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by sell-first movers in a housing recovery ‘

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This is the author's accepted, refereed manuscript to the article published in  
*Journal of European Real Estate Research*, 7(2014)3: 295-306

DOI: 10.1108/JERER-01-2014-0004

Publisher's version available at <http://dx.doi.org/10.1108/JERER-01-2014-0004>

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Strategic sequencing behavior among  
owner-occupiers: The role played by sell-first  
movers in a housing recovery

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September 4, 2014

**Abstract**

Moving owner-occupiers face a simultaneous dual search and matching problem since they must locate both a buyer and a seller with whom to transact. Individual agents solve this optimization under uncertainty by planning to make their bids for a new house partially conditional upon the sale of the old house. This article studies this dual search problem using data on the Norwegian housing market during the financial crisis of 2008 and begins the detailed mapping of the elements in the transmission mechanism from policy to the

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housing market. Norway may function as window into a policy quasi-laboratory since the housing market was turned around in December 2008 in the midst of a world-wide financial crisis and after a year and a half of price decreases. The article proposes that one key dimension in the recovery was the reduced frequency of households with conditional demand involving sell-first strategies. Empirical evidence on the sell-first-buy-first differential, for-sale stock, and stock-to-volume supports this proposition and results indicate that the housing market is affected by sell-first strategies. The article discusses policy alternatives.

**Key words:** housing market, strategic behavior, sell-first sequencing plans

**JEL Classification codes:** D1, R21, R31

**Acknowledgements:** We are grateful to *Eiendomsverdi* for allowing us access to data. The views expressed herein are solely those of the authors and do not necessarily reflect the views of *Norges Bank*.

## 1 Introduction

In most markets, sellers and buyers are different agents. The firm *Gadgets'R'Us* buys labor and materials and sells gadgets. Mr. Anderson sells his labor and buys gadgets. In contrast, owner-occupiers who are moving house are sellers and buyers of similar goods in the same market. This makes the housing market's supply and demand interdependent, since a

household's purchase of a new house may be contingent upon what price the household gets when it sells the old home. As a consequence, aggregate realized home equity from the sell side depends upon the aggregate price level, but the aggregate price level is also a function of the deployment of aggregate home equity on the buy side. This endogeneity is one of several features that make the housing market extraordinarily complex and this is, fundamentally, an implication of the dual search and matching problem moving owner-occupiers face. This article examines some less studied parts of this endogeneity and discusses policies that may affect the mechanisms governing the endogeneity. This article suggests that one factor may be particularly interesting, but under-explored: the frequency of moving owner-occupiers who plan on selling before buying compared to the frequency of movers who plan on buying before selling. We examine such strategic sequencing in Norway before, during, and after the financial crisis of 2008. In order to investigate the empirical patterns, we have acquired two unique measures: the interview-based sell-first-buy-first differential and the market-based stock of houses for sale. We ask what role strategic sequencing plays in a housing crisis and recovery and how policy can affect it.

The role played by strategic sequencing is studied by first constructing a simple theoretical framework with which to understand how sequencing can change both the supply of for-sale houses and transaction volumes. Then, we turn to the empirical evidence and look for co-movements between strategic sequencing and house price indices. The idea is not to construct statistical

tests that constitute the final say in the issue of causality, but to combine quantitative tests with qualitative assessment to discuss empirical regularities. After all, if strategic decisions on households' buy-sell sequences lie underneath coordination challenges in times of crisis, we ought to be able to detect traces in data.

Both theory and empirical regularities may help policymakers in understanding the propagation of a crisis and what leads to recovery. Potentially, such insights may also help policymakers establish blueprints on how to acquire tools to combat crises. How? If it can be established that house prices and strategic sequencing tend to move together, we may use that insight to think about what causes them to do so and how to affect these causes. Candidate policy tools are bridging loans for buy-first owner-occupiers who fear holding two mortgages, or are denied two mortgages, and a two-mortgages insurance (against not being able to sell the old home). Shiller and Weiss (2000) suggest different home equity insurance schemes, and this article relates strategic sequencing behavior to such schemes. Moreover, we discuss how strategic sequencing is useful in interpreting fluctuations in time-on-market (TOM) and how TOM potentially may be incorporated in the schemes.

We start out by constructing a miniature model of sell-buy sequences that illustrates the synchronization problem that emerges in a crisis. In a crisis, many owner-occupiers may want to buy a house, but they may insist upon selling the old house before buying the new one because they fear

ending up with two mortgages. This article's framework demonstrates how this concern may make the market grind to a halt with few transactions yet plenty of supply of for-sale houses and demand for relocation. Consider the simplest case, a trade triangle in which household A wants to buy household B's house and household B wants to buy household C's house. Household C, in turn, has its eyes on household A's house. Everybody agrees that every house is worth the same. Seemingly, the Pareto optimal solution is easy to reach: they could just switch houses. Any price would work and constitute an equilibrium price because all three sell-and-buy price-pairs would be the same, thus spending would equal income. Yet, if household A is to be the first buyer, it must be willing to hold two houses for some time, and it may not be willing to do so. The two other households may also have concerns about temporarily owning two houses. In fact, if all three households state a conditional demand, with the condition that they will buy only after first having sold, no transactions will take place. The transaction volume falls from three to zero. This illustrates the notion that the functioning of the housing market, and any market where buyers also are sellers, depends upon strategic sequencing. More accurately, the housing market has higher (lower) transaction volumes and lower (higher) stock of for-sale houses when sequencing plans are more (less) heterogeneous.

The policy implications of the findings in this paper are two-fold. First, insights may help us understand the transmission mechanism between monetary policy and the housing market. Second, it can furnish us with possible

future tools of handling crises. The former would help us understand the results of Røed Larsen (2014), who shows that the monetary policy reversal appears to have led to the housing market recovery in the fall of 2008. He suggests that the transmission mechanism comprises household behavior and banks' credit extension. That credit played a role can be deduced from Anundsen and Jansen (2013), who examine the self-reinforcing effects between house prices and credit in Norway 1986-2008. That household behavior played a role is what this article argues.

The article is structured in the following way. The next section discusses recent literature and explains what new ground this article suggests research ought to cover. Section three introduces the theoretical framework in the form of a miniature model of strategic sequencing. The subsequent section presents data sources and an overview of the price development. Section five describes the empirical approach, while section six presents the empirical findings. In the seventh section, we discuss the dynamics of the interdependent supply and demand in the housing market. The last section contains concluding remarks and policy implications.

## **2 Literature**

As Haurin et al. (2013) demonstrate, the standard search model does not fully explain the mechanisms of the housing market. There is, however, a growing literature on search and matching models of the housing market,

following Wheaton's (1990) seminal article with which he launched models of movers who are both buyers and sellers. He demonstrated why there is a strong, inverse relationship between prices and vacancies. The interdependency of the buy and the sell side was followed up by Stein (1995), who showed how different types of agents make decisions while simultaneously considering down-payments and equity in their net demand, i.e. at the same time balancing sell and buy prices. That movers think about what they eventually can get for the house they are leaving, even as early as the time when they are considering buying it, is clear from the contribution in Forgey, Rutherford, and Springer (1996). They constructed a search model that demonstrates how the expected sellability is a feature that increases the value of a house.

Albrecht et al. (2007) constructed a matching model where the duration of the search itself matters since agents entertain degrees of impatience and have a duration-dependent level of selectiveness. That model is akin in spirit to this article's, since we seek to make explicit the possibility that selling and buying become interdependent, i.e. that the sequencing of buying and selling is a key variable over which agents sometimes have preferences. In most other models moving owner-occupiers can buy before selling or vice versa. This article, however, proposes that in times of crisis the sequencing of the sale and the purchase is key. If a small number of households change their sequencing plans they may affect the whole housing market. To illustrate this possibility, we introduce below a trade triangle of moving owner-occupiers.

The model bears some resemblance to more advanced models, e.g. to the matching model by White (1970) and the chain-formation model by Rosenthal (1997), but it is stripped down to illustrate only how synchronization of sequencing plans can affect the transaction volume and the supply of for-sale houses. This idea, i.e. that households contemplate what, where, and when to buy and sell, was also studied by Maclennan and O’Sullivan (2012). Even if they focused attention on spatial dimensions rather than strategic sequencing, the similarity of spirit is clear. They stated: “The inherent nature of housing means that partly informed households typically engage in search activity prior to purchasing a property.” This article supplements this view by spelling out how the prior activity may include the insistence upon selling first.

### **3 A miniature model of strategic sequencing in the housing market**

In a miniature model of moving owner-occupiers, households A, B, and C want to buy and sell in a trade triangle, as depicted in Figure 1. We assume they cannot rent or buy elsewhere. We leave out credit constraints, house attributes, and new construction in order to concentrate attention to the buy-sell sequence. Household  $i$  plans on making a bid,  $b_j^i$ , for household  $j$ ’s house, where the bid is a function of the price household  $i$  obtains by selling its house to household  $k$ ,  $b_j^i(p_i^k)$ , where  $p$  is the sales price and  $i, j, k = A,$

B, C. Let  $p_j^i = b_j^i$  so that the sales price when e.g. household A sells to household C equals an acceptable bid made by household C. For simplicity, we start out by letting the bid function be a linear function of the sales price, so  $b_B^A = \alpha b_A^C, b_C^B = \beta b_B^A$ , and  $b_A^C = \gamma b_C^B$ . The trade triangle is a closed circuit of three bilateral transactions, and each transaction is conditional upon the other. This is formulated in equation (1). Equation (2) follows by necessity, since  $b_B^A$  must equal itself:

$$b_B^A = \alpha(\gamma b_C^B) = \alpha(\gamma(\beta b_B^A)), \quad (1)$$

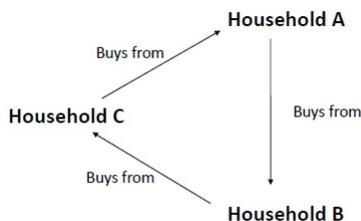
$$\alpha\beta\gamma = 1. \quad (2)$$

The intuition behind the condition  $\alpha\beta\gamma = 1$  is the straightforward logic of a closed economy. If all households decide to use all of the proceeds from their own sale towards their own purchase,  $\alpha = \beta = \gamma$ , and any price will work. But if one household decides to use less on the purchase than what it gets from the sale, at least one other household must use more than what it gets from its sale. For example, if household A decides to use only 90 percent of its sales receipts when it buys, i.e.  $\alpha = 0.9$ , then either household B or household C, or both, must use more, i.e.  $\beta\gamma = 1.11$ . If household B uses all of its sales receipts, but no more, when it buys, household C must add 11 percent on its sales price when it buys off household A.

The simple trade circuit in Figure 1 illustrates the notion that in a mar-

ket where sellers also are buyers, one household's purchase is another household's sale, which in turn makes possible a third household's sale. Thus, if household A's bid function becomes conditional upon its first having sold (if  $\alpha$  no longer is a scalar but a binary function of the realized  $b_A^C$ ), household B or household C must take the role as the first buyer. If neither wants to, this closed trade circuit breaks down and the transaction volume drops from three to zero. At the same time, the number of units offered for sale remains at three and the number of households that want to relocate is still three.

**Figure 1. A trade triangle of size three**



A real-world housing market contains multiple trade circuits of sizes ranging from 2 (two households switching houses) to  $n$ , where  $n$  is limited by  $N$ , the number of moving owner-occupiers in the economy. If all  $n$  participants in a potential trade circuit of size  $n$  switch from unconditional demand, i.e. from being indifferent to buying or selling first, to conditional demand, i.e. with the preference to buy only after first having sold, then the number of transactions in that trade circuit falls from  $n$  to zero. There exists an unknown number of potential trade circuits in any given economy, but the probability that  $n$  out of  $n$  participants in a randomly drawn trade circuit

switch to conditional demand increases with the frequency of switchers in the whole economy. Thus, when the frequency of conditional demand reaches a critical threshold, a first potential trade circuit becomes unrealized and the transaction volume is reduced. In short, the frequency of households that report a plan to buy before selling is a statistic that may have predictive power.

Thus, the transaction volume and for-sale stock are gauges of the housing market and several studies find that there is a positive correlation between prices and volumes; e.g. Stein (1995), Genesove and Mayer (2001) and Ortalo-Magné and Rady (2006). The model above allows us to offer a possible mechanism that is consistent with this correlation. When households are concerned with financial risk, a higher frequency of them switch from unconditional demand to conditional demand. Conditional demand implies an increase in the for-sale stock (supply) and a decrease in active searches for houses to buy and a reduced frequency of active bidding (demand). Households postpone buying until after having sold. This reduces the transaction volume and in turn increases the ratio of the for-sale stock to the transaction volume, which is what we seek to study empirically.

## 4 Data and housing market recoveries

### 4.1 Data

We use the house price index published monthly by *Eiendom Norge* (The Association of Norwegian Realtors). It is a SPAR-type (sales price appraisal ratio) index in which the appraisal is based on hedonic regressions on a rich set of attributes. It is available and described online: <http://www.eiendom-norge.no>. We employ monthly aggregate data on transaction volumes and the for-sale stock from the firm *Eiendomsverdi*, which computes the volumes from realtor-reported sales and the for-sale stock from advertisements. The coverage for these series is January 2003 - March 2014. Data on sell-first and buy-first proportions are sourced from the firm *Prognosesenteret* and range from May 2007 to February 2014. The dataset is based on interviews of a webpanel in which 1,000 households answer with a monthly/bi-monthly<sup>1</sup> periodicity and the sample is stratified and weighted to represent the country through quotas for age and region.

### 4.2 Housing market recoveries of 2009 and 2014

The Norwegian experience during the financial crisis in 2008 differs from that of most other countries. While many countries experienced house price decreases in tandem with a worsening of economic activity, Norwegian house prices turned around at the end of 2008 and started to increase. This is

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<sup>1</sup>A few observations have longer intervals.

illustrated in the upper chart of Figure 2. Norwegian house prices reached a peak in August 2007 and the trough came in December 2008. From peak to trough, a period of 16 months, prices fell 11.6 percent. In comparison, the recent minor correction in the autumn of 2013 entailed a drop in the price index of 5.0 percent, and may serve as a yardstick with which to measure the depth of the 2008 crisis.

## **5 Empirical strategy and techniques**

### **5.1 Empirical strategy**

This article's main ambition is to find out if there is a link between the working of the housing market and strategic sequencing. For this purpose, we use the house price index as an overall indicator of the the housing market along with measures of strategic sequencing: the sell-first-buy-first differential and the for-sale stock plus the stock-to-volume ratio. The plan is to look for simultaneity in discontinuities by testing for structural breaks and continuous co-movement by checking for co-integration and Granger causality.

### **5.2 Empirical techniques**

Although the main thrust of this article comes from qualitative assessment, we do lean on several quantitative inspections. We use Augmented Dickey-Fuller (ADF) tests to look for unit roots (Dickey and Fuller (1979) and

(1981)), trace tests for cointegration (Johansen (1988)), and Granger non-causality (GNC) tests to investigate whether or not one variable Granger causes the other (Granger (1986)).

To measure simultaneous disruptions in the time series, we employ the Chow test (Chow (1960)) for structural breaks. This approach entails partitioning a time series into two segments and comparing the increase in explanatory power in a model with two time trends compared to a model with only one time trend for the whole period.

Then, even if we cannot demonstrate causality, we can make it plausible. Since it is of particular interest to say something about the timing, we pay particular attention to the evaluation of which of the two co-integrated variables Granger causes the other.

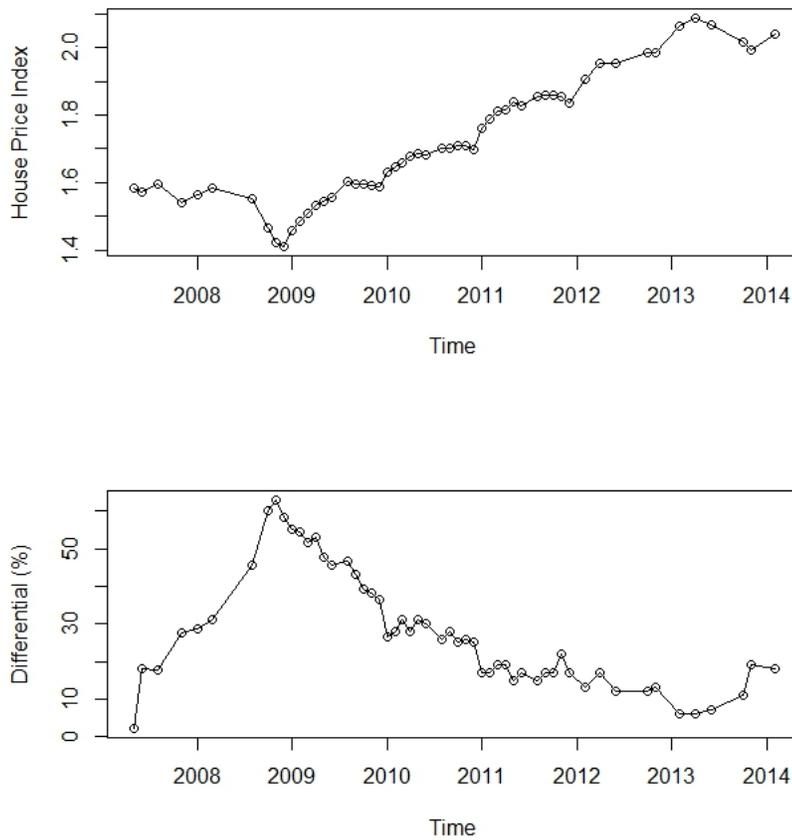
## **6 Empirical results**

### **6.1 The sell-first-buy-first differential**

The empirical regularities that emerge are quite clear and our argument is substantiated by visual inspection of the time series. Figure 2 shows that the house price trough occurs in December 2008 and the peak of the sell-first-buy-first differential occurs in November 2008. We see that these time series display co-movement and this invites several observations. First, when the house price index fell from 2007 to the end of 2008, the differential increased. Second, the two time series turned simultaneously. Third, at the

end of 2013 and the start of 2014, this simultaneity of breaks is repeated. A qualitative assessment of the evidence is that strategic sequencing and the housing market performance appears to be intimately linked.

**Figure 2. The house price index and sell-first-buy-first differential (in percentage points). Norway, May 2007 - February 2014**



Note. 54 observations, non-constant intervals.

## 6.2 Structural break in the differential

The buy-first-sell-first differential is relatively short and observed with different periodicity, so we do not conduct tests for cointegration nor Granger non-causality. Instead, since we are mostly interested in the turning points, we look for simultaneous structural breaks using a Chow-test. Interestingly, the estimated breakpoints reported in Table A1 do occur simultaneously, consistent with the hypothesis put forth in this article.<sup>2</sup>

## 6.3 The for-sale stock and the ratio of for-sale stock to transaction volume

A better measure of strategic sequencing may be offered by the total number of units put up for sale. The time series is longer, it is observed with constant periodicity, and it is marked-based. Table A2 in the Appendix tabulates GNC tests of Granger causality between the for-sale stock, stock-to-volume ratio and the house price index for the longer period ranging from January 2003 to March 2014. The tests<sup>3</sup> in Table A2 indicate that the for-sale stock

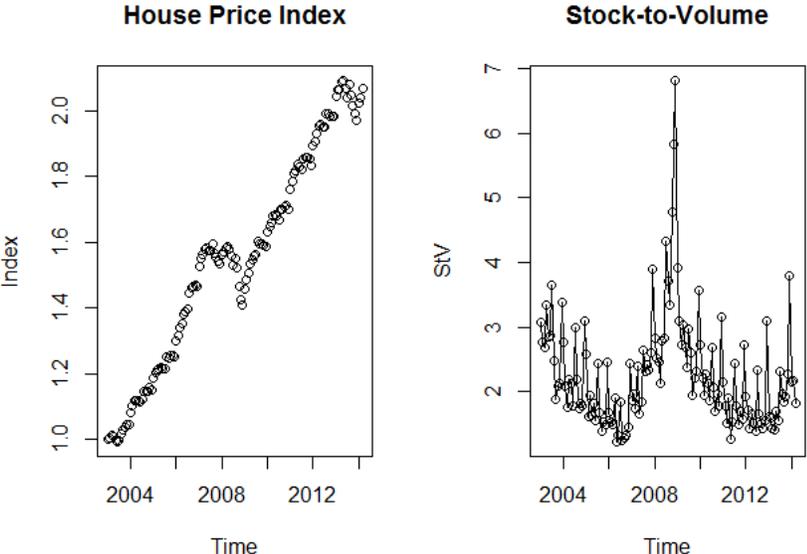
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<sup>2</sup>However, the breakpoint dates are estimated to occur early. Observation number 7 emerges as the clearest breakpoint candidate since it has the largest F-statistic for both the differential and the house price index. This observation dates to August 2008. The early estimated break might, however, be a figment of the irregularity of the interviews, which creates an asymmetry in the weighting of periods.

<sup>3</sup>We do not report all the details of our tests. In short, we first found that all three levels series were non-stationary, but first differences stationary, using ADF-tests. This implies that the series are integrated of order one. We then experimented with different lag lengths, starting with five, and found the optimal lag truncation using the AIC criterion. We then tested for cointegration between the series, since cointegration implies Granger causality in at least one direction. Finally, we conducted tests for GNC. Details are available upon request.

and the stock-to-volume ratio Granger cause the price index, which again is consistent with this article's hypothesis that sequencing plans matter to the functioning of the housing market. We see this from the extremely low p-values tabulated in the table. There is some, but somewhat weaker, evidence for causality in the other direction. The overall picture strongly supports this article's case.

**Figure 3. The house price index and ratio of for-sale stock to transaction volume. Norway, Januar 2003-March 2014**



Sources: *Eiendom Norge* and *Eiendomsverdi*.

## 7 Dynamics of interdependent supply and demand

Equilibrium prices decrease when the supply curve shifts out and/or the demand curve shifts in. Thus, at first blush, the evidence that the house price index shows co-movement with the for-sale stock and the transaction volume is expected, see Stein (1995), Genesove and Mayer (2001), and Ortalo-Magné and Rady (2006). There have been fewer studies of the co-movement of house prices and the for-sale stock, but this article finds a pattern that seems to add to our understanding of the functioning of the housing market. When there is business as usual, some households buy before they sell, others sell before they buy. This leads to relatively steady transaction volumes compared to the for-sale stock. In a crisis, however, households may switch to strategic sequencing, which increases the for-sale stock while the transaction volume decreases.

The evidence is consistent with a system that may work in the following manner: In a crisis, households increase the for-sale stock (so the supply curve shifts) because they prefer to sell first since that minimizes financial risk. Households also make lower bids if they have not already sold their old homes. These two effects amount to an outward shift of the supply curve and an inward shift of the demand curve, and the effects decrease equilibrium house prices. If the demand curve shift is substantial, equilibrium transaction volumes fall. If so, the decreases in prices and volumes increase

the frequency of sell-first households further. The loops of this spiral may continue until an exogenous policy shock stops them, or the cycle has run its course.

The question is: Should and/or can policymakers do anything about strategic sequencing?

The experience of the financial crisis warrants action. Short-term volatility and large long-term amplitudes in the housing market are undesirable for the damage they do to individual households and the instability they create for the macroeconomy. It may be possible to do something about it. Sequencing plans are strategic emergency decisions households make in times of uncertainty. They can be affected by policy if or when policy can affect the perceived risk. Households have at least three concerns: i) that they have to sell before buying, iii) that the realized home equity will be small, and ii) that they may end up owning two houses and having two mortgages for a prolonged period. Below, we turn to what policy can do about these concerns.

## **8 Concluding remarks and policy implications**

This article hypothesizes that strategic sequencing amongst households is key to understand the housing market in times of crises. It suggests that while many households normally are indifferent to the choice between selling before buying, and buying before selling, a higher frequency of them

prefers to sell before buying in times of increased risk. Our trade triangle shows how this can create a no-transaction chain and that there can be sudden swings in transaction volumes. The triangle demonstrates how the transaction volume can be reduced from three to zero if agents form similar and synchronized sequencing plans. We study empirical traces of this, and look at sell-first plans, for-sale stock, and transaction volumes. While the qualitative assessment of the co-movement between the sell-first-buy-first differential and the house price index seems clear, the quantitative evidence is somewhat weaker. On the other hand, the longer time series on market-based evidence tells us that the for-sale stock and the stock-to-volume ratio appear to Granger cause the house price index. This is supporting evidence for the idea that sequencing plans matter to the functioning of the housing market. It also opens up possibilities for policy.

First, it sheds light on the transmission mechanism in monetary policy. Since central banks do not buy houses, but rely on transmission mechanisms, it is useful to examine the channels through which monetary policy works. Røed Larsen (2014) finds econometric evidence suggesting that the monetary policy reversal in Norway in the fall of 2008 reversed the drop in house prices, but he does not show the details of how the central bank did it or the elements in the causality flow. He hypothesizes that household behavior were one of the transmission mechanisms. This article's results support that hypothesis.

Second, policy may address some of the concerns households have of not

being able to get a loan before having sold the old home, the size of realized home equity, and of ending up with two houses (and two mortgages). While policy cannot do much about the second concern, it can affect the former by creating facilities or institutions that extend bridging loans for households with substantial home equity. Such loans can help households that are willing to buy before selling but who are unable to do so because private banks refuse interim funding. The latter may be addressed by creating insurance schemes. Such schemes would make it possible for households to insure against a worst-case scenario: having to make interest payments on two mortgages. One policy possibility is to create a facility that sponsors institutions that actually buy, own, and rent out houses until the housing market turns. Another possibility is to institutionalize insurance schemes so that the insured household pays only parts of the interest payments on the old home's mortgage. A third possibility is that an insurer and household become co-owning partners of the old home, with stipulations on the terms should one party wish to buy out the other. These three possibilities have in common that the household's risk of ending up with two mortgages would be shared with another party and are variants of the home equity conversion schemes studied by Shiller and Weiss (2000), especially schemes like the reversed mortgage, home equity insurance, housing-market partnership and shared-equity mortgage. To speculate, perhaps the most promising scheme would involve transfer of ownership of the old home at a pre-determined time. Co-owning partners would be invited to buy a stake in the house; and

could be banks, public institutions, or private investors. The partnership would be based on a contract that spells out how the proceeds from the future sale would be divided, how equity shares could be functions of time-on-market (TOM), and, more importantly, how the household could defer interest payments on the old mortgage. Ultimately, should the sale not take place within a reasonable time period, i.e. when TOM exceeds an upper limit, ownership would be transferred at a pre-determined share of a local price index with a nominal floor. This would reduce the down-side risk for households, and could potentially reduce the frequency of strategic sequencing, which could help prevent crises from occurring and speed up recoveries when they do.

## References

Albrecht, J., A. Anderson, E. Smith, and S. Vroman (2007): Opportunistic matching in the housing market, *International Economic Review*, **48**: 2, pp. 641 - 664.

Anundsen, A. K. and E. S. Jansen (2013): Self-reinforcing effects between housing prices and credit, *Journal of Housing Economics*, **22**, pp. 192 - 212.

Chow, G. C. (1960): Tests of equality between sets of coefficients in two linear regressions, *Econometrica*, **28**, pp. 591 - 605.

Dickey, D. A. and W. A. Fuller (1979): Distribution of the estimators for au-

toregressive time series with a unit root, *Journal of the American Statistical Association*, **74**, pp. 427 - 431.

Dickey, D. A. and W. A. Fuller (1981): Likelihood ratio statistics for autoregressive time series with a unit root, *Econometrica*, **49**: 4, pp. 1057 - 1072.

Forgey, F. A., R. C. Rutherford, T. M. Springer (1996): Search and liquidity in single-family housing, *Real Estate Economics*, **24**: 3, pp. 273 - 292.

Genesove, D. and C. Mayer (2001): Loss aversion and seller behavior: Evidence from the housing market, *Quarterly Journal of Economics*, **116**: 4, pp. 1233-1260.

Granger, C. W. J. (1986): Development in the study of cointegrated economic variables, *Oxford Bulletin of Economics and Statistics*, **48**: 3, pp. 213 - 228.

Haurin, D., S. McGreal, A. Adair, L. Brown, and J. R. Webb (2013): List price and sales prices of residential properties during booms and busts, *Journal of Housing Economics*, **22**: 1, pp. 1 - 10.

Johansen, S. (1988): Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control*, **12**, pp. 231 - 254.

Maclennan, D. and A. O'Sullivan (2012): Housing markets, signals and search, *Journal of Property Research*, 29: 4, pp. 324 - 340.

Ortalo-Magné, F. and S. Rady (2006): Housing market dynamics: On the contribution of income shocks and credit constraints, *Review of Economic Studies*, **73**, pp. 459 - 485.

Rosenthal, L. (1997): Chain-formation in the owner-occupied housing market, *Economic Journal*, **107**: 441, pp. 475-488.

Røed Larsen, E. (2014): Did the 2008 monetary policy reversal reverse the housing market? unpublished manuscript, Dept. of Econ., BI Norwegian Business School.

Shiller, R. J. and A. N. Weiss (2000): Moral Hazard in Home Equity Conversion, *Real Estate Economics*, **28**: 1, pp. 1 - 31.

Stein, J. C. (1995): Prices and trading volume in the housing market: A model with down-payment effects, *Quarterly Journal of Economics*, **110**: 2, pp. 379 - 406.

Wheaton, W. C. (1990): Vacancy, search, and prices in a housing market matching model, *Journal of Political Economy*, **98**: 6, pp. 1270 - 1292.

White, H. C. (1970): Matching, vacancies, and mobility, *Journal of Political Economy*, **78**: 1, pp. 97 - 105.

## Appendix

**Table A1. Structural break analysis, Chow tests of two time trends versus one. The differential and the house price index, Norway, 2007-2014**

Breakpoint	F-statistics			
	First 15 obs.		First 20 obs.	
	Differential	Index	Differential	Index
6	23.2	4.6	67.7	15.0
7	65.5	25.8	202.4	57.2
8	39.3	22.4	128.3	44.8
9	39.7	12.7	128.8	29.4
10	28.1	11.0	94.4	29.8
11	14.2	10.0	53.0	28.8

Note. 54 observations.

**Table A2. Tests for Granger non-causality, Norway 2003-2014**

Variable (x)	Lags	Causality (p-value)	
Variable (x)	Lags	x→House price index	House price index→x
For-sale stock	2	Yes (0.0000)	Plausibly (0.0320)
Stock-to-volume	1	Yes (0.000)	Probably (0.0102)

Notes: P-values from standard F-tests for Granger non-causality between the house price index and the for-sale stock and the stock-to-volume ratio. Lags refer to lag truncation based on AIC. Small sample corrected critical values have been used for the trace test for cointegration.