STAFF MEMO

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The Housing Phillips Curve and Momentum in the Norwegian Housing Market*

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Abstract

This paper provides descriptive evidence for a housing Phillips curve in Norway, suggesting a negative relationship between the ratio of inventory-to-sales and subsequent house price growth in the market for existing homes. We show that the negative relationship between inventory-to-sales and house price growth in Norway only holds at short horizons, consistent with short-term momentum in the Norwegian housing market. This is in contrast to the U.S. housing market, where the Phillips curve relationship and momentum effects persist over longer horizons. We also examine heterogeneity in the housing Phillips curve and momentum across Norwegian local housing markets and find that the housing Phillips curve is stronger in larger cities. Overall, our findings imply that the Norwegian housing market is less frictional than the U.S. housing market, with homes selling faster on average and house prices responding faster to shocks.

Keywords: House prices, dynamic housing Phillips curve, house price momentum, local projections, months-of-supply, financial stability

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1 Introduction

One salient fact about the U.S. and other housing markets is the negative relationship between house price growth and the inventory of unsold homes. This reduced-form relationship is sometimes refereed to as the housing Phillips curve because of its similarity to the well-known reduced-form relationship between unemployment and wage (or price) growth in macroeconomics (Phillips, 1958). Another prominent and related fact about housing markets is the strong autocorrelation in house price growth, often referred to as *momentum*. This observation was first documented in the seminal paper by Case and Shiller (1989) who examine the efficiency of the market for single-family homes in the United States and provide evidence for a large positive auto-correlation in annual house price growth.[1]

The housing Phillips curve in the U.S. was first explored by Peach (1983). More recently, Caplin and Leahy (2011) also document a negative relationship between lagged vacancies and subsequent house price growth and also positive autocorrelation (momentum) in the U.S. housing market. They suggest that ask price stickiness is important for understanding this phenomenon. Guren (2014) and Guren (2018) follows up on this insight and argues that a small share of sellers with "sticky" ask prices (for example, due to extrapolative expectations) together with strategic complementarity in pricing decisions among sellers due to buyer search patterns can lead to strong momentum effects.[2]

In this analysis, we provide descriptive evidence for Norway on the housing Phillips curve and house price momentum.[3] Overall, our analysis provides new insights into the dynamics of the Norwegian housing market and the factors that influence house prices in Norway. Following the literature that studies this reduced-form relationship in the U.S., we focus on the ratio of inventory to monthly sales as a measure of the inventory of unsold homes in the market for existing homes. This ratio is often referred to as months-of-supply, since it can be interpreted as the number of months it would take to sell all the available inventory of unsold homes if no new properties were listed for sale.

We find that in Norway the negative relationship between months-of-supply and house price growth holds only at short horizons, around 3 to 6 months ahead, and breaks down over longer horizons. This is in stark contrast to a strong negative relationship for house

[1]See also Case and Shiller (1990), DiPasquale and Wheaton (1994), Glaeser and Gyourko (2006), and Guren (2018), among others.

[2]Guren (2014) and Guren (2018) also provides extensive evidence on the presence of house price momentum in housing markets both across U.S. cities but also internationally. Other explanations for momentum proposed in the literature include uncertainty and learning by sellers (Anenberg, 2016), migration frictions that induce autocorrelation in population flows and hence in house prices (Nenov, 2015), or search frictions (Head et al., 2014).

[3]The analysis is purely descriptive and does not identify the causal effect of months-of-supply on house price growth. See Section 4 for additional discussion.

price growth 12 months ahead in the Unites States (Peach (1983), Caplin and Leahy (2011), Guren (2014), Anenberg and Ringo (2022)). However, this observation is consistent with there being substantially less momentum in Norway, with house prices fully adjusting to a house price shock by around 6 to 9 months compared to 8 to 12 *quarters* for the U.S (Guren, 2018). These findings suggest that the Norwegian housing market is less frictional compared to the U.S. housing market, as it takes less time to sell homes on average, which is also evident from the low average value of months-of-supply in Norway. This has potentially important monetary policy and financial stability implications which we discuss in Section 4.

Given our findings, we explore modifications of the standard housing Phillips curve by estimating different specifications for a *dynamic* Phillips curve using the method of local projections (Jordà, 2005). The dynamic specification gives an opportunity to explore the housing Phillips curve across various time horizons. Because of strong persistence in months-of-supply we control for lags of months-of-supply and uncover that a one month higher months-of-supply is associated with house prices declining by around 4 percent within 6 months. Alternative specifications controlling for lagged house prices or using changes in months-of-supply as the regressor deliver slightly smaller effects but with similar dynamic profile.

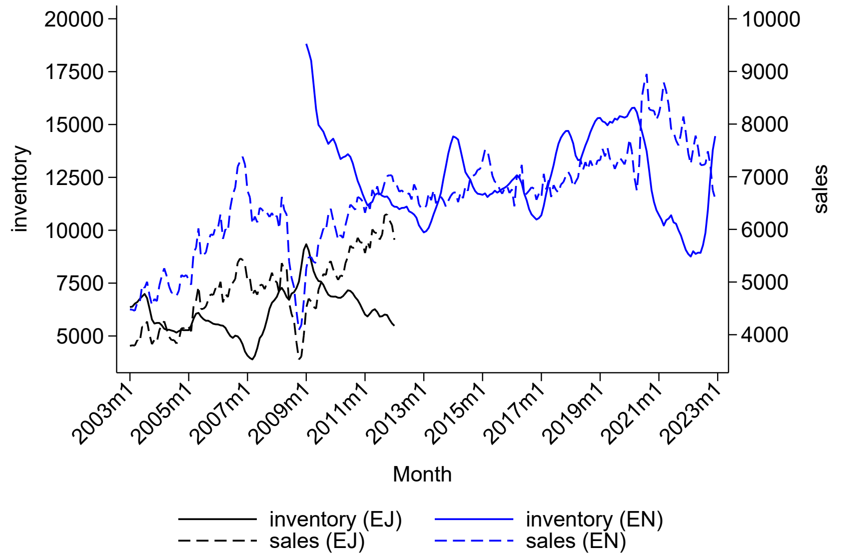
Furthermore we explore heterogeneity in the Phillips curve and momentum across Norwegian local housing markets and find that the housing Phillips curve is stronger (i.e. an increase in months-of-supply by one month is associated with a larger decline in house prices) in large Norwegian cities such as Oslo, Bergen, Trondheim, and Stavanger compared to smaller cities. Moreover, months-of-supply in larger cities tend to be lower on average compared to smaller cities and there is less momentum in the sense of house prices exhibiting faster adjustment to shocks. We argue that some of this local housing market heterogeneity can be attributed to differential housing Phillips curves for apartments versus houses as well as to differential exposure of the larger cities to aggregate housing market developments. One possible explanation for this is the larger market size and the greater availability of relatively similar houses in these urban areas.

2 Data

We start with monthly data on price indices, sales, and inventory of used housing units for Norway and 16 separate local housing markets from Real Estate Norway ("Eiendom Norge" or EN for short).[4] The price indices and sales data are available from 2003M1, while

[4] The data from Real Estate Norway is collected by Eiendomsverdi based on postings on Finn.no.

Figure 1: Inventory and sales in Norway, 2003M1-2022M12 (3-month moving average).



Notes: The inventory and sales seasonally adjusted using an ARIMA X-11 seasonal filter. For the period 2009M1-2022M12 the data is from the data provider Eiendom Norge. For the period 2003M1-2011M12, the data is from Nenov et al. (2016).

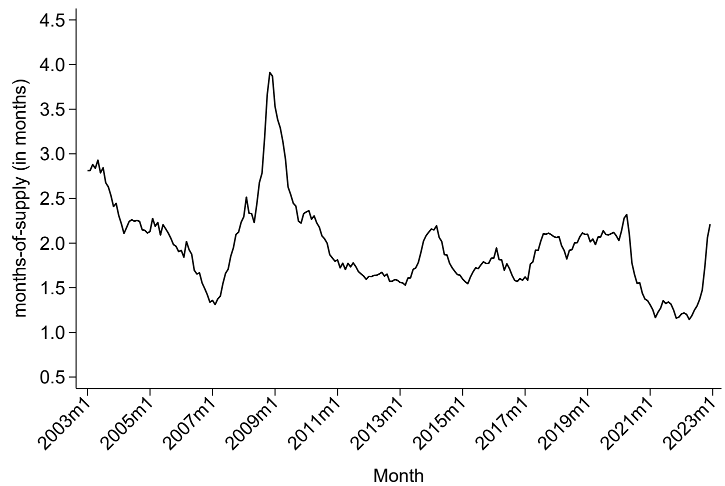
inventory is available from 2009M1. We use data up to and including 2022M12. The price indices are based on a Sales Price Appraisal Ratio methodology combined with additional smoothing/de-smoothing and seasonal adjustment using the ARIMA X-11 procedure. Sales are defined as the number of intermediated sales in a given month. Inventory is computed as the total number of (used) objects announced for sale from the national search platform Finn.no that have not been registered as sold in the past 180 days as of the end of a month. We, therefore, take a one-month lag of that series, so that inventory in a given month t equals the unsold objects at the end of month $t-1$.[5]

We augment this data with monthly sales and inventory data from Nenov et al. (2016). This data is available from 2003M1 to 2011M12. However, unlike the EN data, this data is based only on counts of units for sale that are *eventually* sold, and hence, excludes withdrawals. Nevertheless, withdrawals are fairly limited in our sample period (see, e.g. Grindaker et al. (2022)), so this difference mainly impacts the level of the series.[6] Figure 1 plots the (3-month moving average of the) seasonally adjusted inventory and sales series

[5]See https://eiendomnorge.no/boligprisstatistikk/statistikkbank/rapporter/manedsrapporter/ for additional details. Figure 19 in the Appendix shows our main results using an alternative housing index from Statistics Norway based on stock weights (the value of all homes) rather than turnover weights (the value of all housing transactions) as the the EN housing index.

[6]Consequently this issue has very limited effects on our results. See Figure 15 in the Appendix for the unadjusted inventory-to-sales series, as well as Figure 17 for the results from a robustness exercise based only on the EN data post 2008.

Figure 2: Inventory-to-sales in Norway, 2003M1-2022M12 (3-month moving average).



Notes: Inventory-to-sales is defined as the ratio of unsold (used) housing units at the end of month $t-1$ to the sales of used housing units in month t. The data is seasonally adjusted using an ARIMA X-11 seasonal filter. For the period 2009M1-2022M12 the data is from the data provider Eiendom Norge. For the period 2003M1-2011M12, the data is from Nenov et al. (2016), after scaling by the average ratio of inventory-to-sales from the two different data sources in the overlap period of 2009M1-2011M12.

from the EN data (denoted with "EN" in the figure legend) versus the inventory and sales data from Nenov et al. (2016) (denoted with "EJ" in the figure legend).

To compute the inventory-to-sales ratio, we seasonally adjust the inventory and sales data from the two sources using an ARIMA-X-11 filter, after which we compute the inventory-to-sales ratio for each data source. Furthermore, we "knot" the two series by scaling the inventory-to-sales series from the Nenov et al. (2016) data by the mean ratio of the two series in the period of overlap.

Note that the inventory-to-sales ratio in a given month can be interpreted as measuring the time it will take (in months) to sell all of the current inventory if sales continue at the same rate as in the current month. Therefore, the ratio is often referred to as "months-of-supply" by real estate practitioners in the U.S. A higher value of the ratio implies that it will take longer for the current inventory to sell, and vice versa. Therefore, the inventory-to-sales ratio provides a measure of the inverse of the rate at which objects sell in a given time period.[7] Below we will use the terms inventory-to-sales ratio and months-of-supply interchangeably.

Figure 2 plots the inventory-to-sales ratio for Norway for the period 2003M1-2022M12 after smoothing using a 3-month symmetric moving average. Two properties of this series

[7] In fact in a standard search-theoretic model of the housing market without any object heterogeneity, the inventory-to-sales ratio coincides with time-on-market or with the inverse of the selling rate.

stand out immediately. First, the average inventory-to-sales ratio is around 2 months. Second, the inventory-to-sales ratio varies little over this period with a standard deviation (for the unsmoothed series) of around 0.5 months. In contrast, the inventory-to-sales ratio in the U.S. over the same period tends to be higher on average and substantially more volatile.[8]

3 Results

3.1 The housing Phillips curve in Norway

Following the literature for the U.S. (e.g. Guren (2014) and Anenberg and Ringo (2022)), we examine the comovement of months-of-supply and 12-month house price growth. Figure 3 plots this comovement over our sample period. Surprisingly, given the observed robust negative comovement in the U.S., in Norway there is a small *positive* correlation of around 0.2 between months-of-supply and 12-month house price growth. Therefore, our first finding is that in Norway the housing Phillips curve relationship documented in the U.S. for a 12-month horizon does not hold. Instead, we find a negative relationship between months-of-supply and house price growth only at much shorter horizons. Specifically, Figure 4 shows the comovement of months-of-supply and 3-month house price growth. At this horizon we recover a small negative correlation coefficient of around -0.15 between months-of-supply and 3-month house price growth. This correlation implies that a one-month higher months-of-supply is associated with a 3-month house price decrease of around 0.5 percentage points.

The fact that the housing Phillips curve in Norway is only observed at short horizons points to a more complicated relationship between house price growth and months-of-supply than what the literature studying the same relationship in the U.S. has concluded. To investigate this relationship further, rather than focusing on a specific time horizon, we proceed to estimate the full *dynamic* response of house prices to months-of-supply. Specifically, we estimate the following model

$$\Delta_h \log p_t = \alpha_h + \beta_h MS_t + \varepsilon_{t,h}, \tag{1}$$

where $\Delta_h \log p_t$ denotes the log change in house prices from $t-1$ to $t-1+h$, and MS_t denotes months-of-supply in month t. The interpretation of the coefficient β_h is that it gives the h-month house price growth response (in percent) to months-of-supply being higher by one month at t. We estimate this dynamic response using the method of local projections (Jordà, 2005) by estimating the equation separately for each horizon h. In addition, we

[8]See Figure 2 in Anenberg and Ringo (2022).

Figure 3: Comovement of months-of-supply and 12-month house price growth, Norway 2003M1-2022M12.

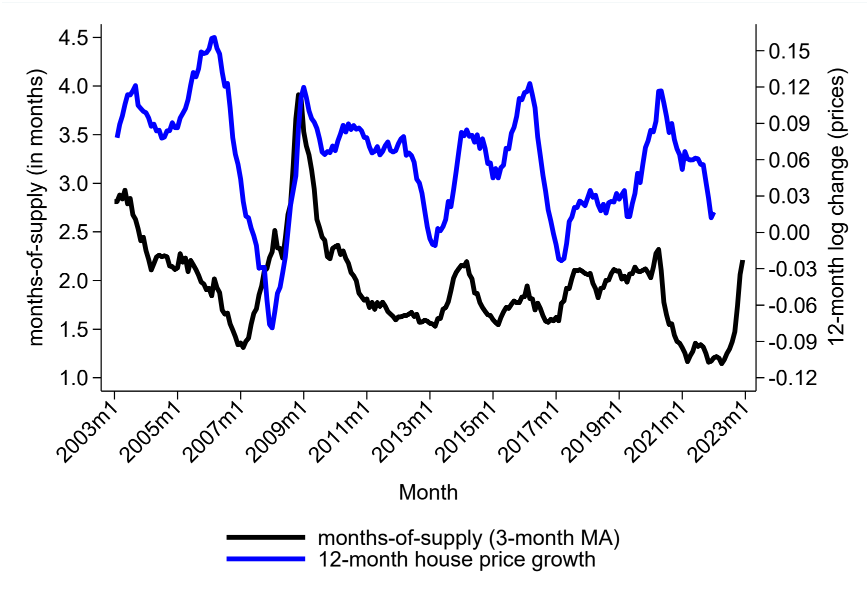


Figure 4: Comovement of months-of-supply and 3-month house price growth, Norway 2003M1-2022M12.

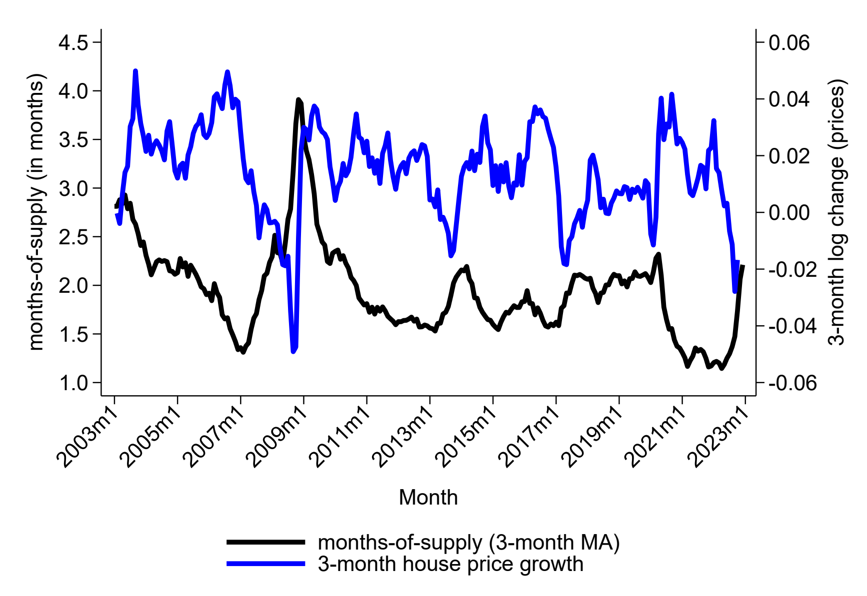
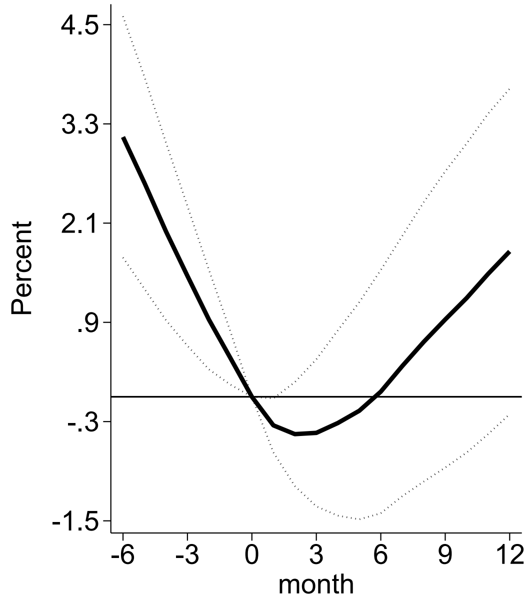


Figure 5: Dynamic Phillips curve: no controls



The figure reports the estimated coefficients $beta_h$ from Eq. (1). The interpretation of the coefficient β_h is that it gives the h-month house price growth response (in percent) to months-of-supply being higher by one month at t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

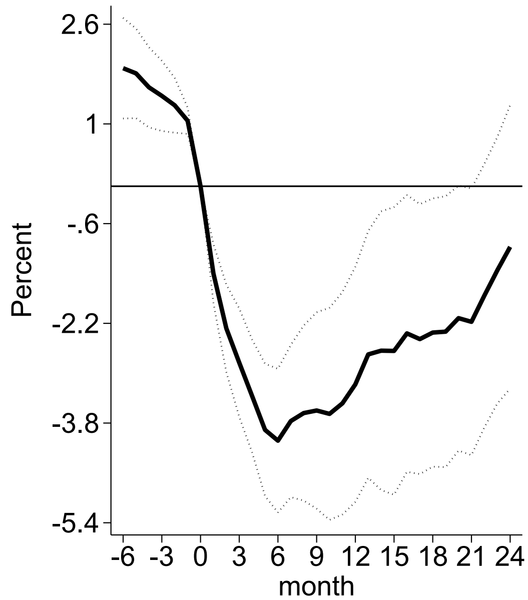
consider the "pre-trend" co-movement between house prices and months-of-supply by taking $h < 0$.

Figure 5 plots the estimated dynamic response using the local projections method for 12 months ahead and a 6-month pre-trend. There is a mild negative and marginally statistically significant effect of months-of-supply on house price growth at short horizons and a positive and marginally statistically significant effect at longer horizons, particularly at 12 months. This is consistent with Figures 3 and 4, since the 12-month and 3-month horizon estimates correspond to these two figures, respectively.

Taken at face value, this figure shows a very unstable relationship between house price growth and months-of-supply. However, what is apparent from the figure is the significant "lead" effects of house prices with a strong positive and statistically significant pre-trend comovement between *past* house price growth and current months-of-supply. One reason for this pre-trend comovement is the strong persistence of months-of-supply itself. Specifically, as shown in Figure 16 in the Appendix, there is a strong positive auto-correlation in months-of-supply at a horizon of up to at least 24 months. Hence, it is necessary to account for the lagged effects of months-of-supply on current and future house price growth.

To this end, we estimate the dynamic response of house prices to months-of-supply, controlling for 12 lags of months-of-supply. The estimated effects are plotted in Figure 6. Controlling for lags of months-of-supply, a one month higher months-of-supply is associated

Figure 6: Dynamic Phillips curve: controlling for lags of months-of-supply



The figure reports the estimated coefficients $beta_h$ from Eq. (1). The interpretation of the coefficient β_h is that it gives the h-month house price growth response (in percent) to months-of-supply being higher by one month at t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

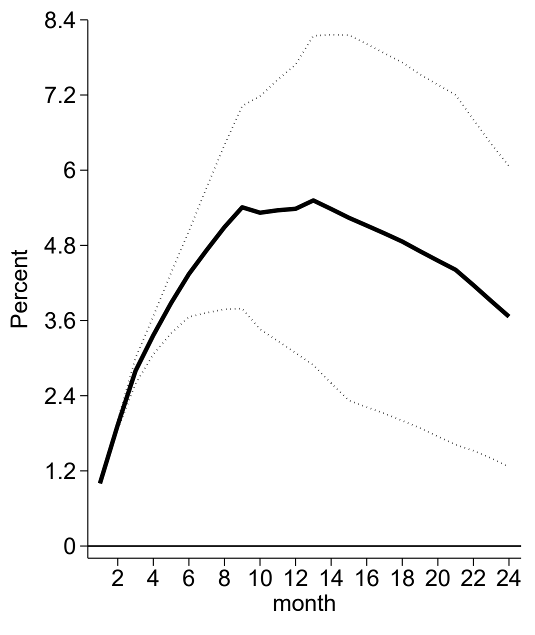
with house prices declining by around 4 percent within 6 months and recovering subsequently within 24 months.

The importance of including lags of months-of-supply when estimating the dynamic response of house prices to month-of-supply suggests an examination of the co-movement of *changes* of months-of-supply and house price growth. See the Appendix for an alternative specification based on "changes" in months-of-supply rather than levels. Additionally, in the Appendix we also estimate a version of the dynamic housing Phillips curve controlling for both lags of months-of-supply and lags of monthly house price changes.[9] Controlling for lags of both house prices and months-of-supply still implies a negative (though smaller in magnitude) effect of higher months-of-supply on house prices.

To sum up, we find evidence for a dynamic Phillips curve in Norway when controlling for lagged values of months-of-supply. However, unlike in the U.S. the effects on house prices appear at much shorter horizons of around 6 months, and tend to die down thereafter. Next, we explore further this much faster response of house prices by investigating house price momentum in Norway.

[9]Figure 18 in the Appendix shows the estimated dynamic effects.

Figure 7: House price momentum in Norway



The figure reports the estimated coefficients $beta_h$ from Eq. (2). The interpretation of the coefficient β_h is that it gives the h-month house price growth response (in percent) to a one percent increase in house prices in month t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

3.2 House price momentum in Norway

Guren (2014) argues that the housing Phillips curve is a consequence of the presence of momentum in the housing market, the observed positive auto-correlation of quarterly house price growth over 8 to 14 quarters in the U.S., first documented by Case and Shiller (1989). Therefore, one possible reason for why there is a housing Phillips curve only at short horizons is Norway is that house price momentum also occurs only at short horizons.[10]

To investigate this possibility, we estimate house price momentum in the Norwegian housing market by estimating the following model

$$\Delta_h \log p_t = \alpha_h + \beta_h \Delta \log p_t + \sum_{k=1}^{12} \gamma_k \Delta \log p_{t-k} + \varepsilon_{t,h}, \tag{2}$$

where $\Delta_h \log p_t$ denotes log change in the national house price index from $t-1$ to $t-1+h$, for $h \geq 1$, and $\Delta \log p_{t-k}$ denotes the one-month log change in house prices between $t-k-1$ and $t-k$, for $k \in 0, 1, \ldots, 12$. By varying h from 1 to 24, we can estimate the correlation between one-month house price growth in t and the cumulative log growth in house prices over the subsequent h months, controlling for past house price changes.

[10]In fact, when investigating whether house price momentum occurs in other countries apart from the U.S. Guren (2014) fails to find momentum at one-year horizon only in Norway.

Figure 7 presents the coefficient estimates from this model together with 95% confidence bands. A one percent increase in house prices in month t correlates with a cumulative house price growth of around 5 percent over the subsequent 6 to 9 months. This is of similar magnitude to the cumulative house price effect in the U.S. but the adjustment is around 3 to 4 times faster compared to the U.S. This faster adjustment in house prices is consistent with the housing Phillips curve in Norway only being present at shorter horizons. It suggests that house prices respond to shocks much faster in Norway than in the U.S.[11]

3.3 Local heterogeneity

Since Norway as a whole is heavily dominated by the Oslo and Akershus housing markets, the aggregate relationships we show in the previous sections may hide important heterogeneity across locations. In this section we utilize the panel dimension of our data to look at local heterogeneity in the Phillips curve and momentum in Norway.

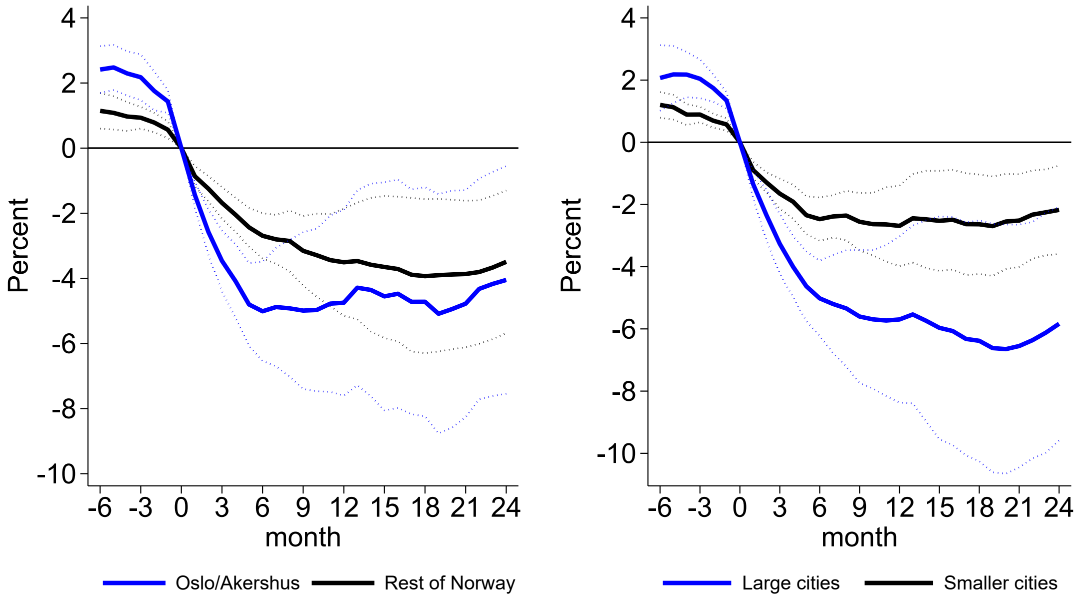
We have data on 16 distinct local housing markets. Figures 20 to 22 in the Appendix plot the months-of-supply, dynamic housing Phillips curve (controlling for lags of months-of-supply), and momentum for each separate local housing market. Several observations stand out: First, months-of-supply tends to be lower in local housing markets in Oslo/Akershus compared to other local housing markets. Similarly, it tends to be lower in large cities (namely Oslo, Bergen, Trondheim, Stavanger) compared to smaller cities. This is confirmed using a (weighted) t-test for the average months-of-supply across markets. Specifically, while months-of-supply is on average 1.9 months for local markets outside of Oslo/Akershus, it is around 1.5 months for markets in Oslo/Akershus. A two-sided t-test rejects equality at the 5% significance level. Furthermore, months-of-supply is on average 1.5 months in large cities and 2 months in smaller cities with the difference being significant at the 1% significance level.

Second, the dynamic Phillips curve for markets in Oslo/Akershus or for large cities tends to be characterized by larger responses and faster adjustment of house prices compared to the Phillips curve for markets outside of Oslo/Akershus or for smaller cities. Third, and possibly related to the previous finding, house price momentum tends to be stronger (i.e. there is a larger cumulative response) for markets in Oslo/Akershus or for large cities. The price response is also faster in those markets compared to markets outside of Oslo/Akershus or smaller cities.

We confirm these observations by estimating the following pooled model

[11] To the extent that auctions are much more prevalent in Norway than in the U.S., the finding of faster adjustment in house prices in Norway is consistent with the role auctions play in weakening momentum in the housing market as suggested by Genesove and Hansen (2020).

Figure 8: The dynamic housing Phillips curve: local heterogeneity.



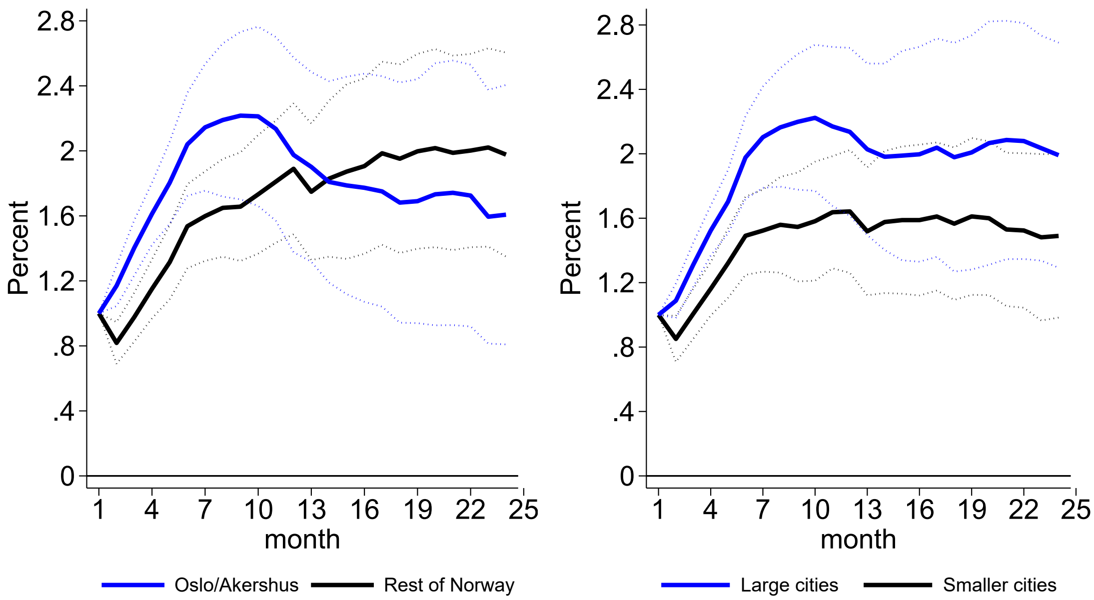
The figure reports the estimated coefficients $beta_{g,h}$ from Eq. (3). The interpretation of the coefficient is that it gives the h-month house price growth response for housing market belonging to group g (in percent) to months-of-supply in that housing market being higher by one month at t. The dashed line shows a 95% confidence interval based on Driscoll-Kraay standard errors with a bandwidth of 12.

$$\Delta_h \log p_{m,t} = \alpha_{m,h} + \beta_{g,h} MS_{m,t} + \left(\Gamma'_{m,h} X_{m,t-1}\right) + \varepsilon_{m,t,h}, \tag{3}$$

where m indexes a market, t indexes month, and $g \in \{Oslo/Akershus, Rest\ of\ Norway\}$ or $g \in \{Big\ City, Rest\ of\ Norway\}$, respectively. Here, $\Delta_h \log p_{m,t}$ denotes log change in market m from $t-1$ to $t-1+h$, $MS_{m,t}$ is months-of-supply in market m and month t. Therefore, we allow for the effects of months-of-supply on house prices across markets to vary between two groups given by g. We again estimate this model by local projections. We also weight the regression by average sales in a market. We estimate a similar model for house price momentum as well.

Figures 8 and 9 present the estimated coefficients for the dynamic Phillips curve and momentum for two groups of local housing markets. The left-hand panels of the figures present the results for the Oslo/Akershus vs. rest of Norway groups, while the right-hand panels present the results for the groups of large cities vs. small cities. The estimated responses confirm the conclusions that the Phillips curve and momentum are stronger for Oslo/Akershus and in large cities compared to the rest of Norway and smaller cities, respectively and that house prices adjust faster in the former group of local housing markets compared to the latter. Specifically, a one month higher months-of-supply is associated with a decline in house prices in Oslo/Akershus or in the group of large cities by around 5 percent

Figure 9: House price momentum: local heterogeneity.



The figure shows the cumulative house price growth response for housing market belonging to a specific group (in percent) to a one percent increase in house prices in that market in month t. The dashed line shows a 95% confidence interval based on Driscoll-Kraay standard errors with a bandwidth of 12.

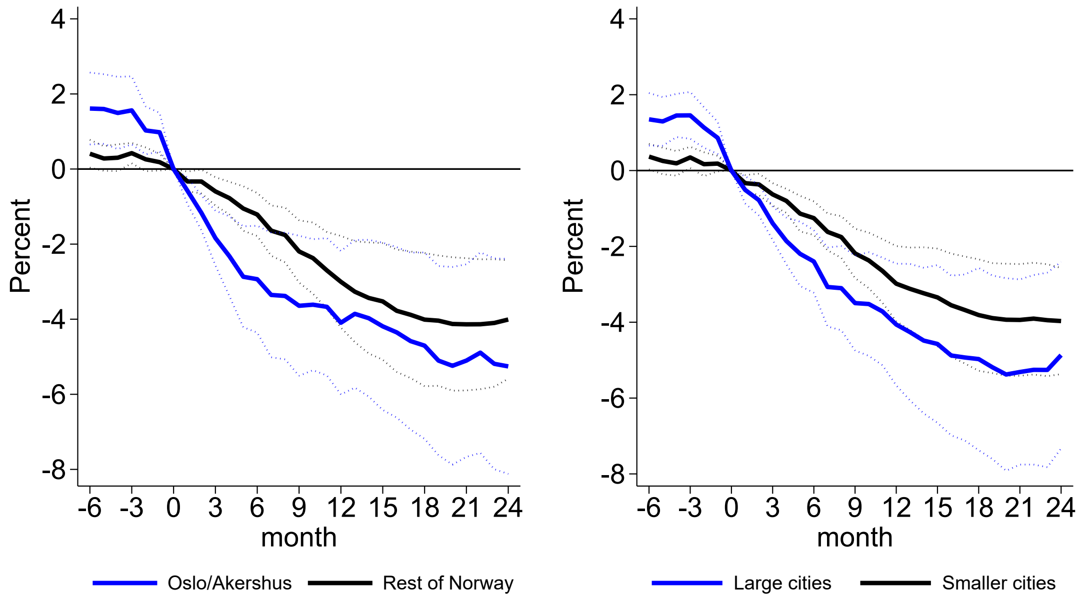
compared to around 2.5 percent for local markets in rest of Norway/small cities.

One possible reason for the local housing market heterogeneity documented in Section 3.3 is that it reflects heterogeneous price responses due to differential composition of types of housing units across local housing markets. If large cities have a larger share of apartments compared to smaller cities and the price of apartments is more responsive than the price of houses, then the observed local housing market heterogeneity may just be the result of heterogeneous responses across types of housing. To explore this possibility in the Appendix we present estimates by type of housing, namely apartments and single-family houses. This analysis suggests that the price of apartments tends to be somewhat more responsive to an increase in months-of-supply compared to houses and that the price of houses adjust more slowly though the differences are not statistically significant.

3.4 Including time fixed-effects

In addition to exploring local housing market heterogeneity, one additional motivation for examining data on local housing markets is to be able to control for common time trends across housing markets via month fixed effects. Moreover, even though strict econometric identification of the effect of months-of-supply on house prices is beyond the scope of the current analysis, including such controls brings us somewhat closer to being able to interpret

Figure 10: The dynamic housing Phillips curve: including time fixed-effects.



The figure shows the cumulative house price growth response for housing market belonging to a specific group (in percent) to months-of-supply increasing in that market by one month at t. The dashed line shows a 95% confidence interval based on Driscoll-Kraay standard errors with a bandwidth of 12.

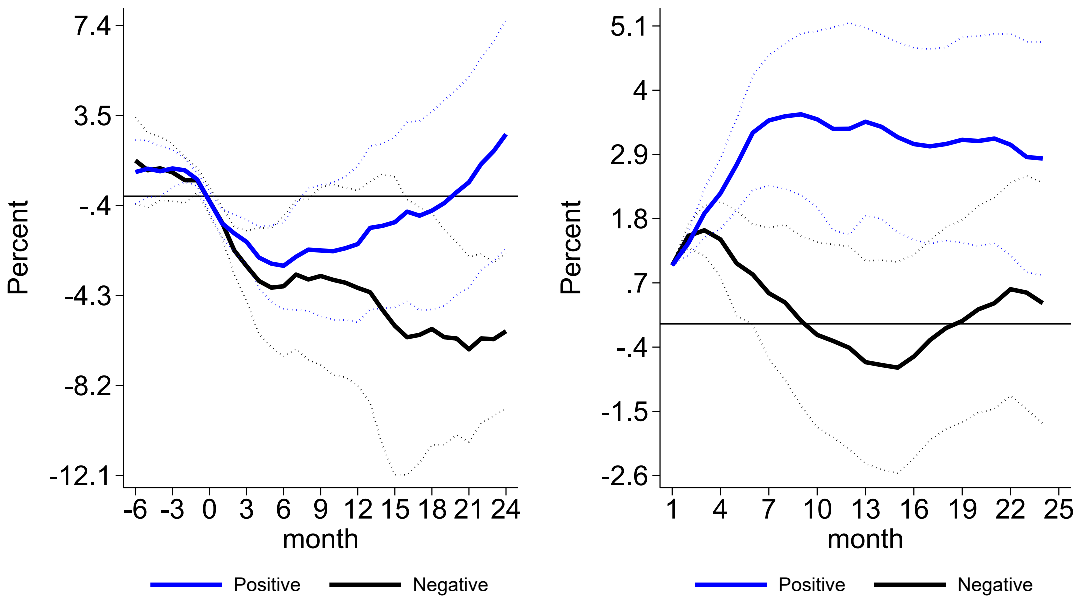
the estimated dynamic housing Phillips curve as a structural rather than purely a reduced-form relationship. Figure 10 presents the estimated dynamic Phillips curve for local housing markets Oslo/Akershus vs. Rest of Norway (left panel) and for large vs. smaller cities. Comparing against the results in Figure 8, a few notable differences stand out. First, the differences in house price responses between the two groups are much smaller after accounting for time fixed-effects. This is particularly notable for the group of large vs. smaller cities. Second, the response of house prices takes substantially longer to build up after controlling for time fixed-effects. Therefore, the relatively quick house price adjustment of local housing market in Oslo/Akershus or for large cities estimated without month fixed-effects is likely an artefact of the relatively quick adjustment in aggregate house prices documented in Section 3.2. Overall, the results with month fixed-effects support the presence of an association between local months-of-supply and local house price growth even after accounting for aggregate house price trends.

3.5 Asymmetric effects

Next we consider heterogeneity along a different dimension, namely with respect to positive vs. negative contemporaneous house price changes. Specifically we estimate Eqs. (1) and (4) by allowing for the estimated effects of months-of-supply/house price growth to vary

Figure 11: The housing Phillips curve and momentum: asymmetric responses

(a) Phillips curve (b) Momentum



The left-hand panel of the figure shows the cumulative house price growth response (in percent) to months-of-supply increasing by one month at t given either a positive or a negative monthly contemporaneous change in house prices. The right-hand panel of the figure shows the cumulative house price growth response (in percent) to a 1 percent log change in house prices in month t given either a positive or a negative change in house prices. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

depending on whether the contemporaneous monthly change in house prices are positive or negative.[12] Figure 11 presents the estimated dynamic Phillips curve and momentum effects. While the short-run response (up to month 6) of house prices to a one month higher months-of-supply are relatively similar, the medium-run response is different. Specifically, prices essentially recover if there is a contemporaneous positive shock to house prices, while they remain lower if there is a contemporaneous negative shock to house prices.

In terms of momentum, house price momentum is much more pronounced for positive shocks to house prices compared to negative shocks to house prices. In fact there is quick mean-reversion in house prices after a negative shock, with prices recovering fully by around 12 months. This asymmetry in house price responses likely is a reflection of our sample period with very few periods of sizable and persistent house price declines.

To summarize, we find some evidence for local heterogeneity in the dynamic Phillips curve and momentum in Norway with a particular dichotomy between local housing markets in Oslo/Akershus or large cities on the one hand and the rest of Norway or smaller cities on the other. Specifically, an increase in months-of-supply by one month is associated with a 5 percent decline in house prices in Oslo/Akershus (6 percent decline for large cities) within 6

[12]For the dynamic Phillips curve regression we present results with controls for lags of months-of-supply.

months compared to a 4 percent decline in the rest of Norway (2.5 percent decline in smaller cities) within 18 months. It is possible that some of this local heterogeneity is due to the different housing type composition in large vs. smaller cities. Controlling for common time trends via month fixed effects absorbs some of the local differences and uncovers a somewhat more persistent housing Phillips curve. Finally, we find some evidence for asymmetric effects, particularly for momentum with substantial mean-reversion due to negative (log) changes in house prices compared to positive changes.

4 Discussion

The main insight from our analysis on the housing Phillips curve and momentum in Norway is that the Norwegian housing market is substantially less frictional than the U.S. housing market where the Phillips curve relationship holds for much longer horizons, and there is house price momentum up to 3 years ahead. The low average level of months-of-supply in Norway is also consistent with a high transaction rate and low time-on-market for housing units in Norway.

The fact that the Norwegian housing market is less frictional and that house prices in Norway adjust much faster in response to shocks has implications for both monetary policy and financial stability. On the one hand, faster price adjustment to shocks, including monetary policy shocks, implies that any propagation channel of monetary policy through house prices (for example, via housing wealth effects) would operate with shorter lags than in the U.S., for example. On the other hand, faster price adjustment to shocks implies that house prices can be more volatile in Norway. This in turn has implications for financial stability and the ability of regulators to respond to such shocks in a timely fashion.

Our analysis is purely empirical but it does raise the important question of the underlying economic forces that lead to the observed reduced-form relationship between months-of-supply and subsequent house price growth. The existing literature on the topic suggests at least two possible channels at play. On the one hand, shocks to months-of-supply due to, for example, shocks to the propensity of moving owners to buy before selling ("buy first") as in Moen et al. (2021) and Grindaker et al. (2022) or due to other shocks to the flow of buyers and sellers may end up changing the ratio of buyers-to-sellers in the housing market. This may in turn trigger a process of adjustment in the housing market, which may be sluggish due to informational or other frictions, resulting in momentum. In support of this mechanism, Grindaker et al. (2022) show that in Norway there is a causal effect of changes in market tightness on house price growth.

On the other hand, shocks to prices may also trigger specific patterns of endogenous entry of buyers and sellers in the presence of house price momentum that may end up impacting months-of-supply. For example, as argued by Guren (2014) if prices are expected to increase buyers choose to enter early and sellers choose to wait and enter late. Early arrival of buyers lowers months-of-supply and that coincides with subsequent price appreciation due to momentum. Alternatively, as argued theoretically by Moen et al. (2021), anticipation of future price increases may increase the propensity of moving owners to buy first, which raises the buyer-to-seller ratio and lowers months-of-supply.

The above discussion paints two opposing conceptual views of the housing Phillips curve. According to the first view, the shock to months-of-supply has (or proxies for a variable that has) a causal effect on subsequent house price growth. According to the second view, months-of-supply is merely an outcome of house price momentum.

In practice both of the economic channels described above can be relevant for short-run housing market dynamics since they are not mutually incompatible. Consequently our empirical analysis does not rule out either of these two channels. For example, examining the "pre-trends" from our analysis with controls for lags of months-of-supply (cf. Figure 6), suggests that house prices tend to "lead" months-of-supply even after controlling for lags of months-of-supply.[13] This evidence is also consistent with the findings of Benedictow et al. (2020) for Norway who show that price changes cause (in the sense of Granger causality) changes to the unsold rate. Overall, this points to a reverse causality interpretation of the Phillips curve relationship – from house price growth (and subsequent future house price growth due to momentum) to changes in months-of-supply. On the other hand, as discussed in Section 3.1, controlling for lags of both house prices and months-of-supply still implies a negative effect of higher months-of-supply on house prices. Therefore, there is a housing Phillips curve even after controlling for past house price growth.

5 Concluding Comments

In this paper we provide descriptive evidence for a housing Phillips curve in Norway – a negative relationship between the ratio of inventory-to-sales and subsequent house price growth. This relationship occurs only at short horizons, which is consistent with the fact that momentum in the Norwegian housing market also occurs only at short horizons.

Our findings of a reduced-form relationship between months-of-supply and future house price growth imply that one can use the dynamic housing Phillips curve for short-run forecasting of house prices. As an example, consider the recent increase in months-of-supply in

[13] The large one-month lag effect of house prices should be interpreted with some caution due to possible effects of smoothing of the underlying house price index (see Section 2).

Norway from August 2022 to December 2022, which is around 1 month. Taking into account the lag structure of the dynamic Phillips curve we estimate (see Figure 6) and the dynamics of months-of-supply over that period, a back-of-the-envelope calculation implies a fall in house prices of around 2.7 percent from August 2022 to December 2022. The actual price decrease over that period was around 2.2 percent. However, as of April 2023 months-of-supply has decreased, which implies an increase in house prices growth.

Whether the housing Phillips curve is a causal or purely reduced-form relationship is irrelevant when it comes to forecasting house prices but is important for understanding the workings of the housing market at a deeper level. As discussed above, our findings are consistent with both a causal effect of months-of-supply on house price growth as well as a reverse causality effect of house price growth on months-of-supply. However, ascertaining whether there is indeed a causal effect or reverse causality (or perhaps even omitted factors correlating with both house price growth and months-of-supply) requires identifying plausibly exogenous variation in months-of-supply or house prices. We view such an investigation of the Norwegian housing market as promising for future research on this topic.

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Appendix

A Additional analysis

A.1 The "modified" housing Phillips curve

The importance of including lags of months-of-supply when estimating the dynamic response of house prices to month-of-supply suggests an examination of the co-movement of *changes* of months-of-supply and house price growth. In this section, we estimate the following "modified" housing Phillips curve

$$\Delta_h \log p_t = \alpha_h + \beta_h \Delta MS_t + \varepsilon_{t,h}, \tag{4}$$

where $\Delta_h \log p_t$ denotes the log change in house prices from $t-1$ to $t-1+h$, and ΔMS_t denotes the monthly change in months-of-supply in t. The interpretation of the coefficient β_h in this case is that it gives the h-month house price response to a one-month higher *change* in months-of-supply at t. Again we estimate this dynamic response using local projections and also examine "pre-trend".

Figure 12 shows the coefficient estimates at up to 24 month horizon as well as 6 months of "pre-trends", while Figure 13 shows the coefficient estimates with additional controls for lagged house prices. Overall, the estimated effect is quite similar although slightly lower in magnitude to the estimated effect in levels with controls for the lags of months-of-supply from Figure 6. Specifically, we estimate a 6-month decline in house prices of around 2 to 3 percent given a one month higher change in months-of-supply.

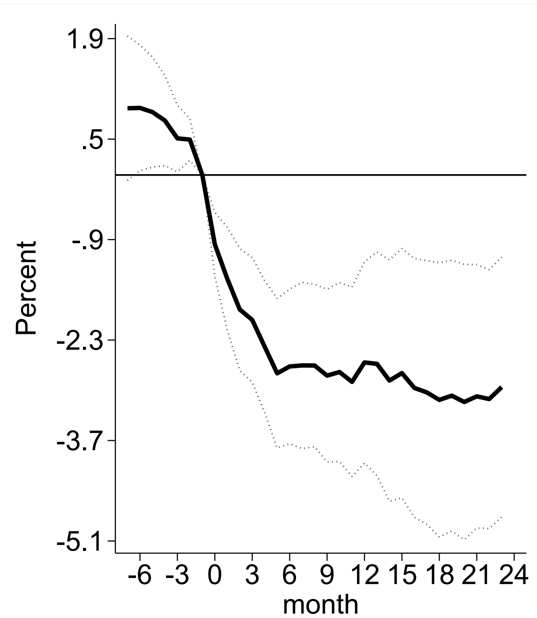
A.2 Apartments vs. houses

In this section we examine heterogeneity by type of housing, namely apartments versus single family houses. In Figure 14 (left panel) we present estimates of Eqs. (1) and (4), based on house price indices for apartments and houses.[14] Figure 14 suggests that the price of apartments tends to be somewhat more responsive to an increase in months-of-supply compared to houses, with an estimated 6-month house price decline of around 5.5 percent compared to around 4 percent for houses (though the difference is not statistically significant). Additionally, Figure 14 (right panel) suggests that the prices of houses adjust somewhat more slowly than those of apartments though again the differences are not statistically significant.

A.3 Additional figures

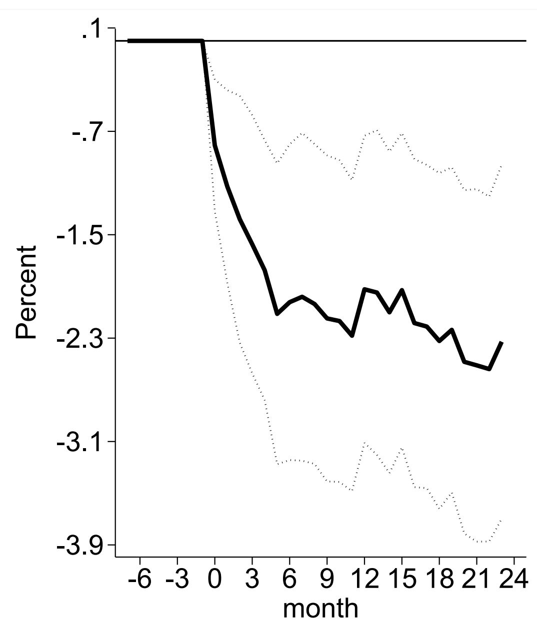
[14]The house price indices by type of housing are from Statistics Norway. These are quarterly seasonally adjusted hedonic price indices that have been linearly interpolated to monthly frequency.

Figure 12: The “modified” housing Phillips curve



The figure shows the cumulative house price growth response for housing market belonging to a specific group (in percent) to months-of-supply increasing in that market by one month at t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 13: The “modified” housing Phillips curve – controlling for lagged house prices

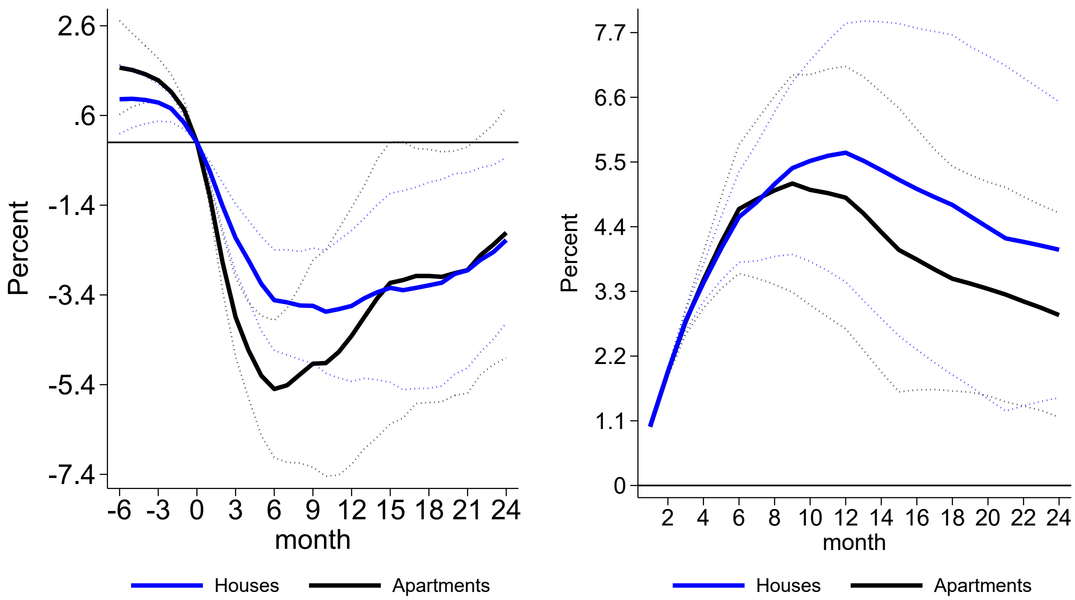


The figure shows the cumulative house price growth response for housing market belonging to a specific group (in percent) to months-of-supply increasing in that market by one month at t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 14: Dynamic Phillips curve and momentum: apartments vs. houses

(a) Phillips curve

(b) Momentum



The left-hand panel of the figure shows the cumulative house price growth response (in percent) to months-of-supply increasing by one month at t. The right-hand panel of the figure shows the cumulative house price growth response (in percent) to a 1 percent log change in house prices in month t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 15: Inventory-sales series without knotting

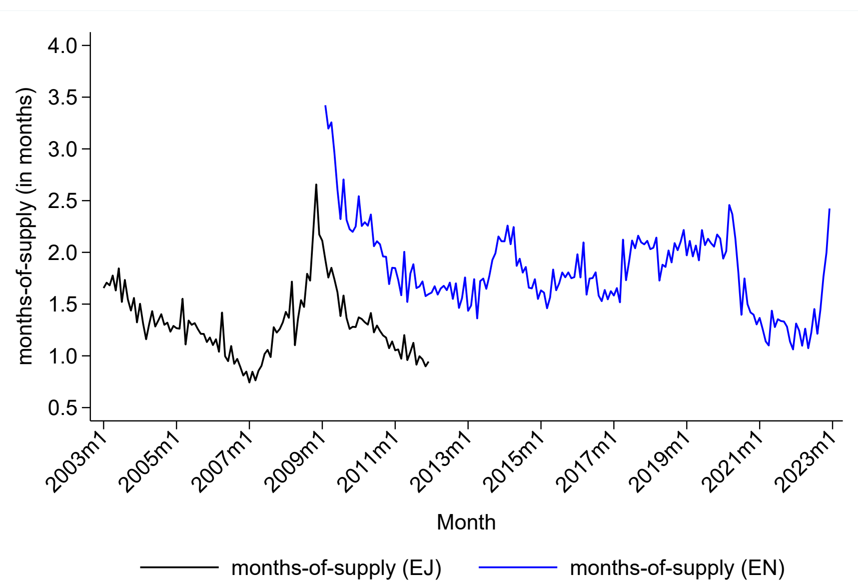
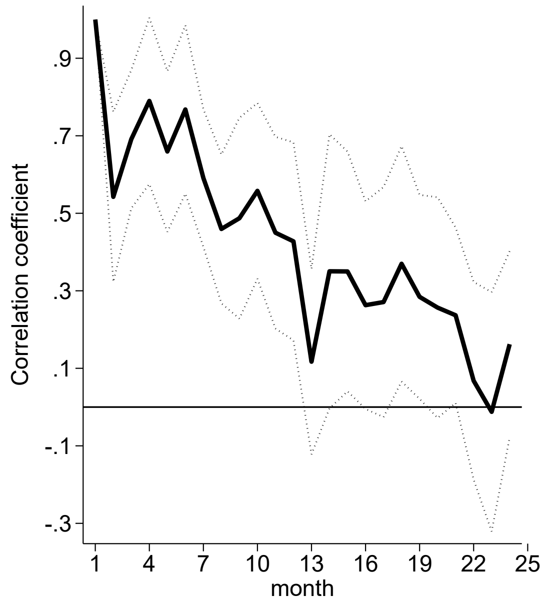
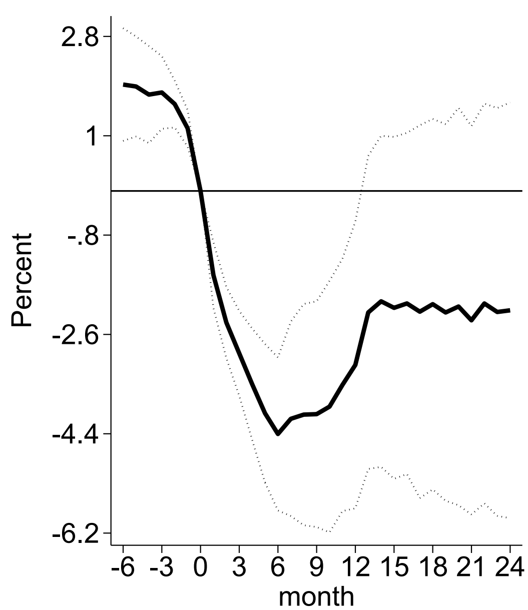


Figure 16: Autocorrelation of months-of-supply



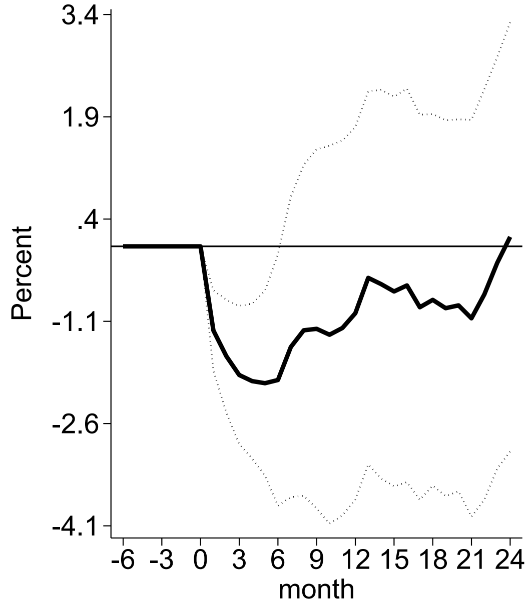
The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 17: Dynamic Phillips curve: controlling for lags of months-of-supply, 2009-2022.



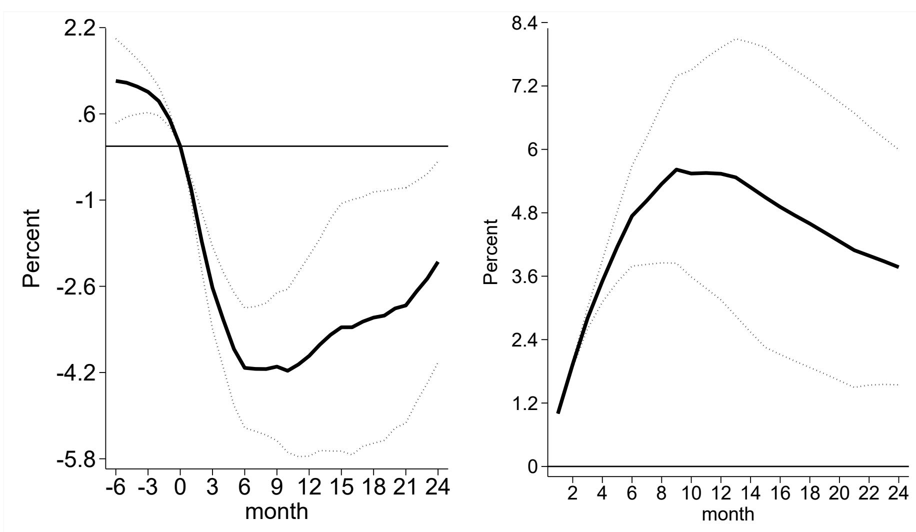
The figure shows the cumulative house price growth response for housing market belonging to a specific group (in percent) to months-of-supply increasing in that market by one month at t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 18: Dynamic Phillips curve: controlling for lags of house prices and months-of-supply



The figure shows the cumulative house price growth response for housing market belonging to a specific group (in percent) to months-of-supply increasing in that market by one month at t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 19: Dynamic Phillips curve (left panel) and momentum (right panel): alternative price index



House price index series from Statistics Norway. The left-hand panel of the figure shows the cumulative house price growth response (in percent) to months-of-supply increasing by one month at t. The right-hand panel of the figure shows the cumulative house price growth response (in percent) to a 1 percent log change in house prices in month t. The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 20: Inventory-to-sales ratios across Norwegian housing markets

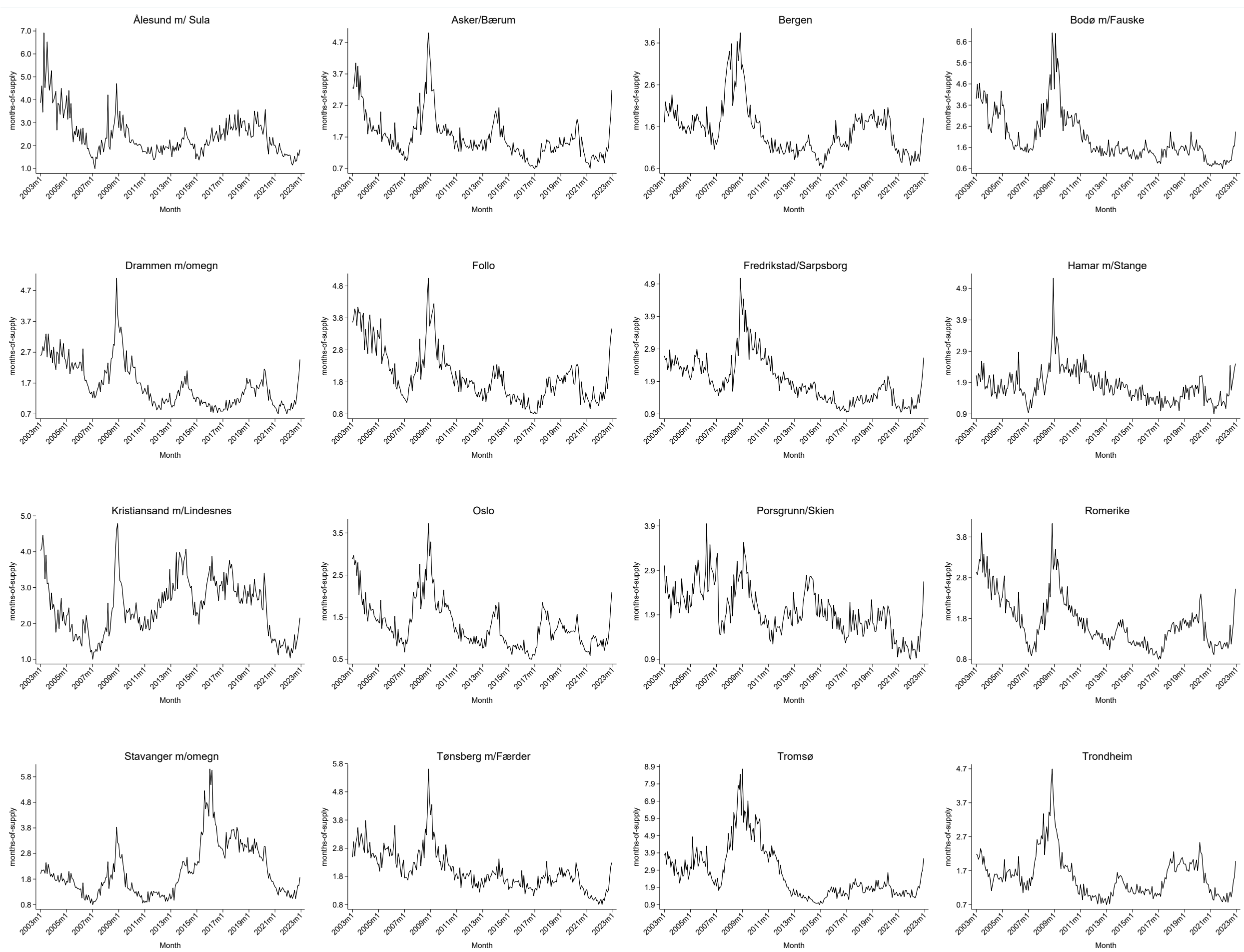
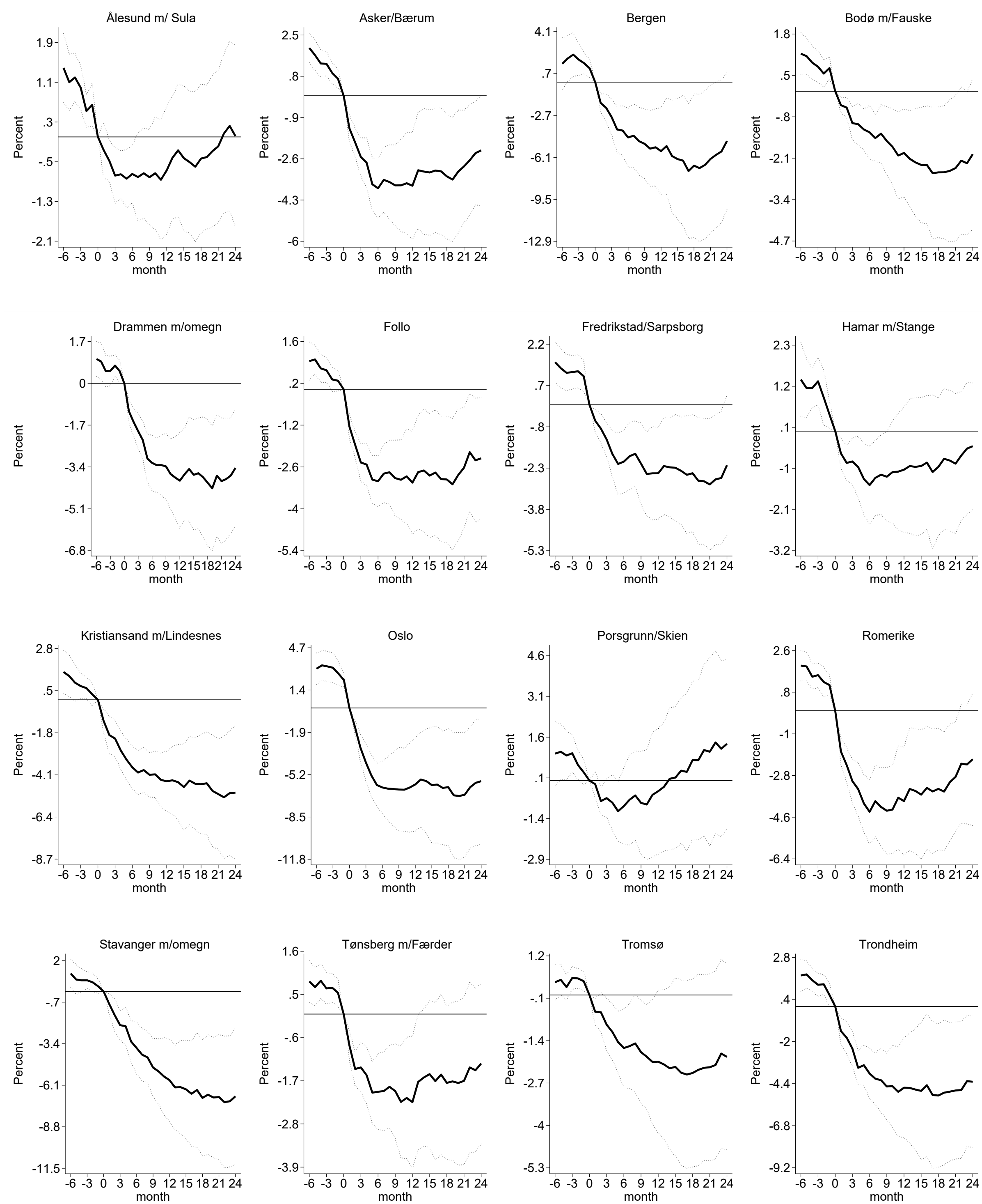
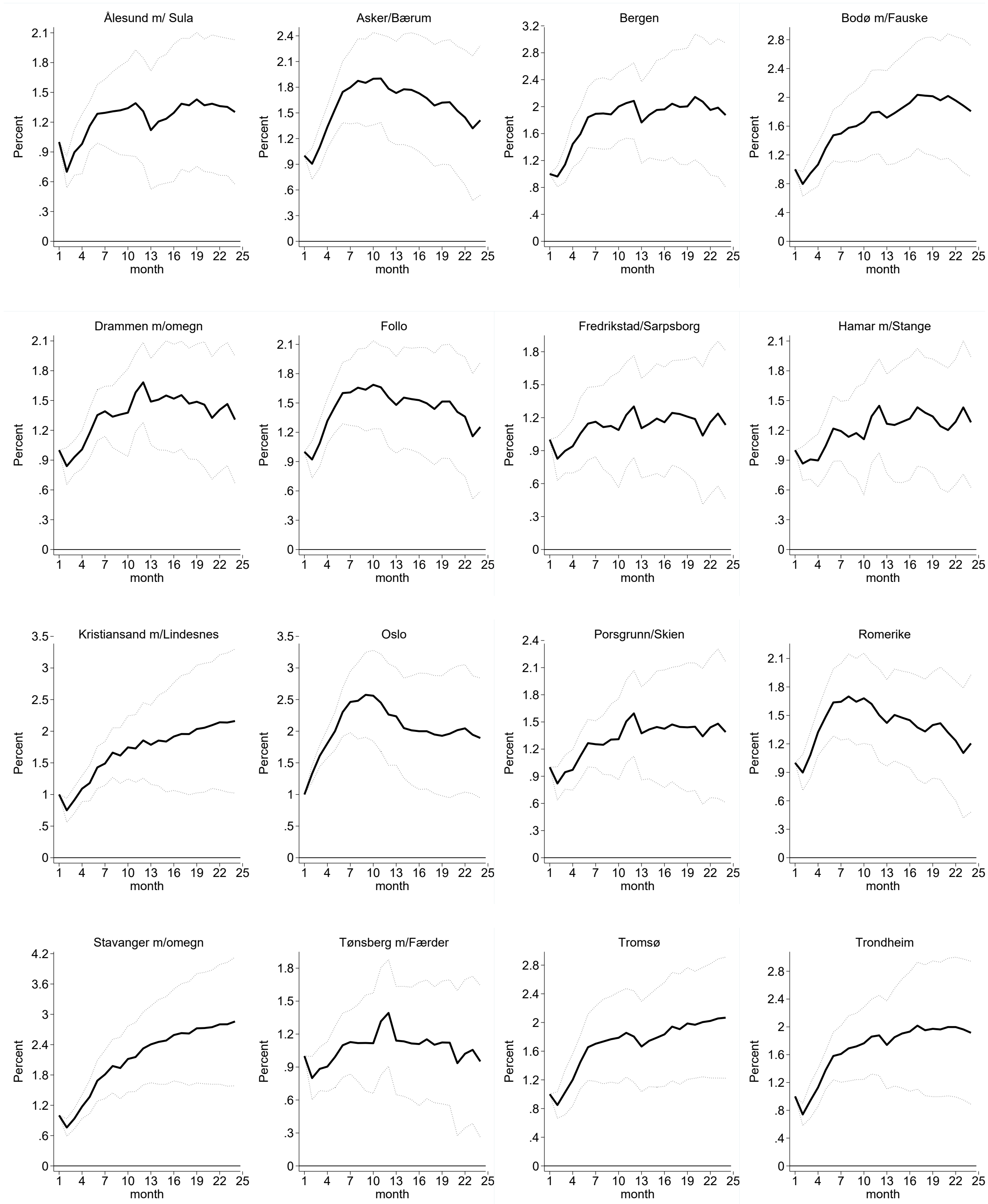


Figure 21: Dynamic Phillips curve across housing markets



The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.

Figure 22: House price momentum across Norwegian housing markets



The dashed line shows a 95% confidence interval based on Newey-West standard errors computed with 12 lags.