Price and Transaction Volume in the Dutch Housing Market

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December 2008
Preliminary version
Do not quote

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1. Introduction. Price-volume correlations

Between the mid 1980s and today real house prices have more or less doubled in the majority of industrialized countries. This has not been a smooth and continuous process. All countries experienced cycles with booms with price increases above trend followed by busts with stagnating or falling prices. Several countries, notably UK and the Scandinavian countries, saw prices falling in nominal terms in the early 1990s, and in the last few years many markets – including the US, UK and Spain – have again experienced sharp price reductions. In this study, we will analyze housing market data from the Netherlands. After a severe crisis in the early 1980s, when Dutch house prices fell by a third in a few years, there has been a continuous price increase with the real price level being almost three times as high today as in 1985. Like in many other countries, Dutch prices stagnated in the early 1990s but shot up sharply in the late 1990s with yearly increases in real terms by five percent or more. More recently, prices are again stagnating.

Price fluctuations alone do not fully characterize the varying states of the housing market. In price booms, the market is typically also more liquid with more transactions taking place and houses selling more quickly, whereas in busts there are fewer sales and many houses remain on the market for a long time. Apparently, prices do not fluctuate sufficiently to clear the housing market at a constant level of liquidity. Variations in demand and supply are partly accommodated by changes in the number of houses offered for sale and the inventory of houses on the market. It is a relatively well established empirical regularity, primarily for US data but also for the UK and Sweden, that price changes and transaction volumes are positively correlated in housing markets.

In fact, a positive correlation between price and quantity seems to be taken for granted by realtors and other market practitioners. While this is confirmed by most studies, the empirical picture is not without some ambiguity. Some authors have been looking at the simple correlation between price changes and number of sales. An early paper by Miller and Sklarz (1986), largely based on condominium data from Hawaii, shows that the hazard of sale in one quarter is positively related to the price change in the next quarter; sales predict prices. Two influential theoretical papers include a look at aggregate US data. Stein (1995) reports a highly significant relation between current sales volume and last year's rate of price change, i.e. a temporal lag in the opposite direction to that found by Miller and Sklarz. Berkovec and Goodman (1996) regress the change in median sales price on the *change* in turnover, again with a significantly positive coefficient.

Other papers analyze dynamic econometric models with more structure. Follain and Velz (1995), again on US data, find price and sales volume to be *negatively* correlated when put in the context of a structural model of housing market adjustment. Two papers study European housing markets. Hort (2000) finds no consistent relation between price changes and turnover changes using panel data for local housing markets in Sweden. Fixed effects regression on sales against the house price level yields negative coefficients at all frequencies. Hort goes on to investigate how shocks to fundamentals (represented by the after-tax mortgage rate) are transmitted into house prices and sales. Her main result is that a positive interest shock has an immediate negative impact on sales but affect prices negatively only with a lag. More recently, Andrew and Meen (2003) study aggregate UK data and also focus on the adjustment to fundamentals, using an error-correction framework. In the first stage, they estimate a long-run levels relation between price and fundamentals represented by income, supply, the number of households and construction costs. In the second stage a two-equation conditional VAR-model is estimated where price change and the number of sales (as a fraction of the stock) are driven by deviations from equilibrium (the residuals from the first-stage equation). The results indicate that a shock to fundamentals impacts on sales and prices in the same direction. The sales effect peaks after about a year and sales are back at their original equilibrium level after a couple of years. Prices, on the other hand, continue to fall for more than two years before turning and oscillating back towards the new lower equilibrium level.

Even though they do not include very dramatic market events, the Dutch data used in the current study clearly illustrate the swings between hot and cold periods. Figures 1a and b depict the rate of change of inflation adjusted house prices (average during past 12 months) along with two measures of market liquidity: the average number of dwellings sold during the past 12 months (Figure 2a) and the hazard of sale calculated as the ratio of sales in the current month to the number of dwellings on the market (Figure 2b). The graphs remind us that our data cover the period when prices were more or less continuously increasing. They start only after the dramatic drop in house prices in the early 1980s, i.e. at a time when the price level most likely was below long-run equilibrium. Some of the subsequent price rise may hence be seen as a catch-up effect. In fact, there is only a short period in 1990-91 with falling prices. This is followed by a more or less continuous boom in the 1990s with the rate of price growth gradually increasing to around 7 percent in 1998. The price fluctuations accompanied by distinct variations in market activity and liquidity. The monthly hazard of sale increased from below 20 percent around 1990 to above 40 percent when prices peaked a decade later. From 1998 the market gradually calmed down with prices staying constant in real terms from 2002 onwards and the hazard of sale falling back down to 20 percent. Overall price changes exhibit a strong positive correlation with the hazard of sale and a less strong positive correlation with the number of sales. A linear regression of price change on hazard of sale yields a slope coefficient of .013 (standard error = .0026). A one percentage point higher hazard of sale is accompanied by prices increasing 0.13 percent faster per month.

Several different theories have been advanced to explain the positive correlation between price and volume. But since most empirical studies have been confined to looking at the number of sales and transactions prices, they have been limited in their ability to discriminate between different interpretations of the underlying mechanisms. Genesove and Mayer (2001) that test and find support for a behavioral explanation is an exception. The Dutch data used in the current study include information about both list prices and transaction prices as well as the number of new houses offered for sale and the number of completed sales. This will allow us to provide more detail about the dynamics of the housing market adjustment process than in earlier studies. Like Hort (2000) and Andrew and Meen (2003) we focus on the transmission of news about fundamentals to house prices and transaction volumes. But unlike these and other earlier studies we are able to say whether variations in the number of houses sold is due to variations in the number of houses entered onto the market (the hazard of entry) or on the conditional probability of sale. We can also test whether new information first gets incorporated into list prices or sales prices.

2. *Theories*

There is no shortage of explanations for the correlation between price and volume in housing markets. Broadly speaking one can identify three groups of theories. One approach, represented by Stein (1995) and Ortalo-Magné and Rady (2006), focuses on the interaction between downpayment constraints and prices. Other papers, like Berkovec and Goodman

(1996), Krainer (2001) and Novy-Marx (2007), model the housing market as a search market. Fundamental disturbances affect price setting and time-on-the-market, thereby generating a correlation between sales and prices. A third group of papers, including Genesove and Mayer (2001) and Engelhardt (2003), takes a behavioral approach and hypothesizes that homeowners are loss averse and hence reluctant to lower asking price below the original purchase price. This can explain why the number of sales decreases in weak markets.

The link between credit constraints and the price-quantity correlation was first highlighted by Stein (1995). In his model the housing consumption of some households is restricted by downpayment requirements. A positive shock to fundamentals increases housing prices thereby improving the equity position of incumbent homeowners and allowing them to trade up to a larger house. This gives rise to a simultaneous increase of price and transaction volume. Conversely, a negative shock would depress prices and lock-in households and lead to a downward price spiral with even more households locked-in due to shortage of equity. More recently, Ortalo-Magné and Rady (2006) have integrated downpayment constraints within a fully developed OLG-model, where households move from starter homes to trade-up homes depending on income shocks and funding possibilities in the capital market. This model highlights the role of demographic factors like the relative size of different generations. It also has implications for variations in the relative prices of small and large houses. A key empirical implication of these models is the feedback effect between price and quantity that arises as price changes strengthen or weaken credit constraints.

Another set of explanations focus on the nature of search and matching in the housing market. In the model of Berkovec and Goodman (1996) sellers are confronted with randomly arriving potential buyers. Neither party has a complete overview of the market. Sellers set asking prices reflecting time-on-the-market and their expectations of buyer reservation prices.[1] A transaction occurs at the asking price if the buyer’s reservation price exceeds the seller’s asking price. Outside the stationary equilibrium sellers and buyers are assumed not to havefull information about market-wide shocks and to adjust their perceptions of the market price level gradually towards the new equilibrium price. As a result, a demand increase (a higher arrival rate of potential buyers) leads to an immediate increase in transactions followed by a gradual

[1] A large literature deals with optimal pricing strategies; see e.g. Haurin (1988), Horowitz (1992), Knight, Sirmans and Turnbull (1994), Yavas and Yang (1995), Glower, Haurin and Hendershott (1998), Knight (2002), and Anglin, Rutherford and Springer (2003)

increase in reservation and transaction prices. Turnover remains above normal during the transition process to the new higher equilibrium price. The model gives rise to a positive correlation between price change and turnover during the transition to equilibrium. In a stationary equilibrium, transaction prices adjust such that the number of houses on the market is constant, i.e. the arrival of new sellers exactly matches the number of houses sold. The positive correlation between price and volume derives from the assumption that price expectations do not fully reflect current market conditions but adjust mechanically to the difference between last period's price and the price that would be required in order to equate the rate of entry and exit from the market.

Another aspect that may account for the price-volume correlation is liquidity variations. Many sales and more houses on the market should be associated with higher liquidity in the sense of a shorter time to sale and less price uncertainty. This connection has recently been modelled by Krainer (2001) and Novy-Marx (2007) in the context of search models of the housing market. Krainer explicitly models the fact that individuals are typically on both sides of the market. The decision to sell and buy is driven by a stochastic process indicating if the household is well matched or not with the particular housing unit it occupies. The value a household derives from a dwelling depends on two factors: an idiosyncratic component and a market fundamentals component that is common to all households. Buyers and sellers follow optimal pricing and search strategies. The higher are market prices, as driven by fundamentals, the higher is the opportunity cost of not being matched and the more eager are buyers and sellers to set reservation prices so as to ensure quick transactions. This leads to the conclusion that sales, liquidity and prices are positively correlated. This conclusion depends crucially on the, realistic, assumption of the absence of a well functioning rental market. If households could move between owning and renting at no cost, then the opportunity cost of not having found a house to buy and live in would vanish and there would be no correlation between price and liquidity. The matching model of Novy-Marx emphasizes that a demand increase, represented by an inflow of buyers, will increase the match rate between buyers and sellers. This will also have a feedback effect on the ratio of buyers to sellers that further reinforces the initial price impact.

Another explanation for the price-volume correlation derives from behavioral considerations. A couple of studies have found evidence that homeowners have an aversion to making losses. Genesove and Mayer (2001) and Engelhardt (2003) represent seller behavior by prospect theory implying that the marginal disutility of losses exceeds the marginal utility of gains. If this is so, sellers should be reluctant to setting an asking price below their original purchase price. Both papers find empirical support for this hypothesis. Genesove and Mayer analyze detailed data on condominium sales in Boston and find that owners with nominal losses set higher list prices and accept longer selling times than other sellers. Engelhardt, using nationwide US data, finds that loss aversion has a significant impact on intra-metropolitan mobility. On the other hand, Englehardt does not find evidence of a connection between equity and homeowner mobility, in contrast with theories emphasizing credit constraints.

3. Data on prices and quantities in the Dutch housing market

Our analysis is based on a data base maintained by the Dutch Brokers Association (NVM). NVM organizes the majority of real estate brokers in the Netherlands. Today the organization has more than 4000 members. Together, NVM brokers handle more than half of all transactions of owner-occupied homes. The market coverage has been growing over the years, from 25-30 percent in the 1980s to 55-60 percent today. In Amsterdam the NVM market share is now 75 percent.

Member brokers are required to report to NVM all houses offered for sale. Information given includes the initial asking price and the date the house was put on the market as well as the date and price of sale.[2] It is also recorded when houses are withdrawn from the market without being sold. The records include the exact address, an exhaustive list of physical characteristics and subjective assessments of the standard of the dwelling.

The original data base contains 3,074,368 observations on dwellings – both one-family houses and owner-occupied apartments – being offered for sale during the period January 1985 – December 2007. After deletion of data with missing observations and some outliers, our analysis makes use of 1,950,666 observations for the list price regressions and 1,585,897 observations for the sales price regressions. Based on these data we compute two series of monthly price indexes: one for the initial list price and one for the sales price. The indexes are based on log-linear hedonic regressions performed year-by-year using monthly time dummies.

[2] There is also some information about intermediate asking prices. This information appears to be incomplete, however, and it is not used in this paper.

We link the within-year index series using the mean characteristics of all transacted dwellings to form Laspeyres price indexes. The resulting index series for sales and list price are depicted in Figure 2. See Appendix 1 for details on the index estimation.

In the Dutch market, the list price represents a commitment from the seller to sell at the posted price. Apparently this is not strictly binding and the data set has some observations where the sales price exceeds the asking price. The great majority of dwellings, however, are sold at (9.6 percent) or below (86.1 percent) the list price. Only 4.3 percent of all sales prices exceed the list price. Prices in excess of the list price are somewhat more common in recent years. The two price indexes follow each other rather closely. Figure 3 depicts the development of the discount of sales price relative to list price. It is calculated by dividing the sales price index, for houses that were sold in month t by the sales price index for houses entered on the market in month t-2, the time lag representing the mean lag from entry to sale. We see that this discount has fluctuated between 2.4 and 5.7 percent. The relation between list price and transaction price can be seen as an issue of the incorporation of new information into prices. When underlying determinants of house prices like income, unemployment and interest rates change, does that affect transaction and list prices simultaneously or does either or both react only with a lag? Does either price provide information that predicts on the other price?

Our data allow us to measure the flows in and out of the housing market. The change in the inventory of houses for sale can be calculated as the net of the gross flows of entries, sales and withdrawals from the market:

> Percentage change in number of dwellings on the market = hazard of entry – hazard of sales – hazard of withdrawal.

In calculating these numbers we have to account for the fact that the NVM market share has increased during the period studied. Thus, new houses entered into the data base partly reflect new brokers entering the NVM reporting system. We have corrected for this based on information on the total number of sales obtained from the Dutch Land Registry (the Kadaster). The details of this correction are described in Appendix 2. It is presumed that sales through NVM brokers are representative for all sales, i.e. that there are no systematic differences between NVM brokers and other brokers. The resulting data, expressed in percent of the number of houses on the market and as overlapping 12-month numbers, are depicted in

Figure 4. The first thing to note is the size of the various flows relative to the inventory of houses on the market. In any month the new houses for sale entered onto market correspond to between 10 and 40 percent of all houses on the market, but at the same time almost as many houses are sold and between 3 and 5 percent are withdrawn from the market. As a result the net change in the number of houses on the market is hardly more than 1-2 percent up or down. Over time, however, even small imbalances between the flows can have a significant impact on the inventory of houses on the market. In fact, from 1985 to 1996 the inventory decreased by as much as two thirds from 180,000 to 60,000. Starting around 1993 the gross flows increase sharply. The rates of entry and sale double from 20 to 40 percent. During this period the difference between the rate of entry and the rate of sale again gets larger and the number of houses more than doubles to reach 150,000 in 2005. At the end of the sample period in 2007 the inventory is again down below 100,000.

The most striking aspect of figure 4 is that the two hazard rates follow each other quite closely. When houses are easy to sell (the hazard of sale is high) then more houses are entered onto the market (the hazard of entry is high). Further, we see that the hazard rates show strong variation over time. In the late 1980s and early 1990s and again after 2001 only about 20 percent of all houses on the market sold in any month, whereas in the hot market of the late 1990s half of all houses sold within a month. Many houses literally sold immediately when they were entered onto the market. The diagram also confirms the positive correlation of the hazard of sale with price changes. This picture is particularly clear for recent years with the peak in price change in 2000 coinciding closely with a peak in the hazard rates of sales and entry.

A key issue of our analysis is the transmission process from underlying shocks to house price fundamentals onto prices and sales. We are interested in capturing high-frequency price and quantity movements, which limits the availability of macroeconomic data. In the current paper, we use monthly observations on two variables to capture shocks to fundamentals: the rate of unemployment and the mortgage interest rate. The mortgage interest rate is defined as…. The unemployment rate is the three-month moving average of the open rate of unemployment as reported by … The development of the interest rate and the unemployment rate are depicted in Figures 5 and 6.

We believe that interest and unemployment are among the most important determinants of house prices[3], but note the absence of other important variables like income, demographics and supply. The long-run influence of these variables is captured by including a time trend in the econometric model.

4. *Econometric model*

House prices and sales are affected both by long-run factors that determine the underlying equilibrium trend and by short-run deviations from this trend. We capture the interplay between these forces in a vector error-correction (VEC) framework, where the dynamics are given by the combination of movements towards equilibrium and new shocks. The model includes seven variables: two prices – the list price and the sales price (Figure 2); three quantity variables – the hazard of entry, the hazard of sales, and the hazard of withdrawal (Figure 4); two fundamentals – unemployment (Figure 5) and the mortgage interest rate (Figure 6). We think of the fundamentals as the basic driving forces and the price and quantity variables as indicators of the state of the market. Our main focus is on the transmission from fundamental shocks to the market indicators.

The hazards of sale and entry play dual roles. They are indicators of endogenous responses to shocks to interest and unemployment, but they also represent exogenous shocks to mobility. An increase in emigration would put more houses on the market, i.e. be reflected in a shock to the hazard of entry. An increase in immigration would, all else equal, mean that houses sold more easily, i.e. show up as a shock to the hazard of sale. A pure mobility shock – e.g. due to lower transaction costs – would mean a more or less simultaneous shock to both sides of the market and affect both hazard rates. If households typically would buy a new house before selling their old house, as is often assumed in search models of the housing market following Wheaton (1990), then an intra-market mobility shock would affect the hazard of sale immediately and the hazard of entry with a lag of a couple of months

For our econometric work we hypothesize that the variables are linked in the long-run through three equilibrium relations. Given that all data series are non-stationary (more precisely integrated of order one) this translates into hypotheses regarding three cointegrating relations.

[3] In fact, the results presented in section 5 indicate that variations in unemployment have little impact on price and quantity dynamics. As an alternative we tried using a broader business cycle indicator, but with similar results.

- The sales price is determined by the fundamentals. There is a cointegrating vector with sales price, unemployment, interest and the rate of entry.
- The ratio of list price to sales price is determined by the fundamentals: There is a cointegrating vector between sales price, list price, interest and unemployment with the two price coefficients restricted to plus and minus one.
- The inventory of houses on the market is stationary. There is a cointegrating vector between the hazard rates of entry, sale and withdrawal with the coefficients restricted to plus and minus one.

We estimate a VEC model using data from 1985:1 to 2007:9, i.e, excluding the last three months in our data set. The reason is that brokers only report to NVM once a spell from entry to sale or withdrawal is completed. This imlies that observations for the last few months of the data base will be biased in favor of including short spells. To account for this we exclude observations from the last three months of 2007.[4]

The first step of the econometric analysis is to ensure that all variables are I(1). The results of stationarity tests are reported in Table 1. Next we test for the number of cointegrating vectors using the Johansen procedure. As is clear from Table 2 we can reject the null hypothesis of two cointegrating vectors against the alternative of three or more, but we cannot reject the null of three against the alternative of four or more cointegrating vectors. Hence, we proceed to estimate a model with three cointegrating vectors.

5. Results

We estimate our VEC model using the maximum-likelihood approach proposed by Johansen.[5] Imposing the coefficient restrictions according to the discussion in the previous section we get the following estimates of the cointegrating vectors (*t*-statistics in parenthesis).

$$p = -\underset{(4.05)}{0.049}u - \underset{(8.97)}{0.146}i + \underset{(21.56)}{2.124}he - \underset{(3.13)}{0.00159}t \qquad (1)$$

$$p = lp + \underset{(2.21)}{0.00074}u + \underset{(3.99)}{0.00205}i + \underset{(6.29)}{0.000097}t \qquad (2)$$

$$he = hs + hw \qquad (3)$$

[4] It turns out that this exclusion has some impact on the estimates. In particular, the restrictions we put on the cointegrating vectors (see below) would be rejected if we used the full data set up to 2007:12.

[5] The estimation is performed using CATS for RATS version x.x.

where the following notation is used

p = log of sales price index

lp = log of list price index

u = unemployment rate

i = mortgage interest rate

he = hazard of entry

hs = hazard of sales

hw = hazard of withdrawal

t = time in quarters

A chi-square test indicates that this restricted model is marginally accepted against the null of an unrestricted model (p-value = 0.087). Note that the prices are in logs are in logs whereas the other variables are in percentage units. Having all variables in logs would violate the normality assumption on the residuals.

The first equation is the reduced form price equation. A permanent one percentage point increase in the unemployment rate leads to a 5 percent reduction in price; an increase of the interest rate by one percent leads to a fall in price by 15 percent; an increase in the hazard of entry by one percentage points leads to an increase in price by 2 percent. The second equation explains the ratio of list price to sales price. It says that the discount of list price to sales price tends to increase with the interest rate (the price of time) and the unemployment rate (perhaps an indicator of risk aversion). Note also that the time trend is significant in both equations, indicating the impact of other variables not present in the model.

The residuals from the cointegrating relations are displayed in Figure 7a-c. They mirror the development of house prices rather closely. Periods when prices were rising fast, particularly 1995-2000, are associated with the price level being below its fundamental value (negative residual of the first cointegrating relation) and the list price being low relative to sales price (negative residual of the second cointegrating relation). Conversely the sales prices were high relative to fundamentals and low relative to list price when prices were stagnating in the early 1990s and after 2000. The residuals from the hazard rate identity (the third cointegrating relation) are mostly positive (corresponding to an increasing stock of houses on the market) during the second half of the 1990s, when prices were rising, and negative (a decreasing stock of houses on the market) in periods of stagnating prices like after 2000.

Our key interest is the dynamics of prices and quantities. These are illustrated by means of impulse response functions, showing the impact of one-standard-deviation shocks. The shocks are orthogonalized by means of a Choleski decomposition, i.e. assuming that the simultaneous interaction between the variables has a recursive structure. The full sets of impulse response functions (with 95 percent confidence intervals) are presented in appendix for four different orderings of the variables:

1. *u, i, he, hs, hw, lp, p*
2. *u, i, he, hs, hw, p. lp*
3. *u, i, hs, he, hw, lp, p*
4. *u, i, lp, p, he, hs, hw.*

In all cases the macroeconomic variables *u* and *i* go first, as our main focus is on understanding how shocks to these are transmitted into prices and quantities. In cases 1 – 3 they are followed by the hazard rates, with the prices coming last. Cases 2 and 3 differ from case 1 by reversing the ordering between the list price and the sales price (case 2) and between the hazard of entry and the hazard of sale (case 3). In case 4, finally, the ordering between the block of prices and the block of hazard rates is reversed. By and large the results are insensitive to the ordering of shocks. Only in case 3 are the results different in a significant way.

Let us now look more closely at the impulse-response graphs. A one-standard-deviation *interest shock* (permanently increasing the mortgage rate by 20 basis points with the full impact being realized after 5 months) has an immediate but temporary negative impact on the hazards of sale and entry and a gradual but lasting impact on prices. When the full price effect has been reached the impact on the hazard rates vanishes. This confirms the patterns found by Hort (2000) and Andrew and Meen (2003). The negative impact on the hazards of entry and sale are of about the same magnitude, and both hazard rates remain around half a percentage point below equilibrium for around a year for around a year. The parallel response of both hazard rates may be natural since most buyers are also sellers at about the same time. During the period of lower market activity prices gradually adjust towards the new equilibrium. Both the list price and the sales price follow essentially identical paths and continue decreasing for at least two years until reaching a new equilibrium level about a half a percent below the starting position. There is no indication of the list price reacting before the sales price or vice versa.

A *shock to the unemployment rate* has very little effect on anything. This may seem surprising given that the unemployment rate is significantly linked to price through the first cointegrating relation. But so is the mortgage rate and it turns out that the unemployment shock gives rise to a small decrease in the mortgage rate.

Shocks to the hazard rates of entry and sale reflect underlying changes in population and mobility. An isolated shock to either can be seen as a supply shock – positive for a hazard of entry shock and negative for a hazard of sale shock. Shocks to the hazard of entry are quite short-lived. They have a small positive impact on the hazard of sale in the quarter that they occur and no impact at all on prices. Shocks to the hazard of sale, on the other hand, tend to be long-lived and have an offsetting effect on the hazard of entry with a lag of a couple of months. The natural interpretation is that they represent a mobility shock where the purchase tends to precede the sale, i.e. households temporarily own two houses. Shocks to the hazard of sale also have a permanent effect on prices. One interpretation of this pattern is that it is driven by income expectations that show up in mobility before they affect prices.[6]

Price shocks, finally, may be interpreted as demand shocks other than those related to interest and unemployment. Shocks to sales prices have little or no impact on anything, including sales price itself after a couple of months. Shocks to list prices, on the other hand, do have a lasting effect and spread almost immediately onto sales prices. One interpretation is that information about permanent changes in market conditions first get incorporated into list prices and then affect sales prices only with a lag of a couple of months corresponding to the average time on the market. This pattern contrasts with the reaction to an interest shock, which affects both prices equally. Possibly price shocks reflect local information that is not dispersed as quickly to the entire market. Finally, we note that price shocks have little or no

[6] The above characterization of the impact of shocks to the hazards of entry and sale holds for three of the four orderings (1, 2, and 4). Ordering the hazard of sale before the hazard of entry (case 3) leads to a different pattern with regard to the impact of a shock to the hazard of entry. All other impulse responses are essentially the same. With this ordering the hazard of entry overshoots after half a year, i.e. a temporary increase is followed by a lasting decrease. There is also a negative impact on the hazard of sale and on both prices. We don’t have a good interpretation for this pattern.

impact on the hazards of sale and entry. Hence, whatever the interpretation, they do not seem to account for the correlation between price and sales.

6. Conclusions

What do these impulse responses tell about the price-quantity correlation? Our model identifies six different shocks. Out of these, three shocks have a significant price impact. In one of these cases – that of a list price shock – there is no quantity response. In the other two cases – the interest shock and the hazard-of-sales shock – quantity leads price. A strong and immediate impact on the hazards of sale and entry is followed by a gradual price response, in both cases in the same direction giving rise to a positive correlation between price and sales. This response pattern is very much in line with the earlier empirical findings of Hort (2000), who also looks at interest rate shocks, and Andrew and Meen (2003), who look at a more general representation of price fundamentals. Neither of these papers distinguishes between sales and list prices and both look at total sales rather than the hazards of sale and entry.

Is the observed pattern consistent with the various theories put forward to explain the price-volume correlation? If the correlation is driven by credit constraints, then we would expect prices to lead quantities. According to these theories, price changes will affect the equity position of households. This will in turn weaken or strengthen credit constraints which will affect mobility and feed back into prices. This interaction between price and quantity would show up in impulse-response functions with gradually increasing responses in both prices and quantities, contrary to what we see. We conclude that this has not been a dominant mechanism in the Netherlands during the period studied.

Search models with lagging expectations, on the other hand, are more in line with our results. If neither seller nor buyer has a good overview of changes in market conditions, or doesn't have rational expectations with regard to the impact of, e.g., interest changes on equilibrium prices, then seller's and buyer's reservation prices would be slow to adjust and the hazard of sale and entry would increase. This is the pattern we see.

Table 1: Augmented Dickey-Fuller Stationarity Test

	Unemployment	*Interest*	*Hazentry*	*Hazsale*	*Hazwith*	*Loglistp*	*Logsalesp*
Test statistic	-1.77	-1.83	-1.72	-1.76	-0.46	-0.62	-0.51
5% critical value	-3.41	-3.41	-2.86	-2.86	-2.86	-3.41	-3.41
Lagged diff	2	2	2	2	2	2	2
Intercept	yes	yes	yes	yes	yes	yes	yes
Time trend	yes	yes	no	no	no	yes	yes
Seasonal dummies	yes	no	yes	yes	yes	yes	yes
Observations	273	273	273	273	273	273	273

Table 2: Johansen Trace Test

Rank	*LR*	*p-val*
0	294.71	0.000
1	186.55	0.000
2	87.06	0.064
3	45.89	0.608
4	21.83	0.912
5	11.13	0.863
6	4.32	0.698

273 observations. 3 lags (levels), intercept, trend and seasonal dummies included

Figure 1a: Percentage price change and number of dwellings sold, 12 month averages

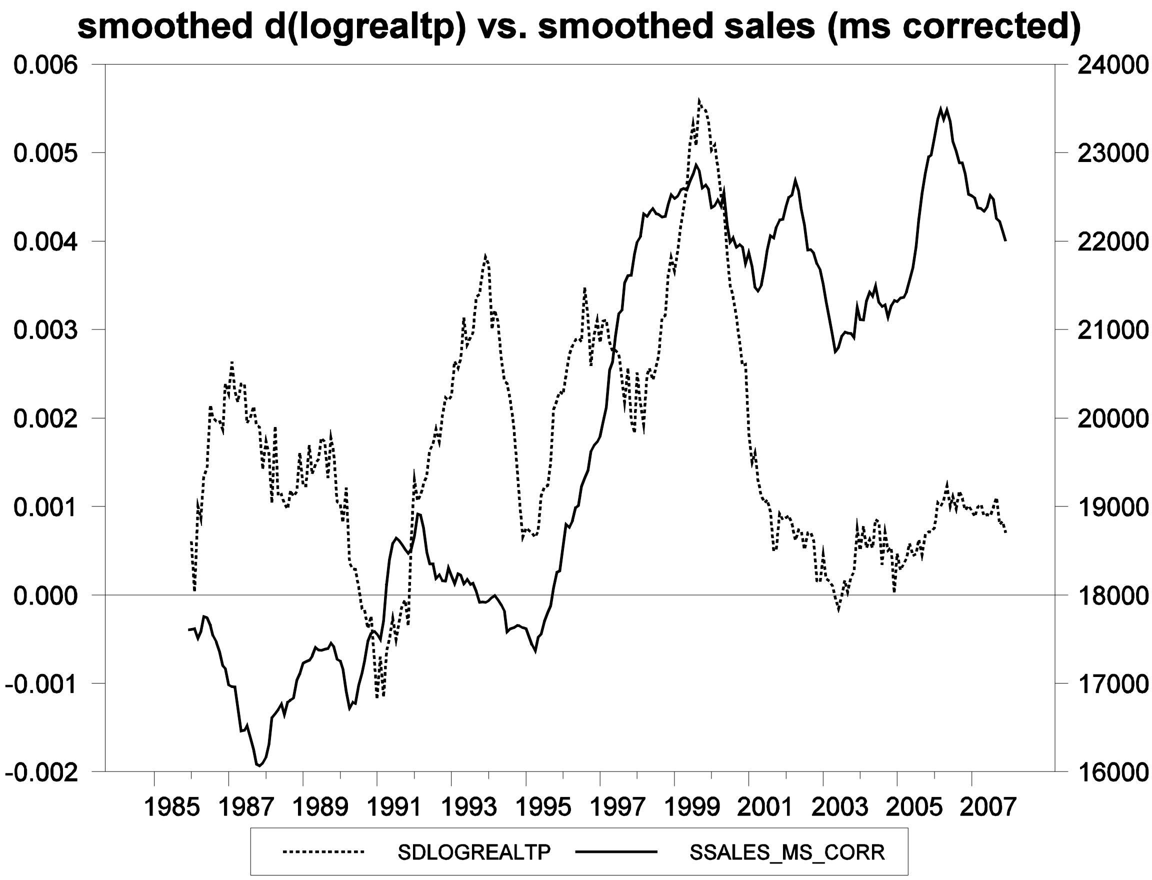


Figure 1b: Percentage price change (12 month moving average) and hazard of sale

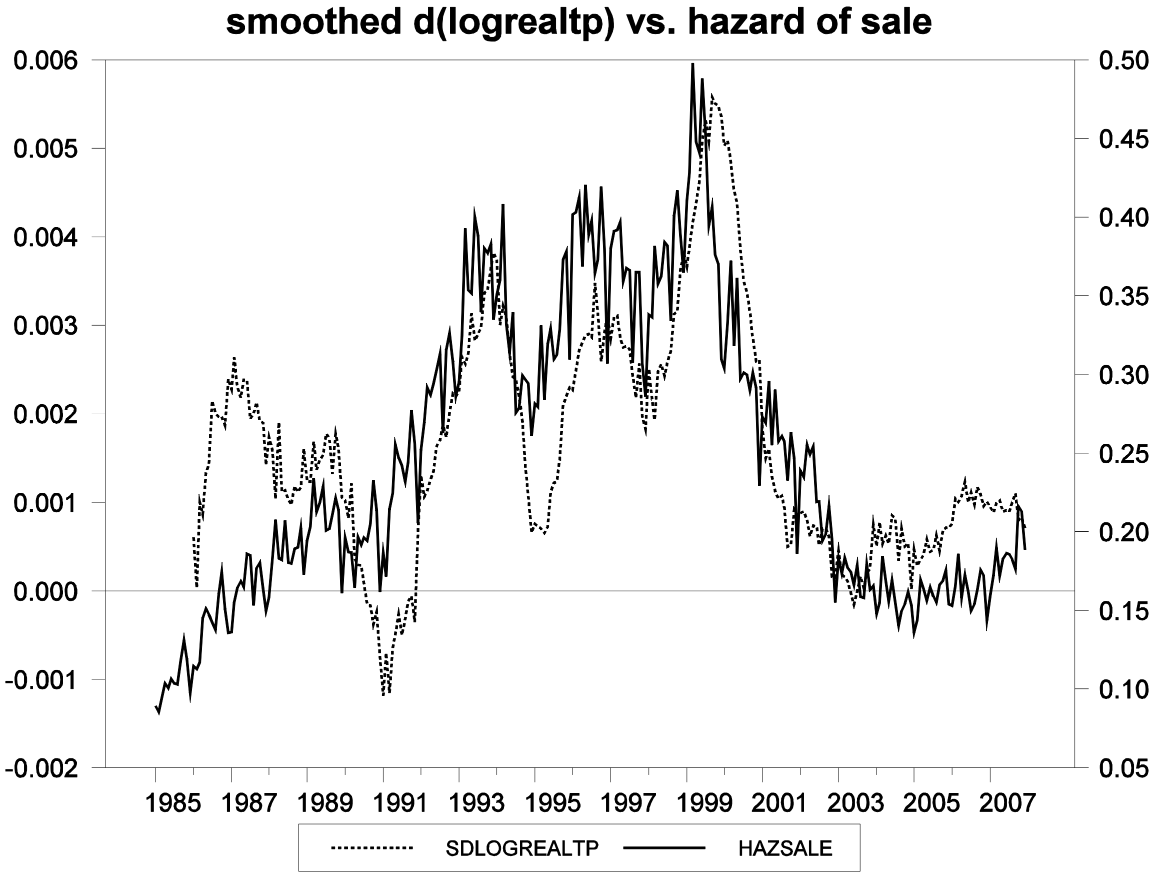


Figure 2: Indexes for sales price and list price (CPI deflated)

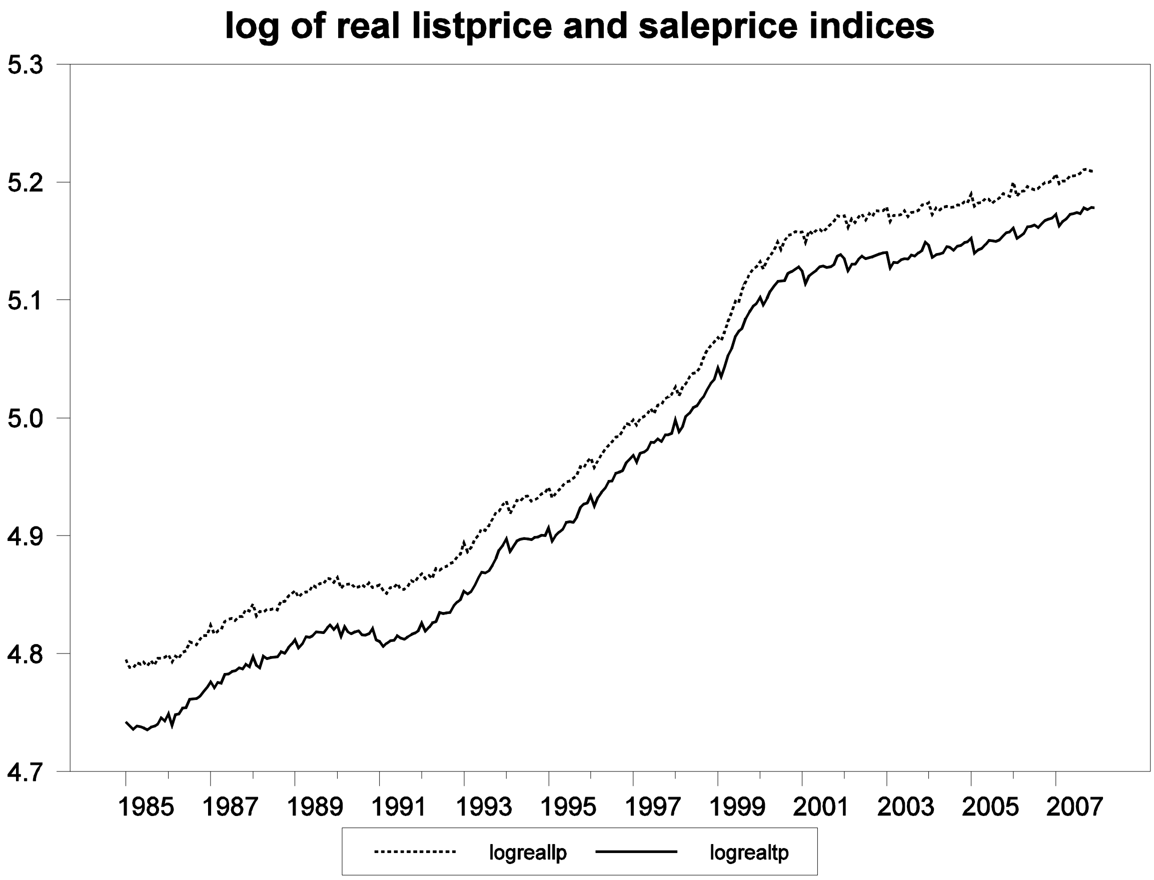


Figure 3. Mean discount of sales price relative to list price (log difference)

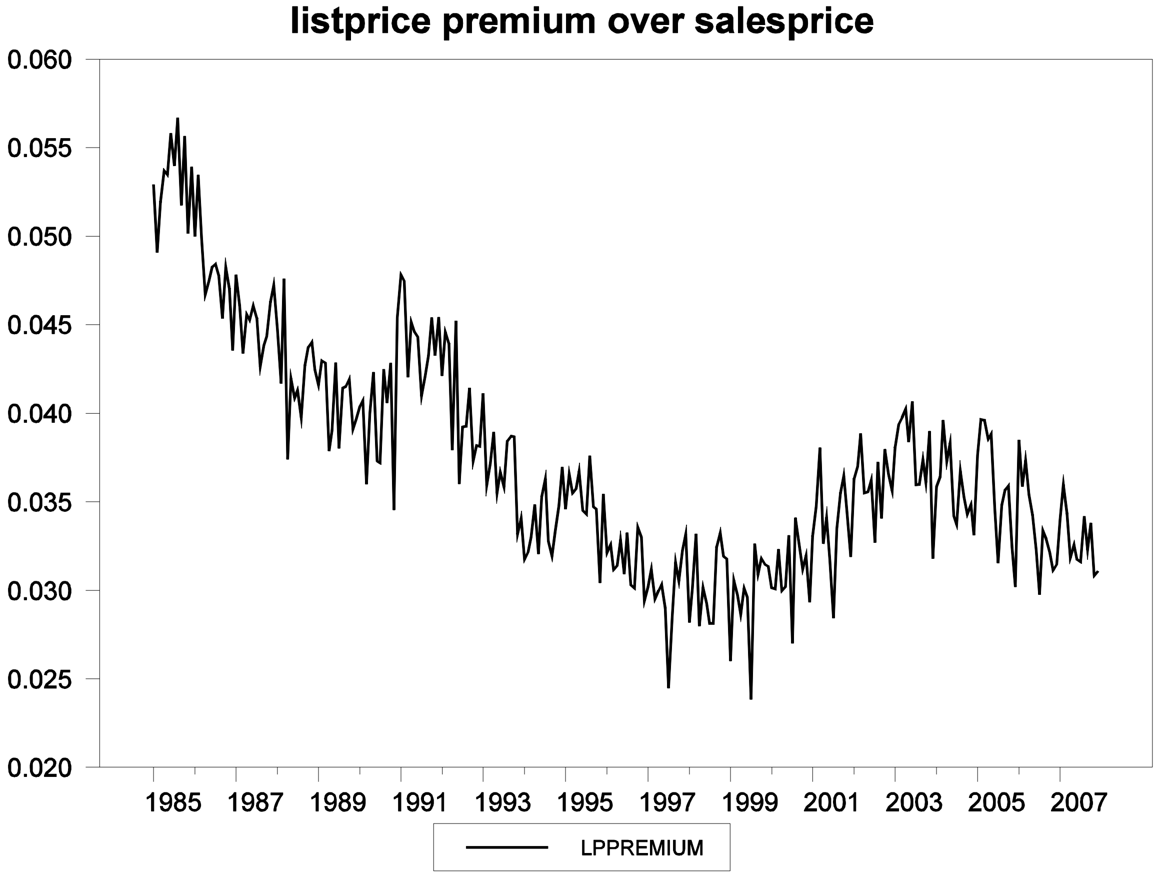


Figure 4: Hazards of entry, sale and withdrawal (12 month moving averages)

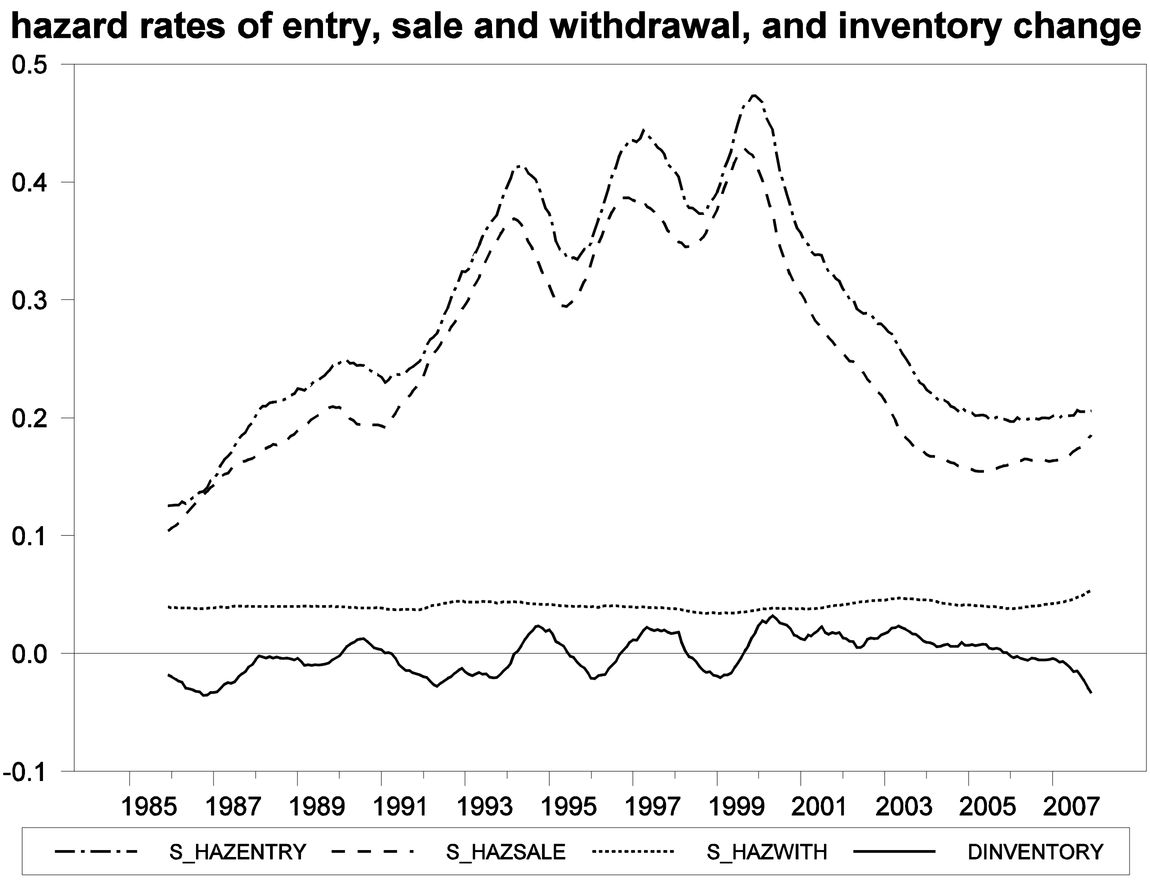


Figure 5: Unemployment rate

Figure 6: Mortgage interest rate

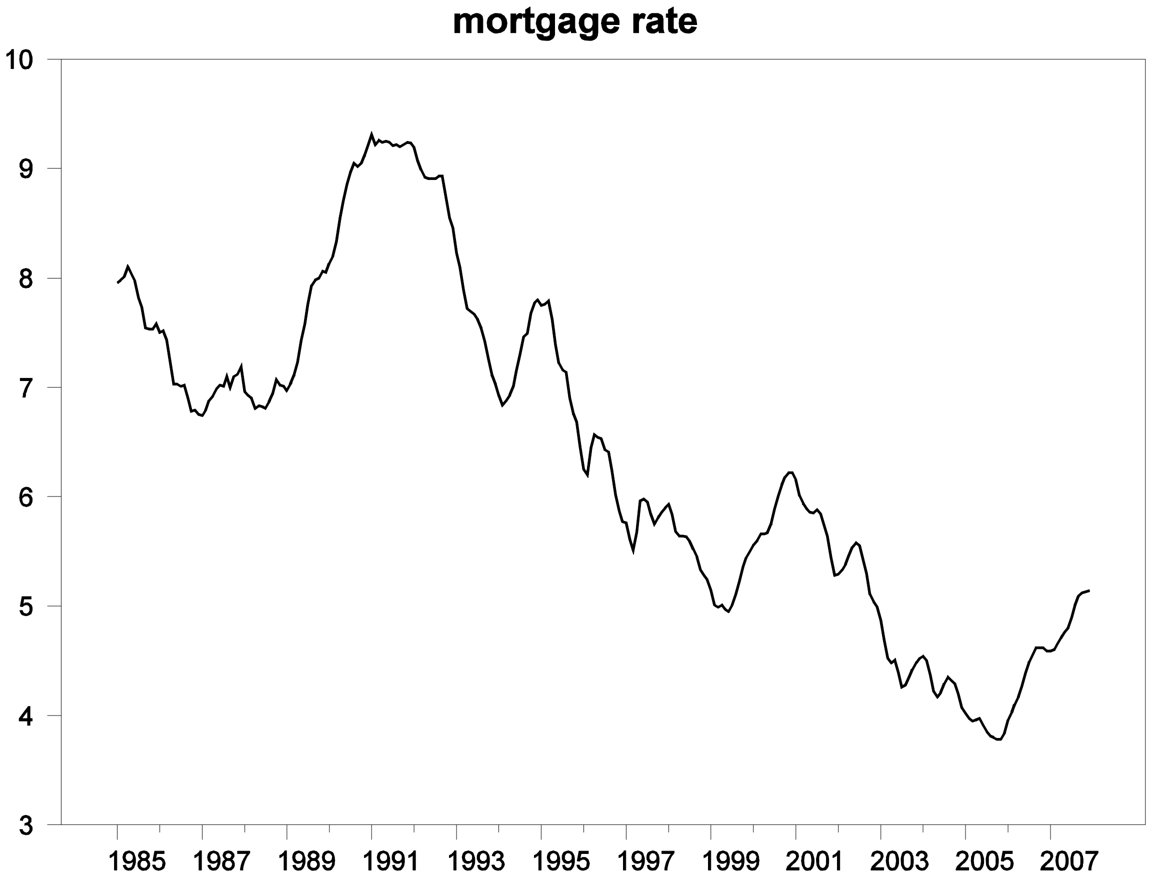


Figure 7 a: The residual from cointegrating relation 1

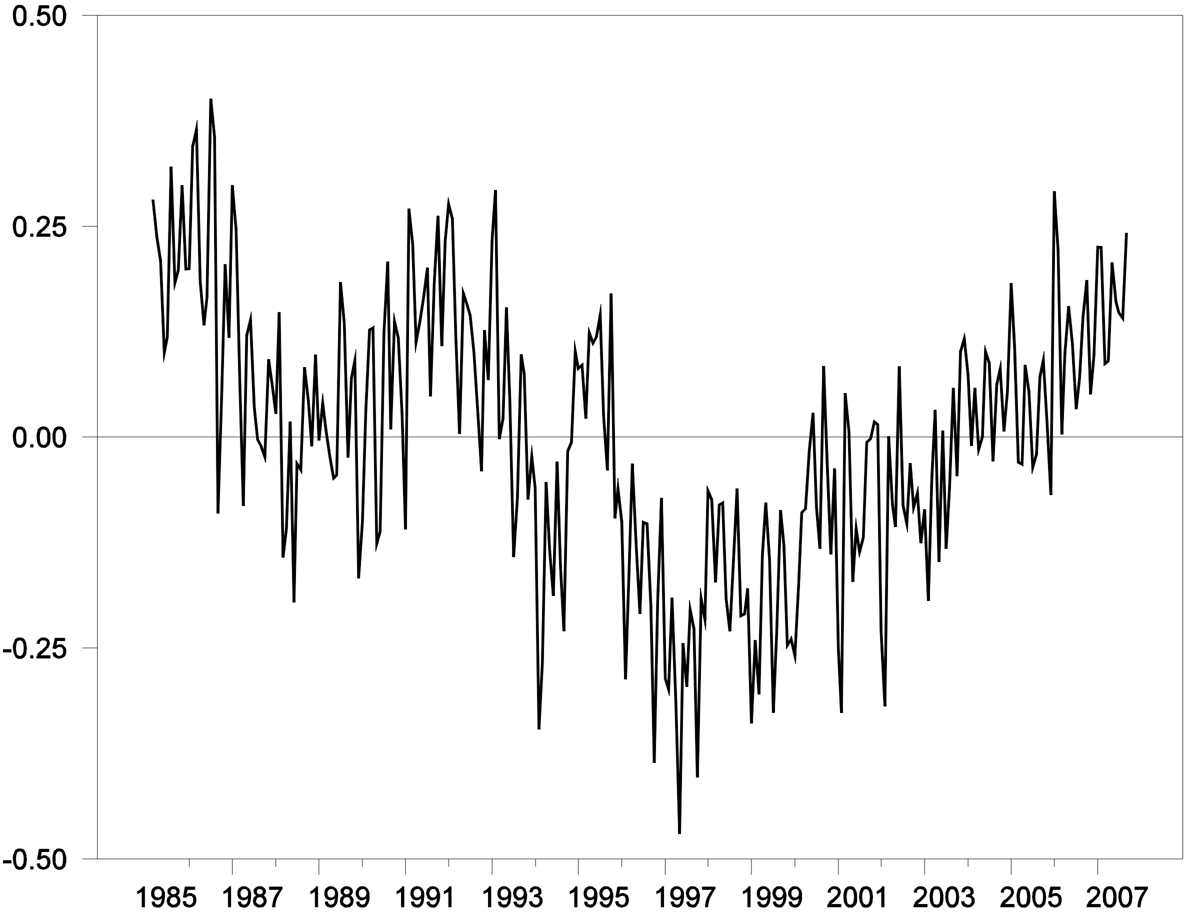


Figure 7b The residual from cointegrating relation 2

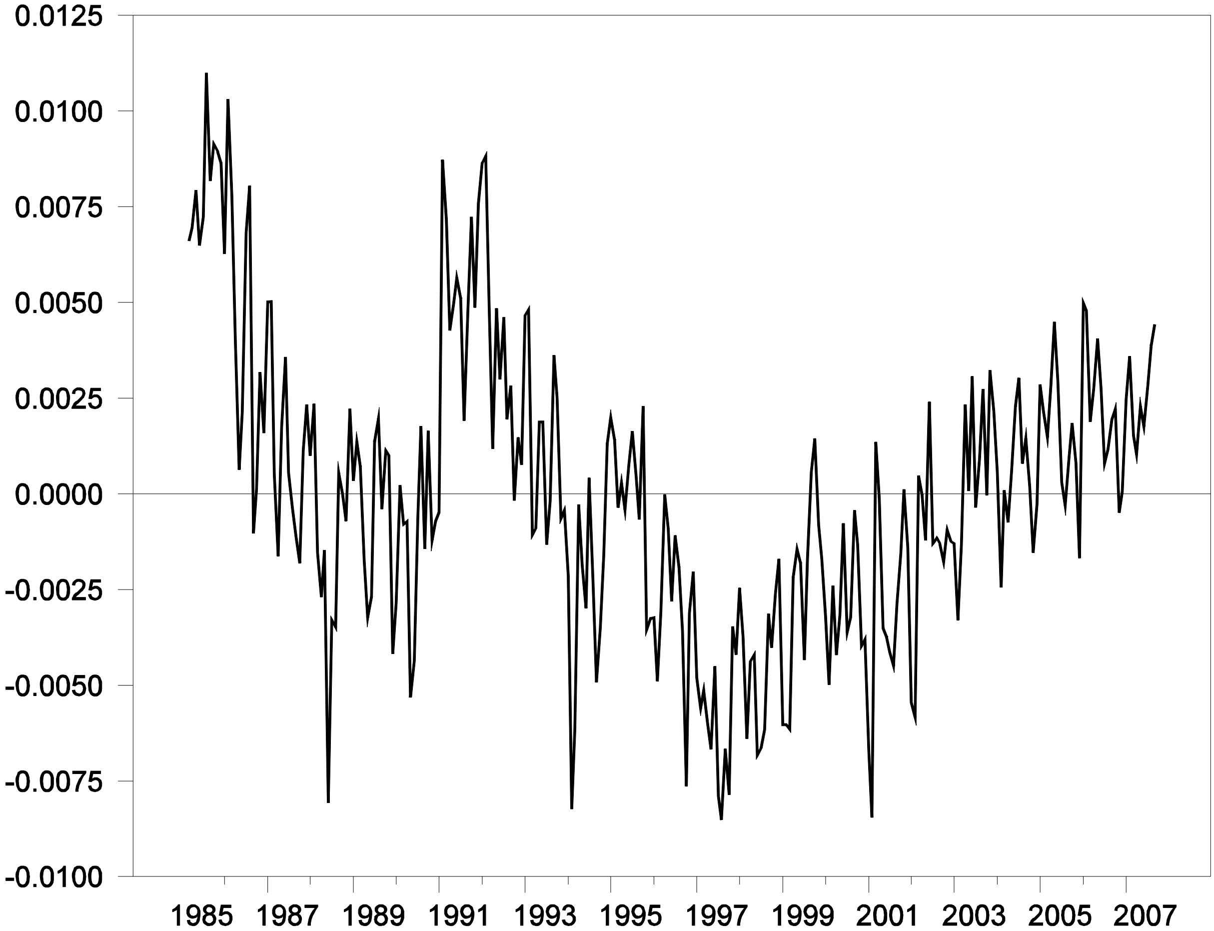
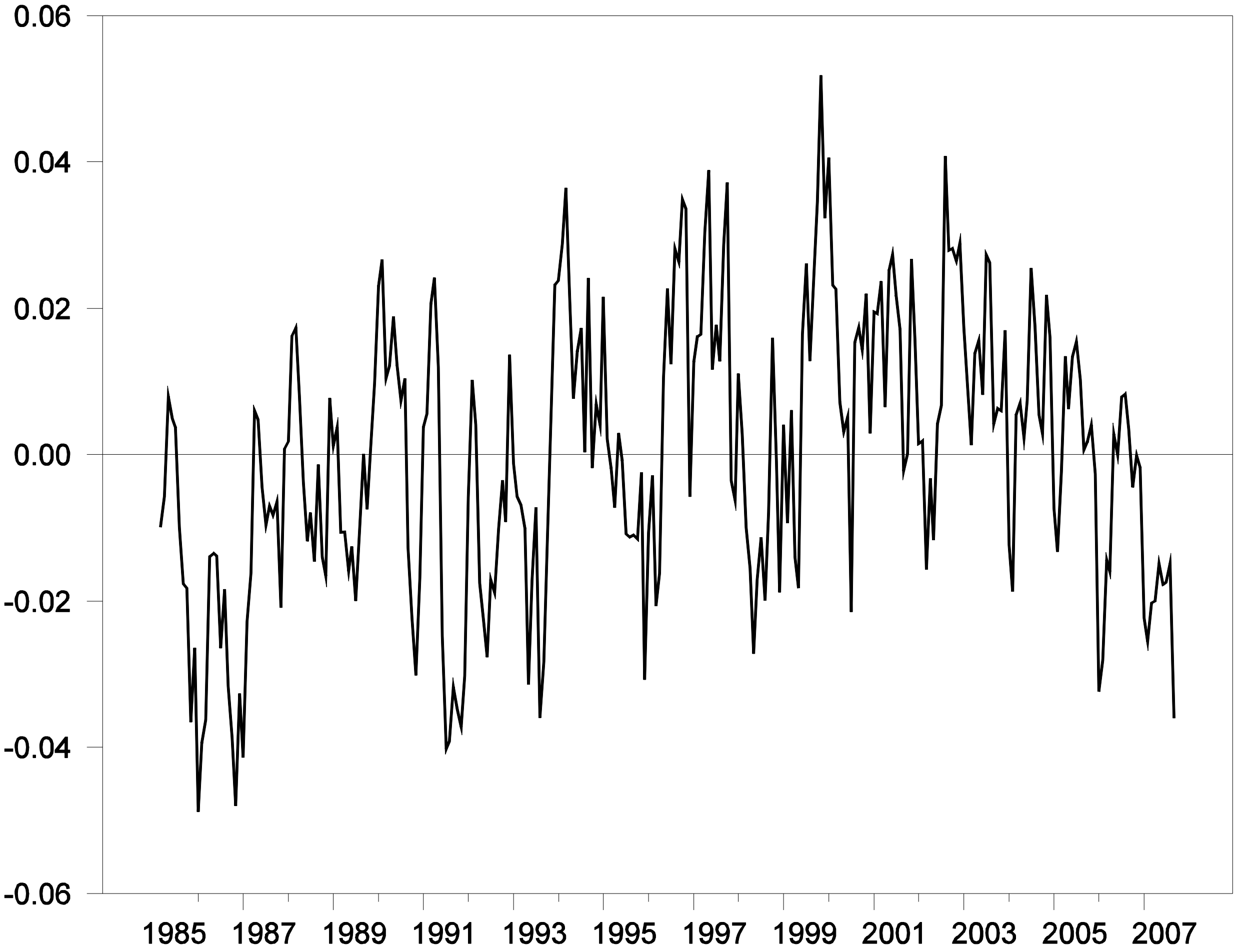


Figure 7c The residual from cointegrating relation 3



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Appendix 1: Price index estimation

[To be written].

Appendix2: Inferring the market rate of entry

The sales covered by our data include only properties sold by NVM. Since the market share of NVM has varied over the years this may bias our measure of the hazard of entry. To account for this we first measure the NVM market share. Statistics on the total number of sales in the Netherlands only exist from 1993 through the Dutch land registry, the Kadaster. In order to backcast sales from 1985 we run an OLS regression on data from 1993:1-2005:12 data for log(#MarketSales) against log(real GDP) and monthly dummies. The results are given below

Variable	Coefficient	Std. Error
LOG(REALGDP)	0.975430	0.056107
D2	0.107217	0.031324
D3	0.283353	0.031324
D4	0.271763	0.031324
D5	0.328597	0.031324
D6	0.306609	0.031324
D7	0.461724	0.031324
D8	0.379500	0.031324
D9	0.311551	0.031324
D10	0.364873	0.031324
D11	0.333500	0.031324
D12	0.679455	0.031324
C	-4.524174	0.694360
Adjusted R-squared	0.854919	
S.E. of regression	0.079860	
Durbin-Watson stat	1.366961	

The Kadaster sales data has a seasonal pattern not found in the NVM. There is also a time lag between the NVM information dated at the time of signing the contract and the subsequent register date in the Kadaster. To take this into account we measure the NVM market share by using 12 month moving averages lagging the NVM observations three months relative to the Kadaster numbers. Denoting the NVM market share of sales by α_t we have

$$\alpha_t = \sum_{i=0}^{11} \#NVMMarketSales_{t-i} / \sum_{i=0}^{11} \#MarketSales_{t+3-i} \ .$$

We have data on entry and exit of NVM properties. We also know the total number of sales and can calculate the NVM market share (in terms of sales). We want to use these data to infer entry and exit rates on the market level.

Next we want to measure the market share of entry. To simplify, and since we don’t have information that would justify another assumption, we assume that α also applies to the number of houses on the market. We assume that the hazards of entry, sale and withdrawal are the same for all brokers, implying that the increasing market share of NVM reflects an increased number of members, not that NVM brokers are different.

Defining the market hazard of entry as

$e_t = Entry_t/Stock_t$

The observed amount of entry (superscript N to denote NVM) can then be expressed as

$$Entry_t^N = e_t Stock_t^N + e_t^{\Delta} Stock_t^N$$

where $e_t^{\Delta} = \frac{\alpha_t^e - \alpha_{t-1}^e}{\alpha_{t-1}^e}$ denotes the extra entry rate from new brokers and α_t^e denotes the NVM market share of entry. Inserting this into the above equation and solving for e yields

$$e_t = \frac{Entry_t^N}{Stock_t^N} - \frac{\alpha_t^e - \alpha_{t-1}^e}{\alpha_{t-1}^e}$$

The conclusion is that we should adjust the observed entry rate by deducting the relative increase of NVM market share. Furthermore, we do not observe the NVM market share of properties entering the market. We approximate this by the lagged market share of sold dwellings.

$$\alpha_t^e = \alpha_{t-x_t}$$

where x_t is the average time till sale in month t (measured in months) rounded to the nearest integer. The figure below displays the NVM market share of sold properties and the NVM market share of properties entering the market.

The figure below displays the resulting corrected hazard of entry along with the uncorrected series.

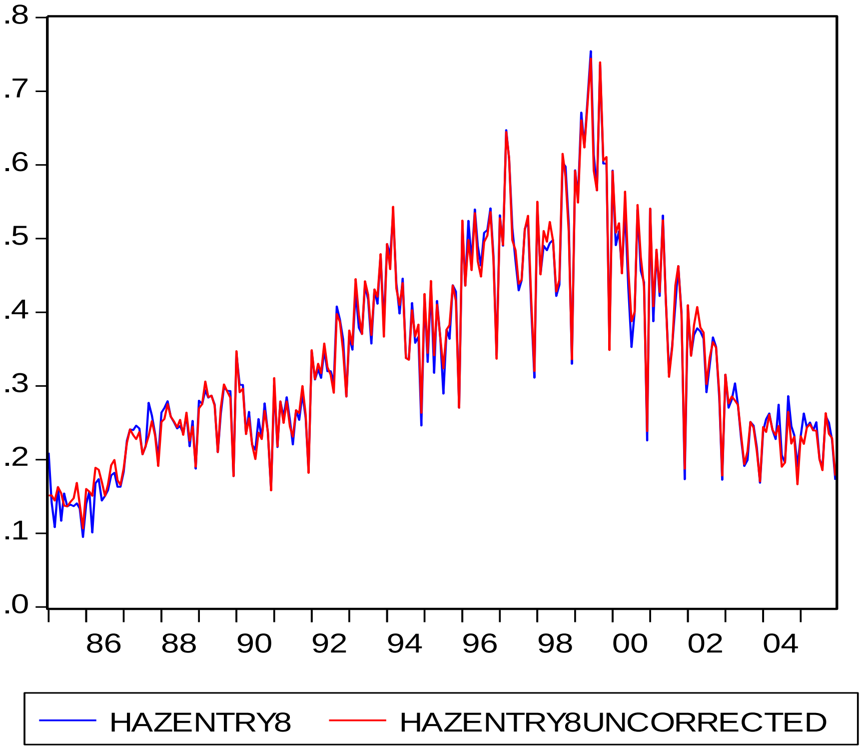
.8
.7
.6
.5
.4
.3
.2
.1
.0
86
88
90
92
94
96
98
00
02
04
HAZENTRY8
HAZENTRY8UNCORRECTED

Table A1: Impulse responses, ordering 1

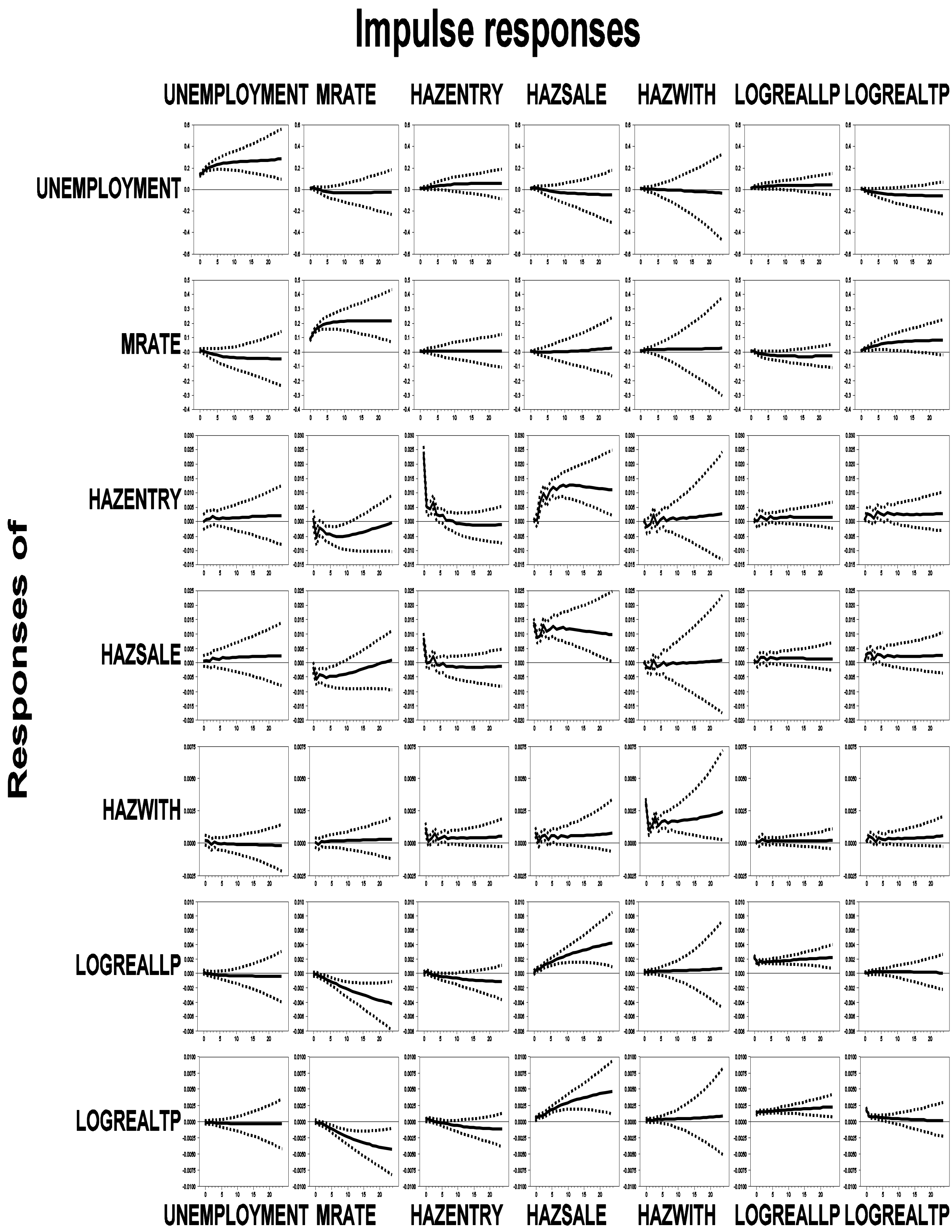

Table A2: Impulse responses ordering 2

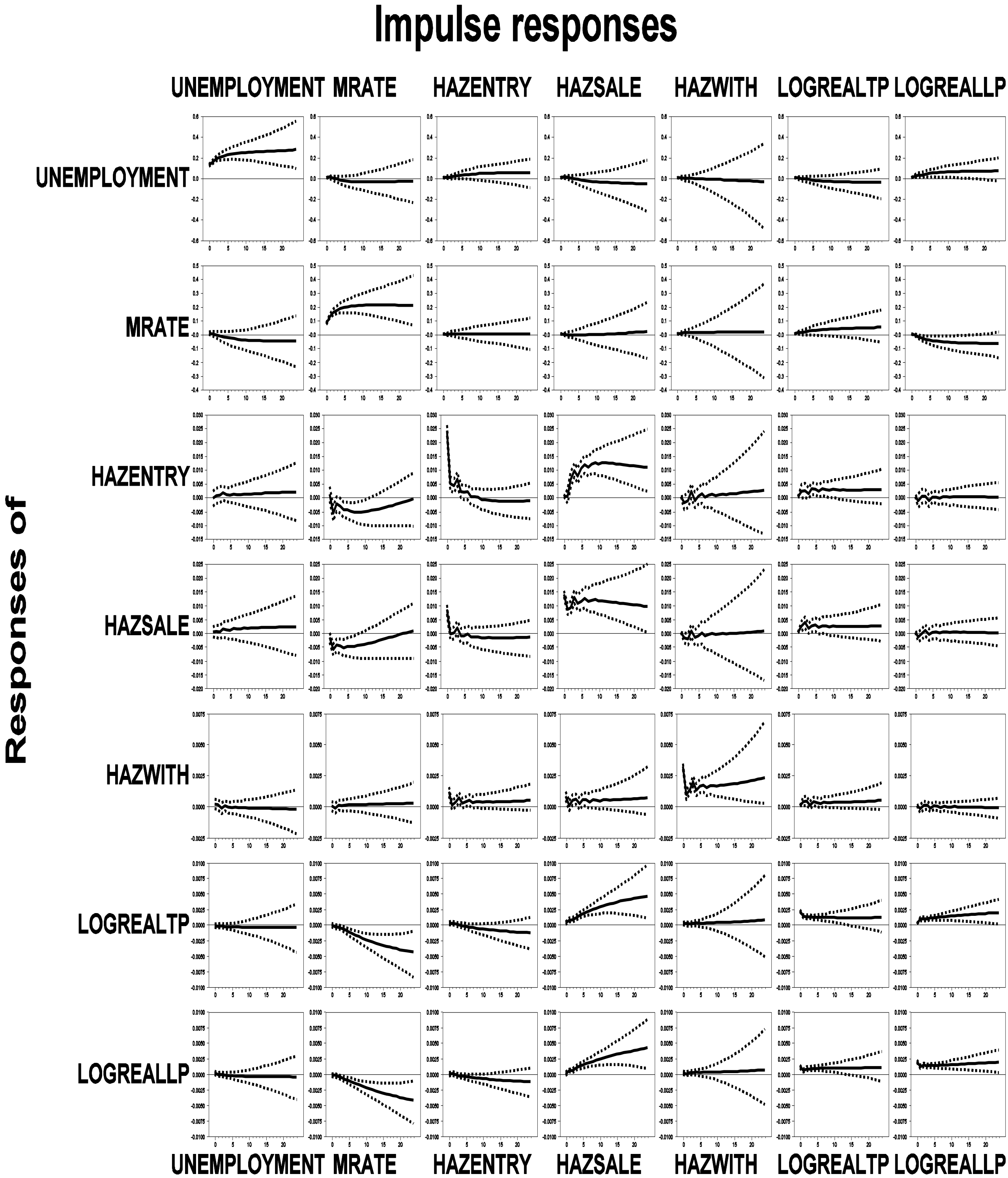

Table A3: Impulse responses ordering 3

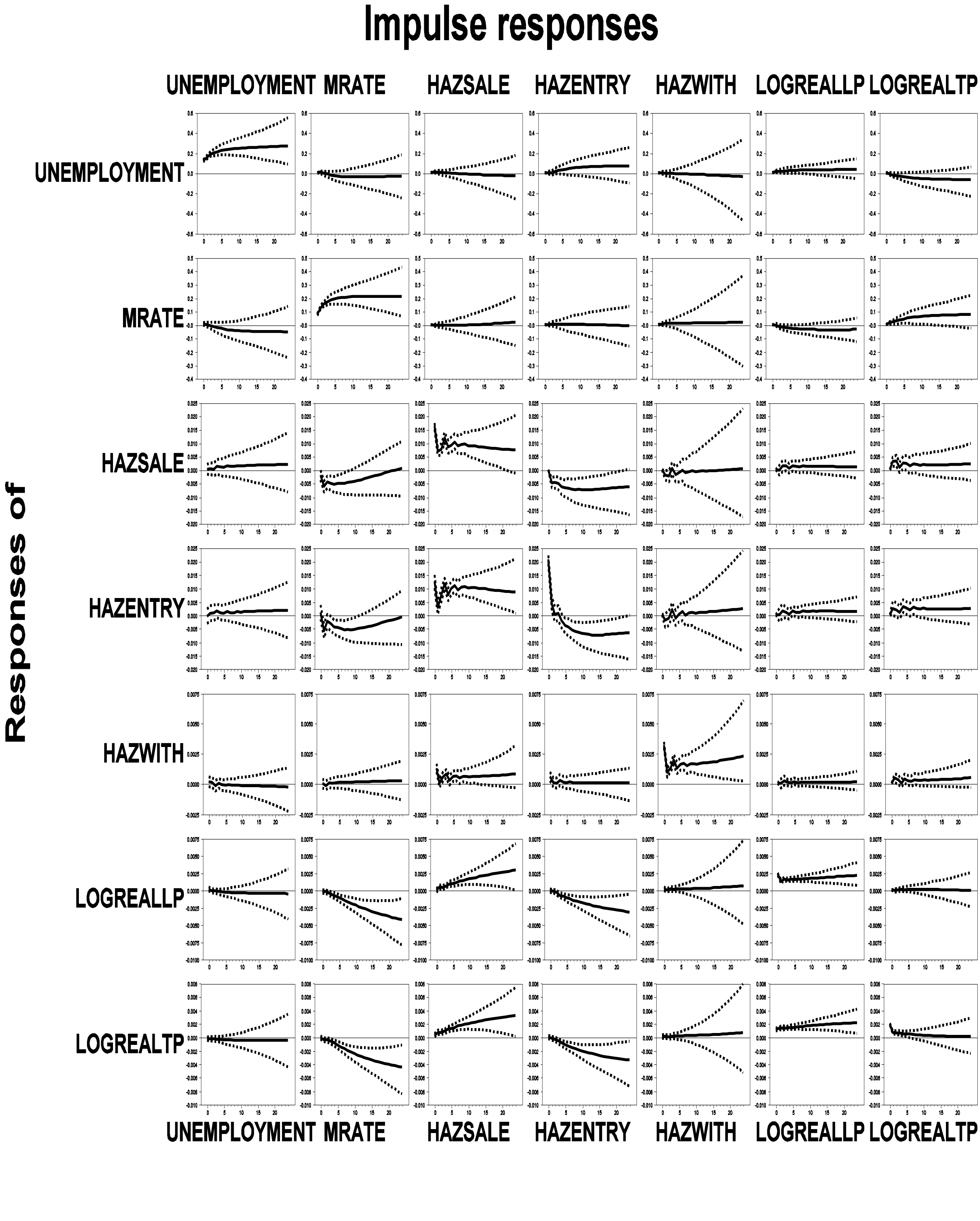

Table A4: Impulse responses ordering 4