Political Economy* 98(6), 1270–1292.

Wooldridge, J.M. (2002): *Econometric Analysis of Cross Section and Panel Data,* The MIT Press.

IN VATT WORKING PAPERS SERIES PUBLISHED PUBLICATIONS

10. Sara Ayllón: Modelling state dependence and feedback effects between poverty, employment and parental home emancipation among European youth. Helsinki 2009.
11. Juha Honkatukia – Jouko Kinnunen – Kimmo Marttila: Distributional effects of Finland's climate policy package – Calculations with the new income distribution module of the VATTAGE model. Helsinki 2009.
12. Juha Tuomala: The threat effect of mandatory programme participation in Finland – A study of activation reform of the labour market support system. Helsinki 2010.
13. Ilja Kristian Kavonius: Fiscal policies in Europe and the United States during the Great Depression. Helsinki 2010.
14. Miikka Rokkanen – Roope Uusitalo: Changes in job stability – evidence from lifetime job histories. Helsinki 2010.
15. Heléne Lundqvist: Granting public or private consumption? Effects of grants on local public spending and income taxes. Helsinki 2010.
16. Ossi Korkeamäki – Tomi Kyyrä: Institutional rules, labour demand and retirement through disability programme participation. Helsinki 2010.
17. Tomi Kyyrä: Early retirement policy in the presence of competing exit pathways: Evidence from policy reforms in Finland. Helsinki 2010.
18. Tuomas Kosonen: What was actually cut in the barbers' VAT cut? Helsinki 2010.
19. Tuukka Saarimaa – Janne Tukiainen: Coalition formation and political decision making: Evidence from Finnish municipal mergers. Helsinki 2010.
20. Teemu Lyytikäinen – Torsten Santavirta: The effect of church tax on church membership. Helsinki 2010.
21. Tomi Kyyrä – Ralf A. Wilke: On the reliability of retrospective unemployment information in European household panel data. Helsinki 2011.
22. Ossi Korkeamäki: The Finnish payroll tax cut experiment revisited. Helsinki 2011.
23. Tuomas Kosonen: To work or not to work? The effect of child-care subsidies on the labour supply of parents. Helsinki 2011.
24. Olli Ropponen: Reconciling the evidence of Card and Krueger (1994) and Neumark and Wascher (2000). Helsinki 2011.
25. Olli Ropponen: A Note on the Robustness of Card and Krueger (1994) and Neumark and Wascher (2000). Helsinki 2011.
26. Teemu Lyytikäinen: Tax competition among local governments: evidence from a property tax reform in Finland. Helsinki 2011.
27. Jarkko Harju – Seppo Kari: Dividend taxes and decision of MNEs: Evidence from a Finnish tax reform. Helsinki 2011.
28. Piia Aatola – Kimmo Ollikka – Markku Ollikainen: Informational Efficiency of the EU ETS market – a study of price predictability and profitable trading. Helsinki 2012.
29. Kristiina Huttunen – Jenni Kellokumpu: The Effect of Job Displacement on Couples' Fertility Decisions. Helsinki 2012.

VALTION TALOUDELLINEN TUTKIMUSKESKUS
STATENS EKONOMISKA FORSKNINGSCENTRAL
GOVERNMENT INSTITUTE FOR ECONOMIC RESEARCH

Valtion taloudellinen tutkimuskeskus
Government Institute for Economic Research
P.O.Box 1279
FI-00101 Helsinki
Finland

ISBN 978-952-274-021-2
ISSN 1798-0291