Bank of Israel **Research Department**

The Interaction between Macroprudential and Monetary Policies and the Housing Market – A VAR Examination for Israel [1]

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[1] The views expressed in the paper are those of the author and do not necessarily reflect those of the Bank of Israel.

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ABSTRACT

We examine the interaction between housing-market macroprudential (MaP) measures, monetary policy, and housing market dynamics in Israel. Using a structural VAR, we show that monetary policy and MaP policy react to positive shocks to house prices and to the volume of transactions in the housing market, acting as complementary policies, but do not react to changes in the levels of mortgage debt. We find that MaP measures are tigghtened in response to negative (accomodative) monetary policy shocks, offsetting their effect, while monetary policy only weakly reacts to shocks to MaP measures. Similar to the findings in previous research, contractionary monetary policy and MaP measures tend to mitigate the increase in house prices. Transaction volume declines in response to monetary tightening, and is also reduced in response to MaP measures, after a temporary increase. While monetary policy does not significantly change housing debt, MaP measures do have a mitigating effect on debt after a few periods. Our results are robust to alternative specifications.

הקשרים בין מדיניות מקרו-יציבותית, מדיניות מונטרית ושוק הדיור – בחינה באמצעות VAR עבור ישראל

סיגל ריבון

תקציר

אנו בוחנים את הקשרים בין מדיניות מקרו-יציבותית שמכוונת לשוק הדיור, מדיניות מונטרית, וההתפתחויות בשוק הדיור בישראל. אנו מראים, באמצעות שימוש ב-VAR מבני שהמדיניות המונטרית והמדיניות המקרו-יציבותית, שמכוונת לשוק הדיור הגיבו לזעזועים חיוביים למחירי הדירות ולהיקף העסקאות בשוק הדיור, כאמצעי מדיניות משלימים, אך לא הגיבו לשינויים ברמת החוב לדיור (משכנתאות). נמצא שהמגבלות המקרו-יציבותיות הודקו בתגובה למדיניות מונטרית מרחיבה, אולם המדיניות המונטרית הגיבה רק במידה חלשה להחמרת המגבלות היציבותיות. בדומה למחקרים קודמים, מדיניות מקרו-יציבותית ומדיניות מונטרית מצמצמות, נוטות למתן את העלייה במחירי הדירות. היקף העסקאות קטן בתגובה למדיניות מונטרית מצמצמת, וכן אחרי החמרת המגבלות היציבותיות, לאחר שבתחילה הוא גדל. החמרה במגבלות היציבותיות גם פועלת למיתון הגידול בחוב לדיור לאחר מספר תקופות, בעוד למדיניות המונטרית אין השפעה על היקפו. התוצאות האלו עמידות לנוסחים שונים שנבדקו.

1. Introduction and Related Literature[1]

The last decade has seen increasing use of macroprudential (MaP) measures aimed at curtailing risks to financial stability. In particular, these measures have been widely used in various countries, including Israel, against the background of accommodative monetary policy, in order to reduce the risk of instability resulting from developments in the housing market.[2] This paper joins other papers investigating the effectiveness of MaP policy on the housing market, relating to house prices, housing debt (mortgages), and enhancing previous analyses by adding the volume of house transactions to our investigation. The analysis will also allow us to learn about the reaction of policy to shocks to the housing market.

This paper is closely related to Kim and Mehrotra (2018) and Kim and Mehrotra (2019)—both of which apply a VAR approach to investigate the macroeconomic effects of policy. Kim and Mehrotra (2018) examine the effect of monetary and MaP policies for four inflation targeters in the Asia-Pacific region. Using a panel structural VAR they find similar effects of both policies on macroeconomic variables—output growth and prices—and on credit growth. They interpret their results as evidence for the use of the two policies as complements at normal times. A subsequent paper by both authors, Kim and Mehrotra (2019), investigates the macroeconomic effects of MaP policy for a panel of 32 advanced and emerging economies. There they show, using a Cholesky VAR decomposition, that MaP policy and monetary shocks have similar effects on real GDP, price level, and credit, but the transmission mechanisms are different. While MaP measures mainly affect residential investment and household credit, monetary policy shocks have a more widespread effect on the economy. An additional similar paper by Kim and Oh (2020) investigates the effect of LTV (loan-to-value) and DTI (debt-to-income) policies in Korea, using a structural VAR model, and finds that these measures significantly affect house prices, household credit, and prices. Lee and Jung (2020) show that demographic shifts are important factors in determining house prices and that macroprudential policies are only partially effective in restraining the rise in house prices.

Several papers examine the effect of MaP policies, in general or specifically on the housing market, using panel data for a wide range of countries and span of time. Generally, MaP measures are found to have the mitigating effect as intended, on the housing market and housing credit variables. Cerruti, Claessens and Laeven (2017) document MaP measures in 119 countries over the years 2000 to 2013. They find that about 20 percent of the countries and 40 percent of advanced economies used LTV limits, about 15 percent of all countries and of developed economies used limits on DTI.

Among other papers that examine a panel of countries are Vandenbussche, Vogel and Detragiache (2015), who estimate, using a panel error-correction model, the effect of 29 different MaP measures introduced in 16 countries in Eastern Europe on house prices. They find that capital measures and liquidity measures were effective in mitigating the

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[1] This project was initiated before the outbreak of the COVID-19 crisis in March 2020 and therefore does not include any reference to crisis-related issues.
I thank Aaron Mehrotra and the participants of the Bank of Israel Research Department seminar for their helpful remarks and suggestions.

[2] See Adrian (2017) on macroprudential measures and financial stability.

growth rate of house prices and also had a negative effect on the growth rate of credit. Kuttner and Shim (2016) do this for a panel of 57 countries (including Israel) over three decades and find only moderate support for the success of non-interest rate policies in affecting housing credit or house prices. Akinci and Olmstead-Rumsey (2018) look at 57 advanced and developing economies from 2000 to 2013 and report that MaP policies have a negative and significant effect on bank credit growth and house price appreciation. Richter, Schularick and Shim (2019) use a panel Local Projection method for data for 56 economies, both advanced and developing, and show that changes in LTV have significant effects on credit growth and house price increases. In addition, they investigate the effect of these measures, relative to that of monetary policy on the macroeconomic variables—output and inflation—and find that tightening (by lowering) the LTV limits by 10 percentage point is expected to reduce output by 1.1%, which is comparable to an increase of about 25 basis points in the interest rate. They do convey that this result is imprecise and only present in emerging markets.[3] Benati (2020) finds that the effect of monetary policy on house prices in the U.S., Canada and the U.K., is about three times as large as that on real GDP, and therefore monetary policy that leans against fluctuations in house prices might entail significant losses in real activity. Ehrenbergerova and Bajzik (2020) use meta analysis of 31 studies based on VAR analysis, and conclude that an increase in the short term interest rate does result in a decrease in house prices. The median effect is a 0.7–0.9 percent decline in prices over one to two years as a result of a one percentage point increase in the interest rate.

Gambacorta and Murcia (2020) show for a number of Latin-American countries that macroprudential policies, and in particular, those aimed at mitigating the cycle, more than policies aimed at fostering resilience, have been quite effective in stabilizing credit cycles. They also find that MaP tools are more effective when reinforced by monetary policy. Alam et al. (2019) show for a dataset comprising of 134 countries spanning from 1990 to 2016 that the effects of LTV changes on household credit are strong and non-linear. Revelo et al. (2020) also examine the interaction between macroprudential and monetary policies, looking at a sample of 37 emerging and advanced economies. They find that the growth rate of credit (to the private sector and to households) is reduced due to macroprudential measures, and stress that restrictive monetary policy enhances the effect of the macroprudential measures, and that the two policies complement each other.[4]

In 2018, the IBRN[5] targeted its research project at investigating the interaction between MaP policies and monetary policies, emphasizing the international spillover effects of policies in core economies on other economies. One of the papers in this project, by

[3] Hulsewig and Horst (2021) employ the Local Projections methodology and show for a panel of euro area countries, that monetary policy shocks that can be related to unconventional monetary policy, affect house prices, and therefore should take into account the risk of fluctuations in the housing market.

[4] Bruno, Shim and Shin (2017) who study the effect of capital flow and banking sector measures on the growth of bank capital flows, bond portfolio and credit in 12 Asia-Pacific countries in 2004–13, find that MaP measures did have an effect on inflows only prior to 2009, and that they are effective only when implemented in accordance with the direction of monetary policy.

[5] International Banking Research Network, hosted by the New York Fed. The Bank of Israel is a member of this network. See: https://www.newyorkfed.org/ibrn. See Bossiere et al. (2020) for a review of seven papers written in the 2018 project.

Everett et al. (2020), which is a joint paper by authors from the central banks of the Netherlands and Ireland, found that stricter domestic prudential regulations had a significant effect on mortgage credit growth in Ireland. Contrary to these findings, for the Netherlands it was found that the growth of Dutch mortgage credit was only influenced by monetary policy shocks, with no evidence of a significant impact of domestic MaP policy. Another paper in this project, studying the interaction between macroprudential policy and monetary policy in Norway and Sweden (Cao et al., 2020) finds evidence that aggregate MaP policy depresses aggregate lending, although they find it hard to detect separate effects for different types of macroprudential steps.

Benchimol et al. (2022)[6] investigated the interaction between MaP policy targeted at the banking sector, and monetary policy in Israel in its effect on the bank credit market, analyzing separately business credit, consumer credit and housing credit (mortgages). Using bank panel data for 2004–2019, they find that domestic MAP measures targeted at housing sector credit reduce the growth rate of this credit but contribute to the growth of business credit, so that total bank credit does not decline due to housing MaP measures.

Concerning Israel, IMF (2014), in its country report for Israel, assesses the effectiveness of housing sector MaP measures on prices, turnover and mortgages. Measures like LTV or debt to income limits are defined as direct measures, and supplementary provisioning and capital surcharges as indirect measures. The analysis shows that the effect of the measures was limited and that direct measures are more effective than indirect measures. They find that MaP policies reduced somewhat the level of transactions but do not find evidence for an effect on house prices.

The effect of the housing market oriented MaP on the Israeli housing market was investigated by Tzur-Ilan (2019). Citing two of her previous papers that analyzed loan-level data, she reports that the LTV limit induced borrowers to buy cheaper, lower quality assets, but it did not exclude any segment of borrowers from the market. She also found that investors were the borrower type that was most affected by the 2012 LTV limits.

Orfaig (2017) analyzed the link between monetary policy and house prices in Israel using a structural VAR for the period 1995–2015 and found that a positive shock to the Bank of Israel interest rate generated a decline in the real prices of houses. Nonetheless, these shocks were not a dominant factor in explaining the changes in home prices in the research period.

It is worthwhile noting that, to the best of our knowledge, none of the papers studying the effect of macroprudential measures on the housing and mortgage markets analyze or refer to the influence of these measures on the volume of house transactions, or the effect of transaction dynamics on the tendency to set new policy measures. The inclusion of the volume of transactions in the current paper allows better understanding of the dynamics in the housing market, relating to both prices and quantities.

[6] This paper was also initiated within the IBRN project.

2. Macroeconomic Background

2.1 The housing and mortgage markets

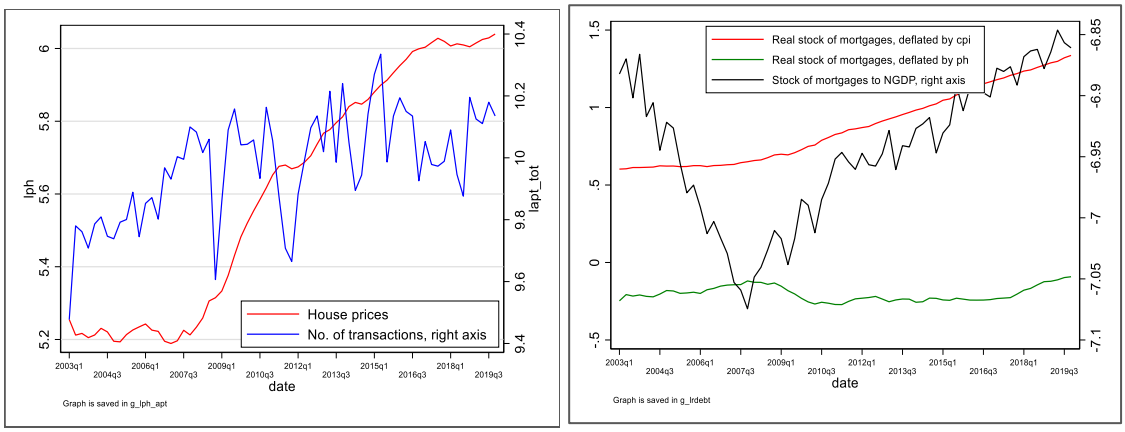
House prices remained relatively stable during the first years of the 21st century, after the cycle in the housing sector that was driven mainly by the vast immigrant influx in the 1990s ended. Since the end of 2007 house prices escalated rapidly, and more or less doubled by 2017. In subsequent years, until 2019, prices have been generally stable. (Figure 1).

The persistent rise in house prices may be attributed to both demand side and supply side factors. On the demand side, the sharp decline in short and long term interest rates in the wake of the GFC, both globally and domestically, supported the search for yields in alternative assets, including housing, and also worked to lower the cost of mortgages. On the supply side, the volume of housing starts being below the assessed volume required to meet population growth supported additional pressure on house prices.

In recent years, a significant government program was launched in order to assist first-time young buyers in acquiring an apartment ("Mechir LaMishtaken"—"Buyer's Price"). The program essentially subsidized new apartments for buyers who met the requirements set by the government and was assessed to have a significant impact on the market because it generally removed both supply and demand from the free market, while in contrast it may have encouraged households that did not plan to purchase a home to join the market.[7]

Alongside the substantial activity in the housing market and the rapid rise in prices, the volume of mortgages has also grown significantly during these years (Figure 1, right panel). The real annual growth rate (deflated by CPI, or relative to output) of bank mortgage loans has been rapid since 2008. Due to the prevailing rise in house prices, the stock of mortgages deflated by house prices has remained relatively stable.

Figure 1: House Prices, Transaction Volume, and Real* Stock of Bank Mortgages (in logs), 2003–2019



* Deflated by CP , house prices or nominal GDP (right axis).

[7] For further discussion, see Bank of Israel Annual Reports for 2017 and 2018.

2.2 Macroprudential policy in the housing market and monetary policy

Against the backdrop of the rapid rise in house prices and mortgages and the potential risk to the banks and to financial sector stability entailed in these developments, the Banking Supervision Department in the Bank of Israel chose to implement macroprudential measures targeted specifically at this market.

Macroprudential measures related to the housing market may be divided into two different types. The first—which relates to the characteristics of the loan itself, mainly the LTV ratio—is aimed at the borrower by limiting the size of the loan acquired relative to the value of the asset bought, and its composition, thus influencing the quality of mortgages and borrowers' risk. The other type of measures are focused directly at the lender, aimed at strengthening the banks' resilience to a crisis, such as increased provisions and additional capital requirements, and raises costs to banks. Table A.1 in the appendix summarizes the MaP measures taken in the last 15 years in connection with the housing market.[8]

In the first stage (2009–10) MAP measures included some bank warnings and limitations. Later on, there were additional capital requirements for risky loans, and provisions and restrictions on the characteristics of the loans that can be offered by the banks.

In 2011–14, a number of MAP measures were adopted to strengthen the stability of banks and households. In 2011, a requirement was introduced, according to which only up to one-third of the total loan can bear interest at a variable rate that is adjusted at a frequency of up to 5 years. This measure was presented in order to cope with the large demand for loans bearing a variable interest rate against the background of low interest rates, which led to new loans with variable interest rates reaching 80 percent of total new loans at that time.

Due to the continued rise in housing prices and mortgage volumes, additional measures were implemented. In October 2012, the loan-to-value (LTV) ratio was limited to 75 percent for first-time home buyers, 50 percent for investors, including nonresidents, and to 70 percent for all others.

In February 2013, a change was made in the capital allocation and the provision for doubtful debts in respect of housing loans, and later in the year, 3 new measures were introduced: 1)The PTI ratio was limited to 50 percent of income. Housing loans where the monthly repayment is over 40 percent are to be weighted at 100 percent of risk weighted assets (RWA) for the purpose of calculating the capital adequacy ratio; 2) The portion of the loan at variable-rate interest was limited to two-thirds of the total loan, for all loan periods; 3. The loan period was limited to 30 years.

In September 2014, an additional capital allowance requirement was introduced, amounting to 1 percent of outstanding housing loans, to address vulnerabilities and boost the banks' loss absorption capacity.

[8] Compilation of the housing MaP measures and the index used here is based on Benchimol (2020).

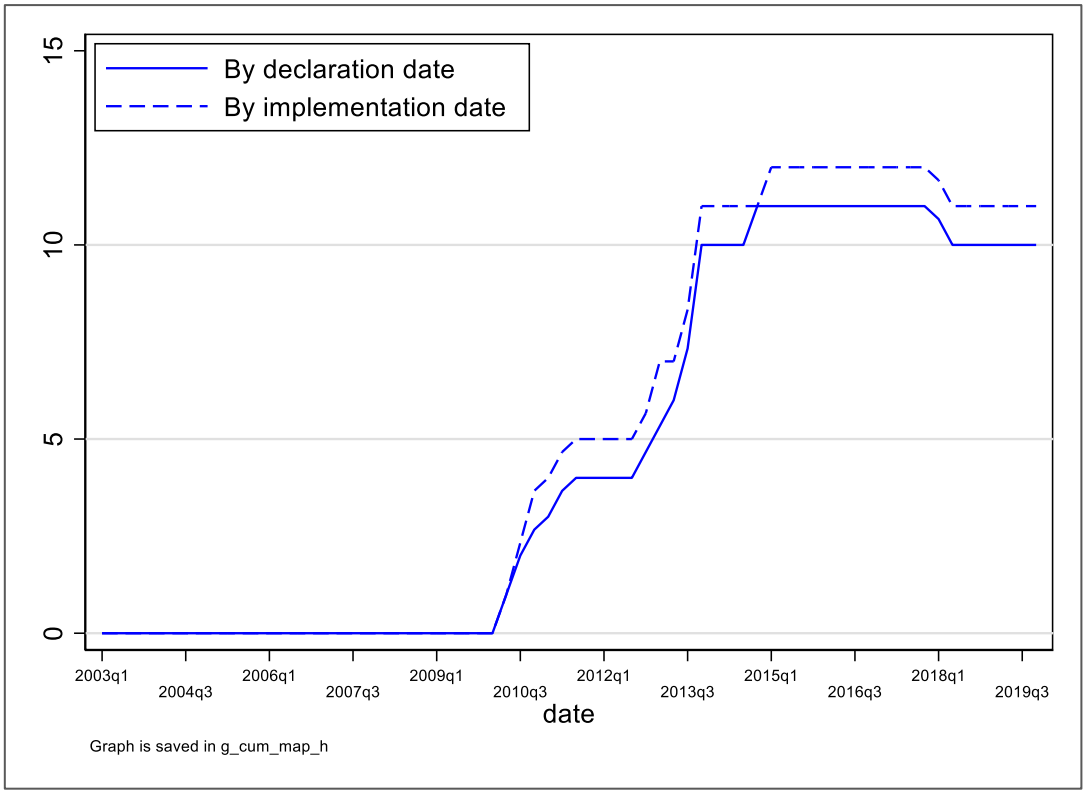
A single loosening of MAP measures was taken in March 2018, when the Banking Supervision Department announced that housing loans with an LTV of 60–75 percent will be weighted by the bank at 60 percent for purposes of calculating the capital adequacy ratio instead of 75 percent that were required up to that time.

An analysis by Baudot-Trajtenberg et al. (2017) of the MAP measures showed that these led to a decrease in the average LTV on new mortgages and to a decrease in the average PTI. Despite the measures taken, until 2017, housing prices continued to rise, and the housing market remained very active, mortgage interest rates continued to decline, and the volume of mortgage lending rose, as did the volume of housing market transactions.

In addition to the MAP measures that were implemented by the Bank of Israel, other factors, no less important, affected the supply side: measures by the government to increase the supply of land and to increase the number of housing starts, and on the demand side, such as government measures in taxation.

Following the literature (see Cerruti et al., 2017a) we construct[9] an index for the accumulated housing MaP measures implemented in Israel since 2003. Figure 2 summarizes this index, according to the declaration and implementation date of the steps taken.[10] In what follows, we will consider alternative specifications of the MaP measures index, accumulating the steps over a limited number of past periods instead of accumulating the steps over all historic periods.

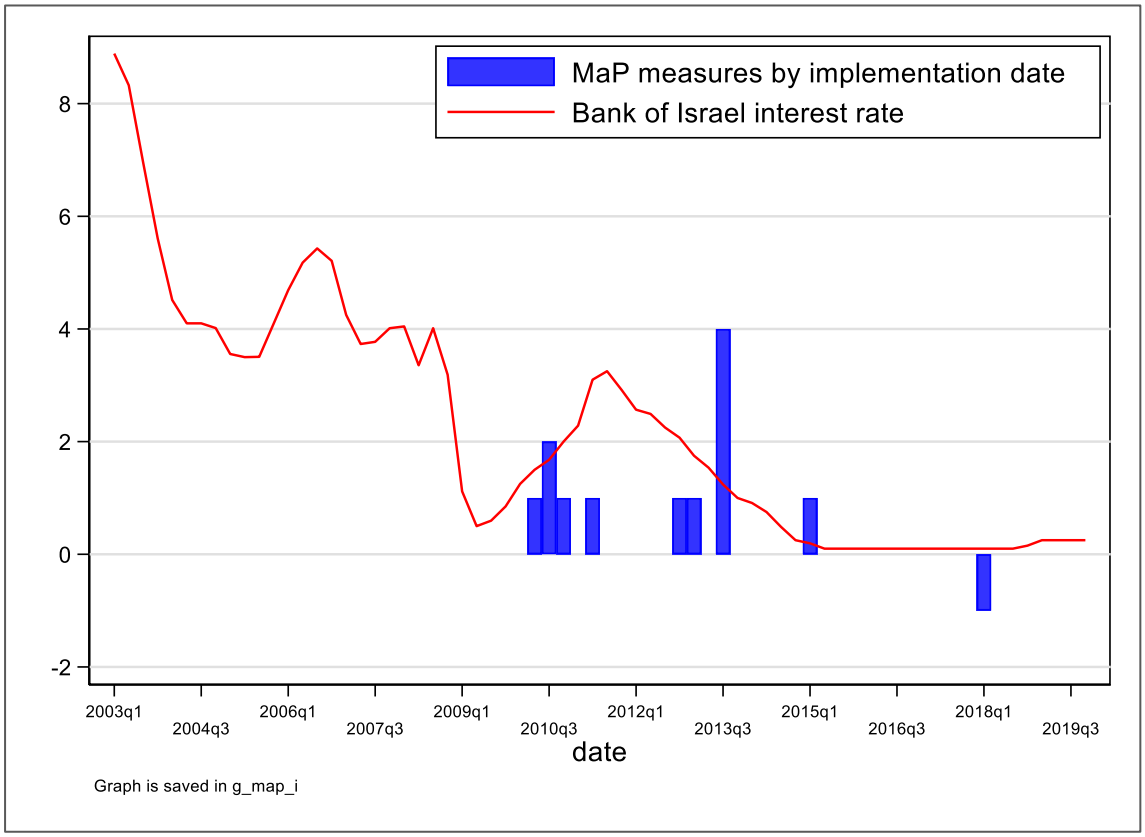
Figure 2: Accumulated Housing MaP measures, quarterly average



[9] See footnote 8.

[10] The figures shown are the quarterly average of the monthly level of accumulated measures directed at the housing market

Figure 3: Bank of Israel interest rate and housing MaP measures



Monetary policy during those years was generally characterized by a downward trend of nominal interest rates, after the adoption of a price stability inflation target (1–3%) starting from 2003. Following the sharp decline in interest rates due to the GFC, a relatively rapid improvement in the economic environment was met by a steady tightening of monetary policy. With the European financial crisis, which was followed by lower local growth rates and inflation, monetary policy became more accommodative and stayed so, at historically low rates of 0.1 to 0.25 percent until the end of the period studied. Figure 3 shows the evolution of the Bank of Israel's key interest rate alongside the timing and number of housing market MaP measures. Note that the majority of MaP measures were implemented while monetary policy was loosened.

3. The Methodology and Data

We employ a VAR model to identify the effect of policy instruments—both the interest rate and Macroprudential (MAP) policy—on the dynamics of house prices, transactions, and mortgages. Following Kim and Mehrotra (2018) and Kim and Mehrotra (2019), who investigated these issues for a panel of economies, both advanced and emerging, we devote our empirical analysis to the Israeli economy, and include, in addition to the macroeconomic variables Kim and Mehrotra (2018, 2019) investigate, house market variables.

Generally, the structural VAR form of the economy may be represented by:

(1) $A(L)y_t = C(L)x_t + \varepsilon_t$,

with A and C matrix polynomials in the lag operator L, y a vector of $i=1,..,K$ endogenous variables and x a vector of exogenous variables. ε is the structural shock with $Var(\varepsilon_i)=\sigma_i$ and $Cov(\varepsilon_i, \varepsilon_j)=0$.

We assume a lower triangular structure (Cholesky decomposition) of A(L), and estimate the system of equations:

$$(2) \quad y_t = B(L)y_{t-1} + D(L)x_t + u_t \,,$$

with B and D matrix polynomials in L and u_t being the reduced form residuals.

Our system includes eight variables: Two policy variables—an index for MaP measures relating to the housing market and the interest rate set by the Bank of Israel, output, house prices, volume (number) of house transactions, the real (deflated by CPI) stock of bank mortgages[11], the (nominal) effective exchange rate, and consumer prices. The inclusion of the house transactions in the analysis is to the best of our knowledge unique, as the analyses in the literature that we are aware of refer to house prices and/or credit, but do not discuss the impact of policy on activity in the housing market, or the impact of the volume of transactions on policy decisions. The identification of the structural shocks is implemented using a simple Cholesky ordering. In the benchmark specification, the policy variables are ranked first, assuming that both may affect economic developments contemporaneously but are preset. This is reasonable due to the fact that the interest rate for a certain period is set and announced in advance, given the information only concerning economic developments in previous periods. In order to ensure that interest rates are indeed exogenous to developments, interest rate data are used lagged one month, so that the average for a particular quarter includes the first two months of the current quarter and the last month of the previous quarter.[12]

MaP measures are also usually announced in advance relying on information about the past.[13] The nominal effective exchange rate is seventh in the order of the variables, conveying the assumption that the exchange rate may react instantaneously to policy or other shocks, and may affect consumer prices immediately; consumer prices are last in the system.[14]

Specifically, the variables are included in the VAR system in this order: *i1, cum_MaP, log(GDP), log(ph), log(apt) log(rdebt_h), log(e), log(cp),* where *cum_MaP* is the quarterly average of the monthly cumulative index of macroprudential measures aimed at bank mortgages (see Figure 2), *i1* is the Bank of Israel declared interest rate lagged one month,

[11] For robustness we alternatively include mortgages deflated by house prices or the change in mortgage debt, i.e., an indicator for the net flow of mortgaged credit.

[12] Alternatively, we also estimate a VAR system where the policy variables appear last – so that they are affected contemporaneously by all other variables, but affect them only with a lag.

[13] Table A.1 in the Appendix indicates the exact dates of each of the decision dates for the MaP measures and the monthly (at that time) interest rate decisions. The MaP decisions usually announced just a few days before or after the monetary policy decision, with no clear pattern. Therefore we decided to position them in our benchmark estimation first in the Cholesky ordering.

[14] Robustness checks presented later show that changing the order of the variables, and specifically placing the policy variables last in the system – assuming they react immediately to other shocks, does not alter the results noticeably.

GDP is real seasonally adjusted output, *ph* is the index of house prices, *apt* is the volume (number) of apartment transactions, *rdebt_h* is the average quarterly stock of bank debt for housing deflated by the CPI, *e* is the nominal effective exchange rate, and *cp* is the level of the consumer price index. We include in the system a few additional exogenous variables to take into account the global economic environment—(log) US output (lagged one quarter) and the Fed's interest rate (contemporaneous and lagged one quarter), and long term domestic yields (lagged 10-year real yield on government bonds). We include, in addition, seasonal dummy variables for the quarters.

Our benchmark quarterly frequency estimation is for the period starting in 2003 and ending in 2019, a total of 68 observations.[15] We chose to terminate our sample just before the (local) outbreak of the COVID-19 crisis in order to move away from its possible extreme effects on economic variables and dynamics. Due to sample length limitations, we include only 2 lags, taking into account the lag length tests, and employ the *F* and *t-statistics* adjusted for small samples.

The size of the impulse response is normalized to one standard error of the structural innovations derived from the Cholesky decomposition.

4. Results

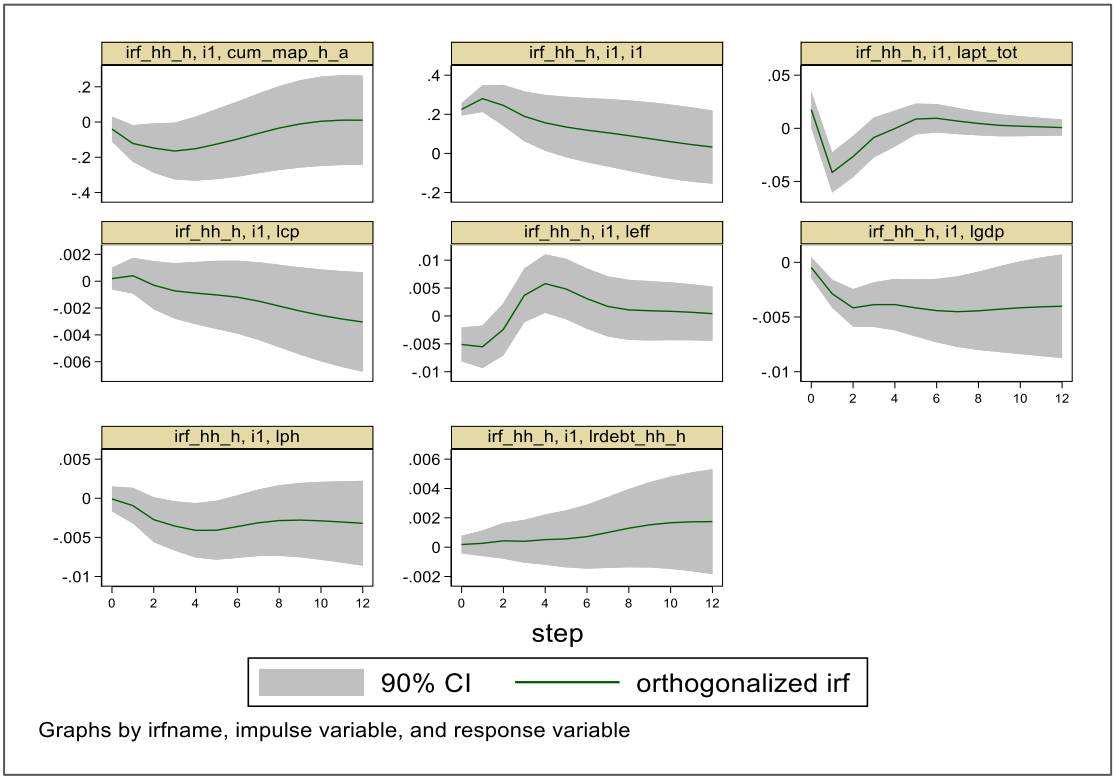
The eight-variable VAR makes it possible to examine the effect of policy—both MAP measures and monetary policy, on the volume of house transactions, mortgages and house prices, and also makes it possible to assess the reverse relationship between the housing market and policy—to what extent do developments in mortgages or house prices drive innovations in policy. This is done within a system that includes the basic macroeconomic indicators—output, consumer prices and the exchange rate—so that the interaction between policy innovations and the economy is taken into account.

4.1 A shock to the monetary interest rate

First, we show the effect of a shock to monetary policy—an unexpected increase in the Bank of Israel's interest rate—on all other variables. Recall that we include the quarterly average of the interest rate lagged one month, and that according to our baseline formulation the interest rate may affect all other variables concurrently, but is affected only with a lag due to the fact that policy is set in advance.

[15] As part of the robustness checks we estimate the system for shorter subperiods.

Figure 4: Impulse Responses to an Interest Rate Innovation



* The grey area depicts a 90% confidence interval.

A shock to the interest rate generates a negative response of macroprudential policy. According to this result, which is easier to interpret with opposite signs, a more accommodative monetary policy is accompanied by stricter MaP measures. This pattern was revealed in BoI communications that stressed that MaP measures place a wedge between eased monetary policy and the cost of loans, and thus weaken the effect of the accommodative policy on the mortgage market and eventually on financial stability.[16] We find that higher interest rates reduce the volume of house transactions alongside a decline in house prices, indicating a decline in demand for houses. The level of mortgage debt (deflated by CPI) remains unaffected. As expected, output tends to decline, while the effect on inflation is less evident. The exchange rate appreciates as a result of the positive shock to the interest rate (Figure 4).

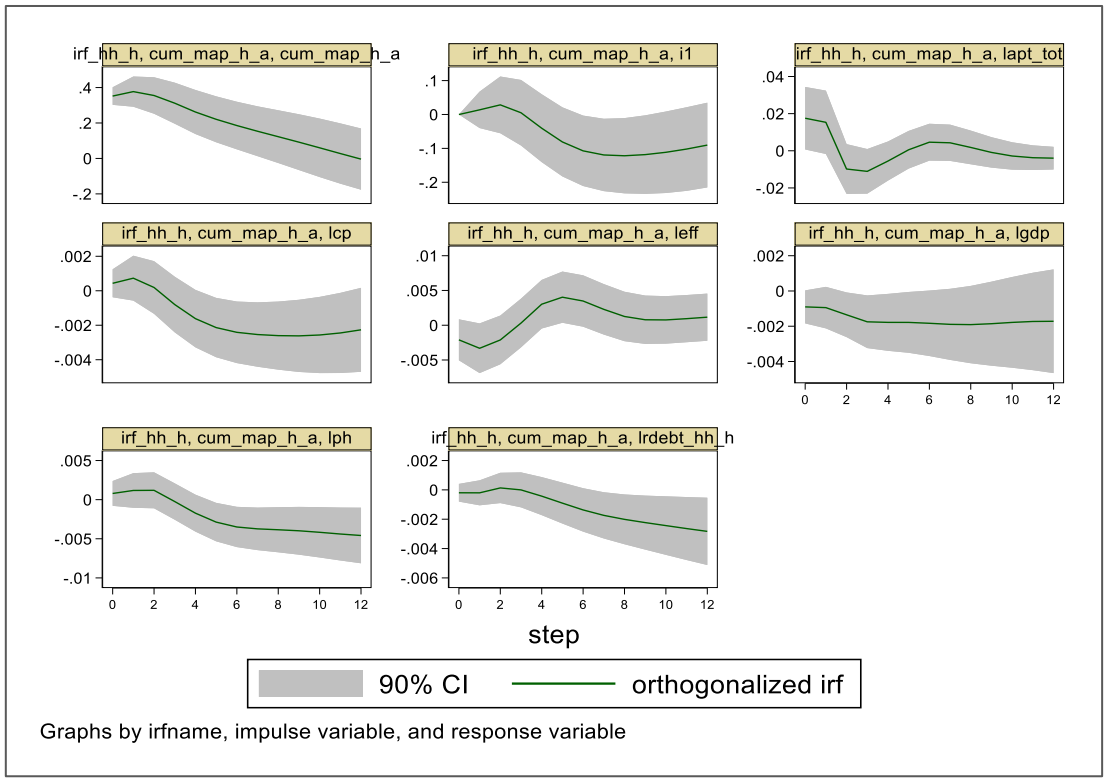
4.2 A shock to MaP measures

Since 2010, several steps have been taken to address the risks in the mortgage and housing markets. According to the impulse responses it seems that these steps had some contractionary effect on house prices and on the stock of mortgages after about a year, and on the volume of house transactions, although only after a rise in transactions in initial periods. A 1-std innovation (of the size of 0.4 in the index terms) results in a decline of about 0.5 percent in house prices after about two years. Therefore an increase of 1 point in the index (one MaP measure), is expected, on average, to result in a decline of the magnitude of about 0.7 percentage points in house prices, the volume of transactions rises somewhat in the short-term and later tends to be a bit lower. This result is different from

[16] See for example the Bank of Israel Monetary Policy Report (2013).

that of IMF (2014) in their analysis of the Israeli market, which did not find a significant effect of MaP policy on house prices. There is also evidence for a contractionary effect on the stock of mortgages, with a decline of about 0.2 percentage points for a 1-std innovation in MaP measures, or about 3 pp for an additional measure after about a year or two[17] (Figure 5).

Figure 5: Impulse Responses to a Macroprudential Innovation



* The grey area depicts a 90% confidence interval.

Contrary to the response of MaP policy to monetary shocks, a shock to the MaP measures does not result in a significant response in the opposite direction of monetary policy in the short run; it is marginally significant after a considerable delay. It is consistent with our understanding that macroprudential steps, which were targeted at the housing market, were implemented, at times, taking into account monetary policy, while monetary policy, as was also communicated to the public, did not tend to react in the short term to macroprudential policy measures. In the medium term, stricter MaP measures allowed, to some extent, a somewhat more accommodative monetary policy.

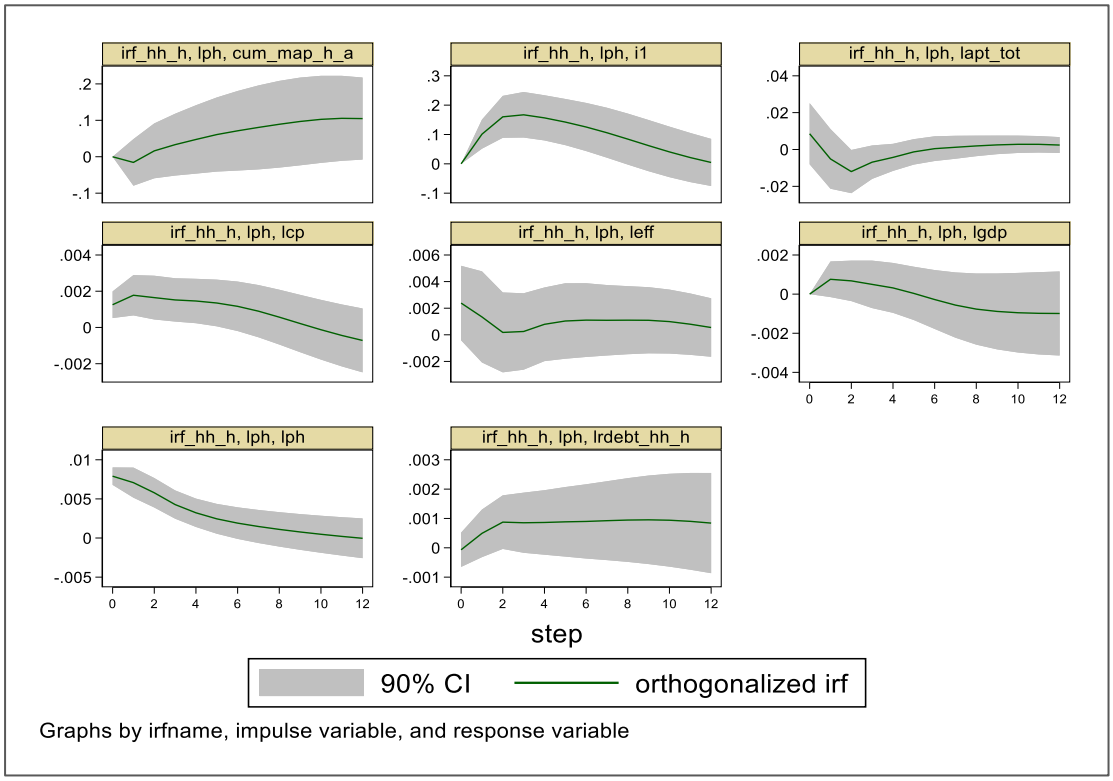
4.3 A shock to house prices

In response to an unexpected shock to house prices, transaction volumes decline, but debt volume (in CPI real terms) increases moderately, although not statistically significantly. While monetary policy reacts quite rapidly and significantly to the shock, MaP policy's reaction is much more protracted and harder to identify, although a positive reaction can

[17] In an alternative specification of the VAR system, where MaP measures and the interest rate appear last in the system, the mitigating effect of a shock to MaP policy on debt is significant for most periods.

be detected after some periods. In this sense – in reacting to a price shock, policies are complementary – both react in the same direction to a shock to house prices. Monetary policy reacts to shocks in house prices, although their development is generally not viewed as the core interest of monetary policy, but rather a financial stability concern. According to the estimated response function, an increase of about 10 percentage points in house prices will result in (approximately) one additional MaP measure after about more than a year and about a 1.5pp interest rate hike. (Figure 6).

Figure 6: Impulse Responses to an innovation in house prices

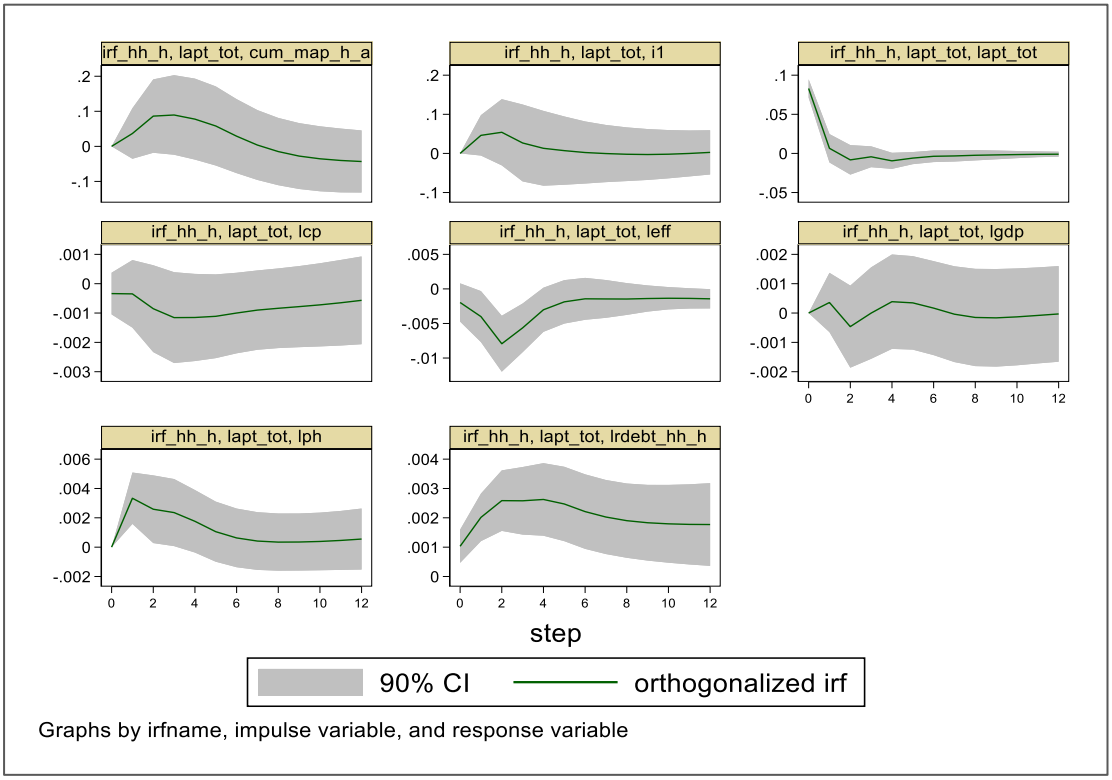


* The grey area depicts a 90% confidence interval.

4.4 A shock to the volume of transactions

A shock to the volume of house transactions is accompanied by a rise in house prices, and the volume of debt, indicating a demand shock. Unlike a shock to prices, in this case the reaction of monetary policy is weaker and hard to identify. The response of MaP policy is somewhat stronger and relatively quick.

Figure 7: Impulse Responses to an innovation in the volume of house transactions

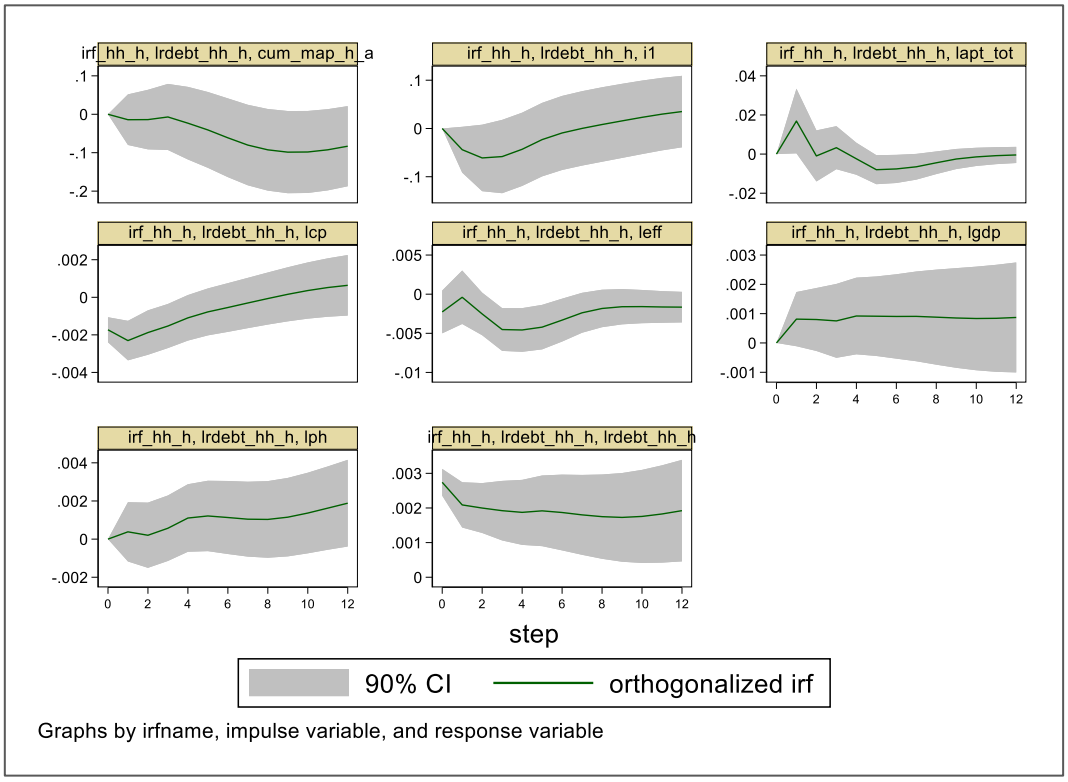


* The grey area depicts a 90% confidence interval.

4.5 A shock to mortgage debt

The results of this exercise need further investigation. According to our analysis, MaP policy does not react to these shocks. The policy rate is reduced, but not in a statistically significant manner. The reaction of house prices is insignificant, but some tendency for transactions to rise may be detected. This combination of higher debt with more transactions and higher prices may be interpreted as a supply shock to debt from the supply side, i.e., the banks. (Figure 8).

Figure 8: Impulse Responses to an innovation in the real stock of mortgages



* The grey area depicts a 90% confidence interval.

5. Additional Analysis

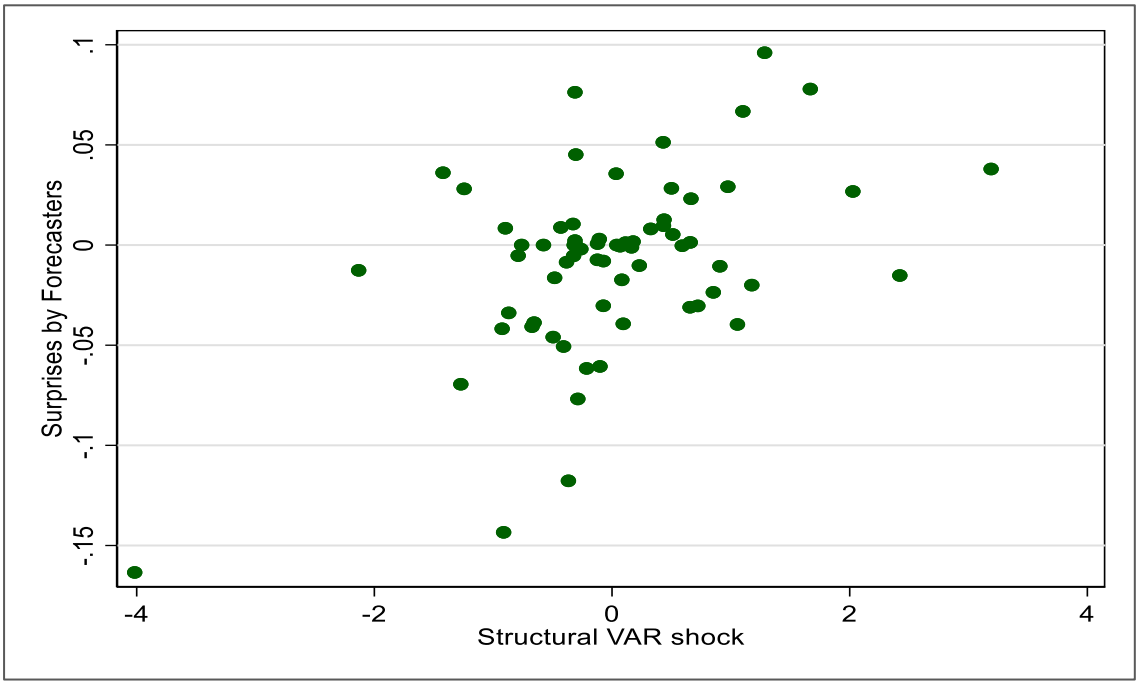
5.1 Interest Rate Structural Shocks

Based on the Cholesky decomposition, we may retrieve the structural shocks that have materialized in our sample. By construction, the correlation between each pair of structural shocks is zero.

In order to evaluate the plausibility of our identification, we compare the structural shocks derived from our VAR system to the average quarterly deviation of the actual change in the Bank of Israel's interest rate from the average forecast of the professional forecasters.[18] Although these two measures of deviations of the interest rate from its expected value are a product of two different methodologies, we find that the correlation between these two indicators is rather high – about 50%. (Figure 9).

[18] The monthly deviation of the forecasters' forecasts from the actual interest rate was lagged one period before being averaged to quarterly frequency, similar to the transformation of the actual rate, used in the estimation of the VAR system.

Figure 9: Surprises according to Professional forecasters and VAR structural shocks



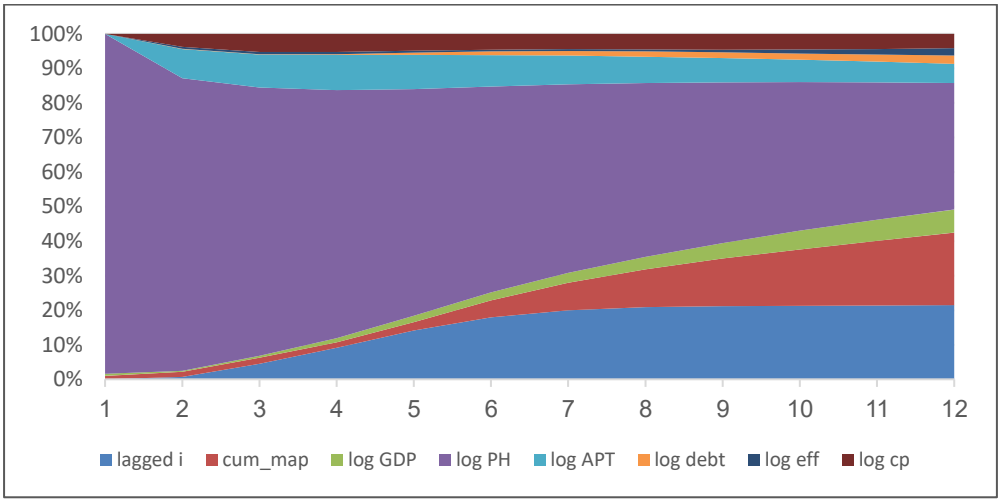
5.2 Variance Decomposition

In the framework of a structural VAR system, the variance decomposition indicates how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other endogenous variables. Figure 10 presents the variance decomposition for the three house market variables in the system – house prices, transaction volume and the volume of debt.

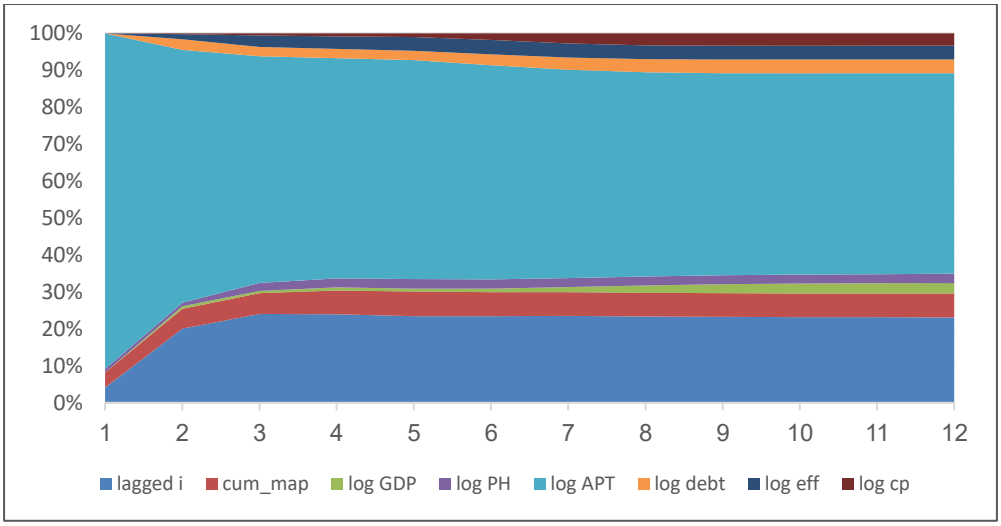
The variance of house prices is affected, apart from by its own variance, which is mostly evident in the short run, by policy – both by the interest rate and the MaP measures, which together account for about 40% of the variation in forecasted prices. The forecast variation of transactions volume is explained by its own variation but also by policy, and in particular by the variation of monetary policy. Variation in debt is to a large extent due to variation in the volume in transactions, but also, to some extent to MaP measures.

Figure 10: Variance Decomposition, selected variables

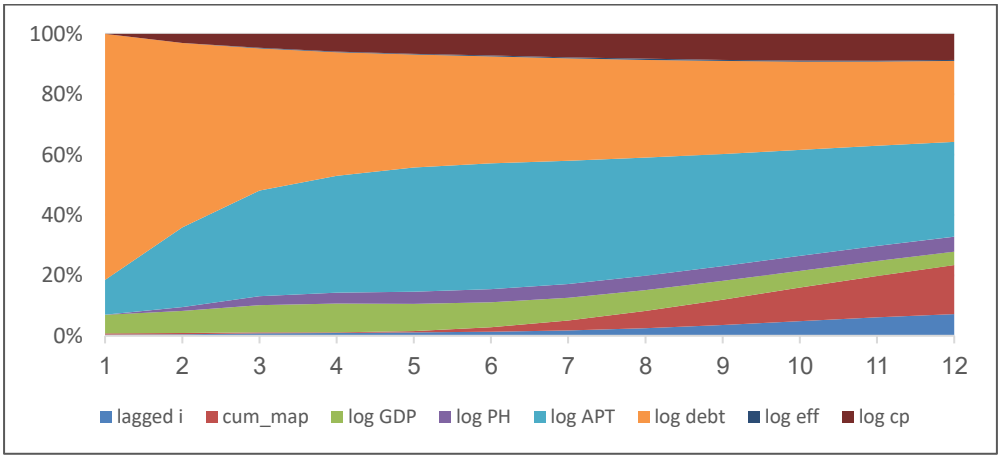
a: House Prices



b: Transactions



c: Mortgage Debt



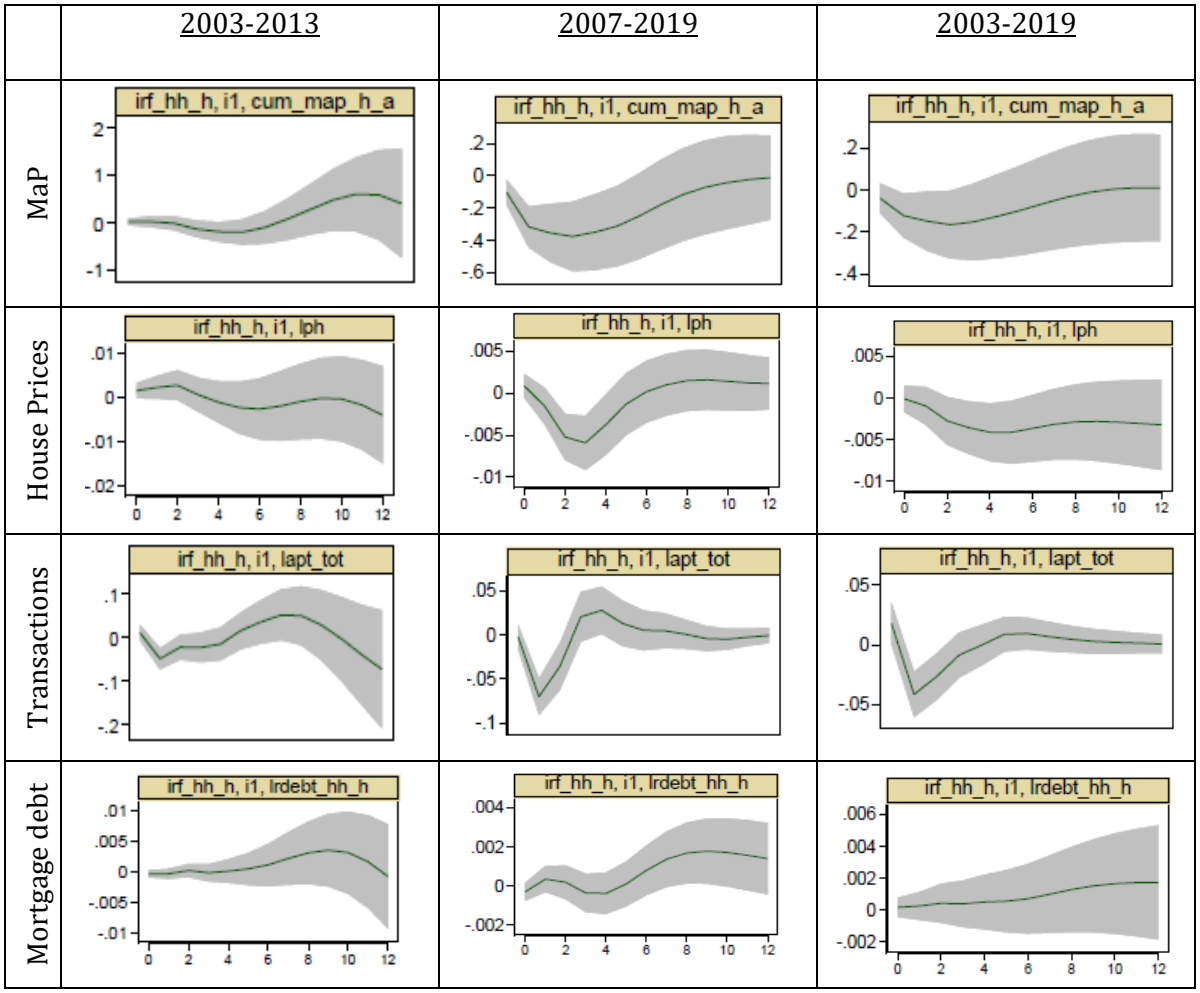
6. Robustness Tests

In order to verify the robustness of the results we estimated the VAR system with several alternative specifications. Generally the qualitative results remain unchanged.

6.1 Alternative Samples

For the benchmark estimation we chose to start our sample in 2003, in order to allow a time period which is not too short and includes at least one business cycle. Nonetheless, MaP measures were implemented mostly in the second half of this sample, while monetary policy remained generally unchanged during the later part of the sample. Therefore we re-estimate the VAR for two partial samples, although overlapping subsamples (due to the sample length limitations). The first subsample includes the earlier part of our full sample – 2003 to 2013, and the second spans 2007–19. The specification of the system remains as it was for the full sample, following our benchmark ordering with the interest rate, lagged one month, first and MaP measures second. Generally the qualitative results remain unchanged.

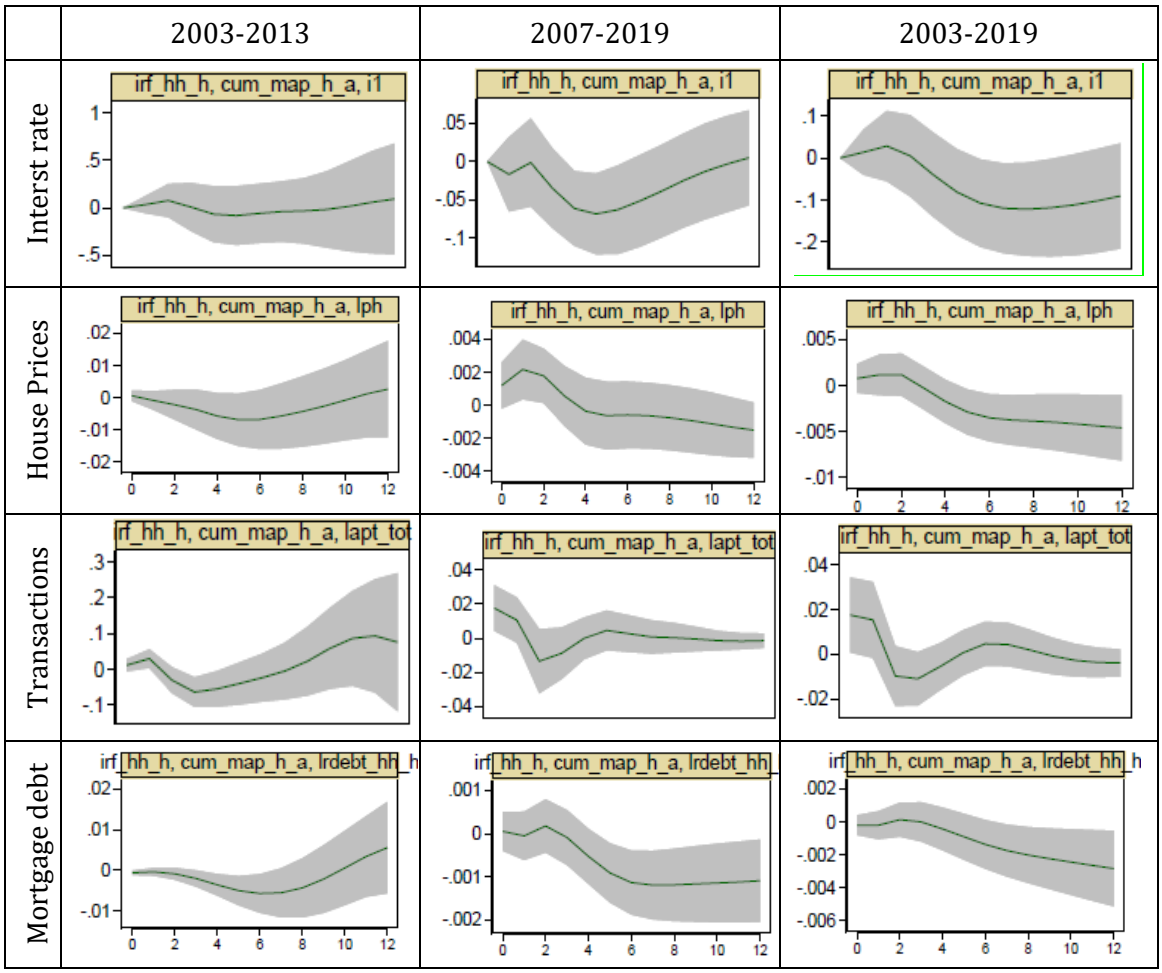
Figure 11: The responses to a monetary policy shock, different samples



Looking at the response to a contractionary shock to monetary policy, we find that while looking at the earlier sample, we do cannot identify a significant reaction of MaP policy, for the later period a significant negative reaction of MaP measures to an increase in the interest rate may be easily detected. According to these results, alongside accommodative interest rate policy, MaP measures were tightened in order to create a wedge between the desired macroeconomic effects of accommodative monetary policy and its possible unintended effects on the housing and mortgage markets. In this sense, MaP measures were substitutable to monetary policy in mitigating stability risks, when macroeconomic conditions justified accommodative monetary policy.

A positive innovation to the interest rate is manifested in a decline in house prices and transaction volume in the later period, more than is evident in the earlier period. The effect on housing debt is mostly insignificant in both subsamples.

Figure 12: <u>The responses to a MaP shock, different sub-samples</u>



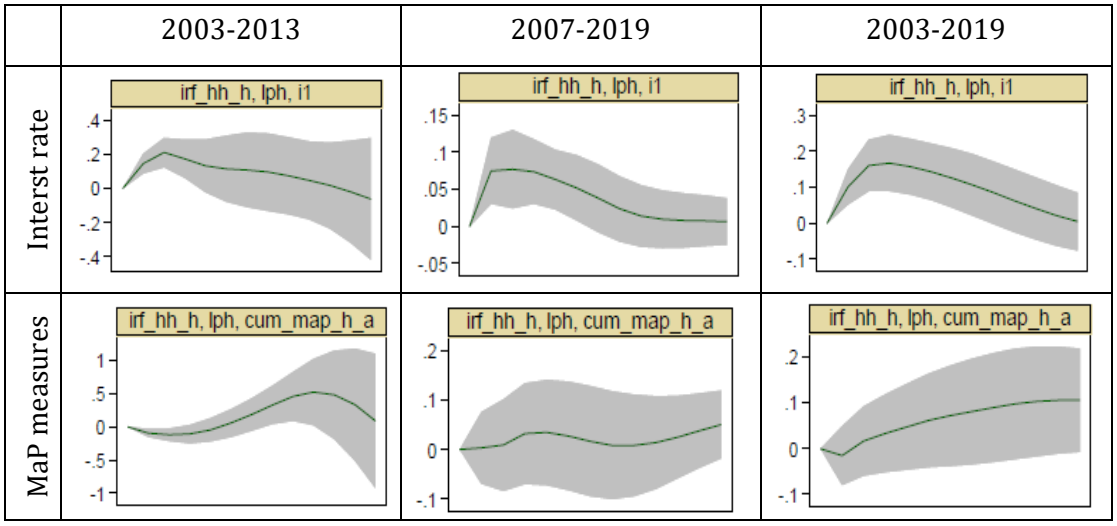
We look at the reverse causality and find that monetary policy, as reflected in changes in the interest rates, does not react significantly to shocks on MaP policy in the earlier part of the sample. For the later part of the sample, and to some extent in the full sample, a negative response is detected in subsequent periods (Figure 12). Given that major MaP measures were initiated starting in 2010, the estimated effects of a shock to MaP policy is evident only in the later sample and full sample. House prices tend to rise somewhat in

the short-term, and later decline to a lower level than their initial level. This is accompanied by an initial increase in activity (transactions) that diminishes after a few months, and a subsequent decline in the volume of mortgage debt, both evident in the full sample and in the later part pf the sample, 2007–19.

We will also look at the response of policy to shocks in the housing market, as estimated for the alternative samples. The response of monetary policy is stable over the alternative samples and exhibits a contractionary policy in response to a positive shock to house prices. We cannot detect a significant response of MaP policy in any of samples (Figure 13).

We examine the response of policy to a shock to the mortgage debt and to the volume of transactions (both not shown) for the subsamples, and find that the estimated responses remain relatively stable. Interest rate and MaP measures tend to be increased in response to a positive shock to the volume of transactions, with a somewhat stronger response in the earlier sample. The response of policy to an unexpected shock to debt is weaker and insignificant, with the exception of a strong increase in MaP measures in the earlier sample.

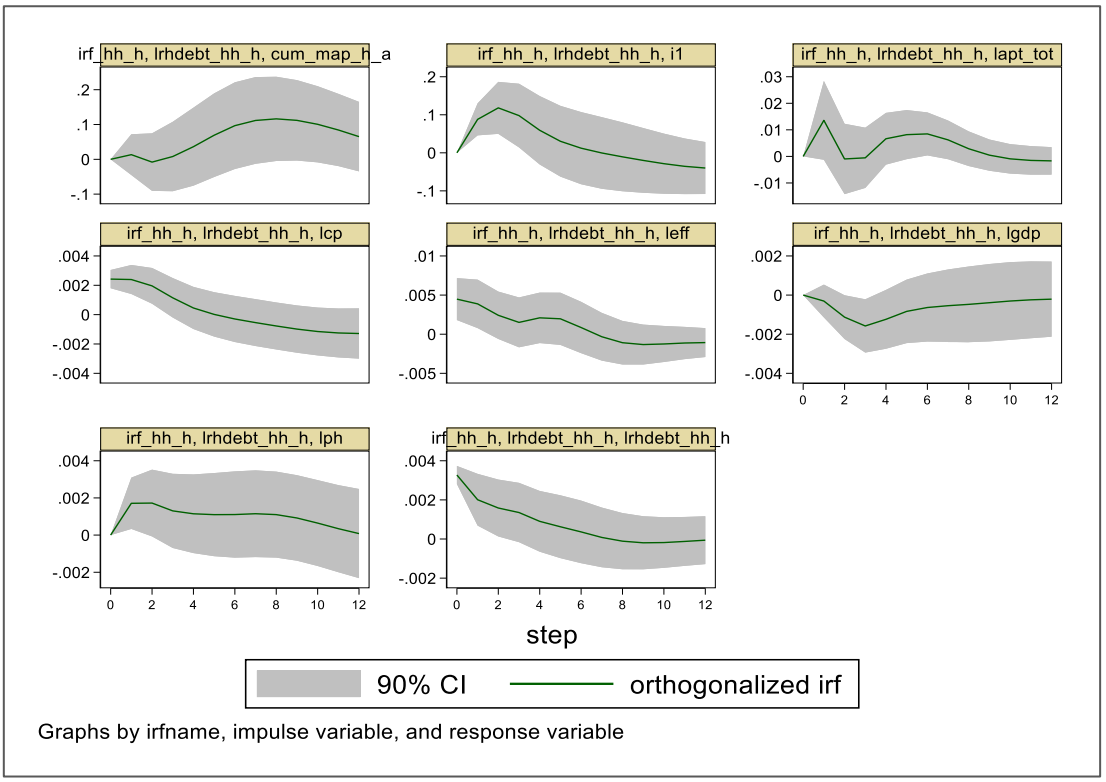
Figure 13: The response of policy to a shock to house prices, different sub-samples



6.2 Debt deflated by house prices

In our benchmark specification, we referred to the real stock of mortgage debt deflated by the CPI, in order to express the volume relative to the general price level in the economy. But, given that house price dynamics differed considerably from those of consumer prices, with house prices surging in the years examined (Figure 1), it is worthwhile to examine the evolution of the mortgage debt relative to the asset it finances. Therefore, we analyze the development of housing market variables and policy variables with debt deflated by the house price index (which is one of the variables included in our system). The evolution of the debt in house price terms is characterized by a substantially lower rate of growth. (See Figure 1.) These differences are revealed in the impulse response functions of MaP measures and housing market variables.

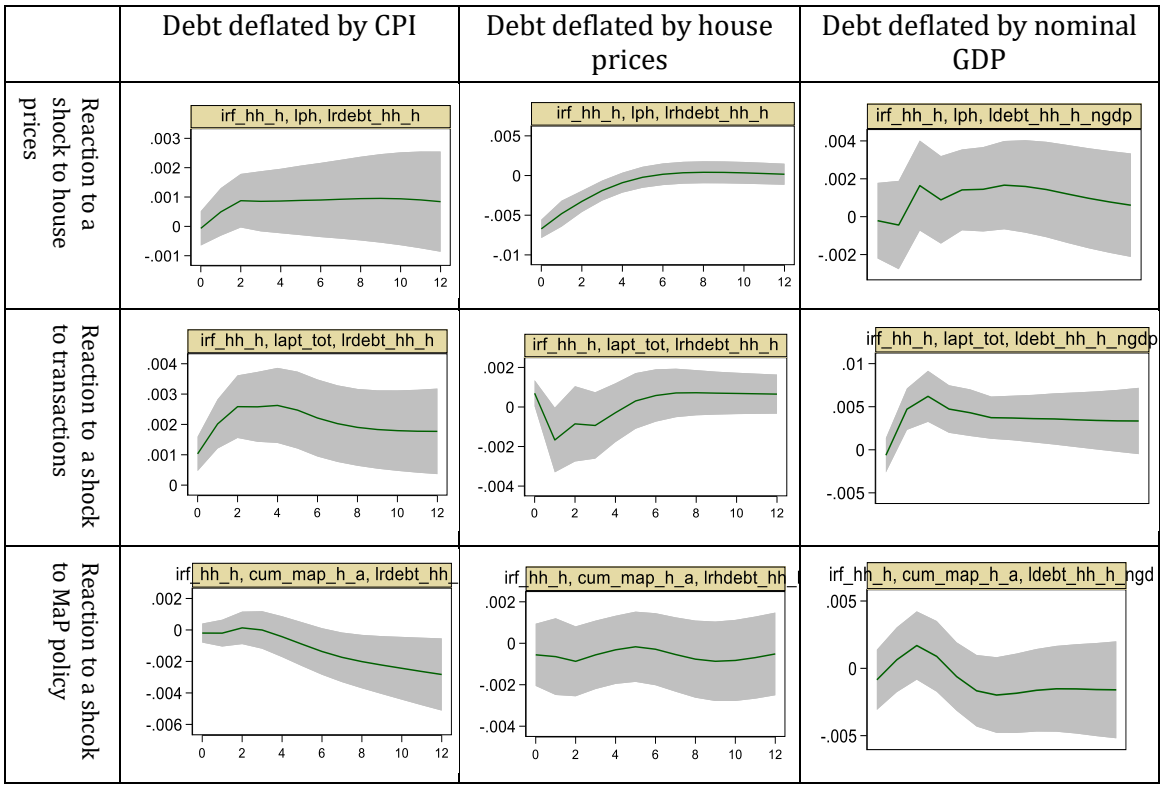
Figure 14: <u>Impulse Responses to an innovation in the real stock of mortgages, deflated by house prices</u>



In contrast to our benchmark results, where MaP policy and interest rates did not react to a shock in debt, when debt is deflated by house prices we do see a significant response of monetary policy by raising interest rates, and MaP policy also reacts to some extent after a few quarters. (Figure 14). House prices tend to increase somewhat, while in our baseline specification there was no significant reaction of prices. Because house prices increased significantly more than the CPI, a positive shock to house debt in house prices terms is more appreciable and meaningful, and therefore triggers a policy reaction, while an increase in debt in CPI terms is less alarming. In an alternative specification with debt deflated by nominal GDP, the response to a shock in housing debt is similar to that in our benchmark specification (not shown).

Inspecting the effect of a shock to other house market variables on real debt we find that a positive shock to house prices or to the volume of transactions produces a decline in the real stock of debt, in house price terms, while in the benchmark specification and when deflated by nominal GDP, some increase in debt suggests that the adjustment of debt to the rise in house prices is only partial (Figure 15). We find that the effect of a MaP shock on debt in all three specifications is generally insignificant, with some delayed negative effect on debt deflated by CPI.

Figure 15: the response of debt to different shocks – alternative definitions



6.3 Including the change in the stock of debt

In the benchmark specification, we chose to include the (log) level of real mortgage debt, alongside the level of interest rate, prices, exchange rate, and activity. We found that innovation to MaP policy produces a negative response of the level of debt, although mostly insignificant. Looking at the housing market and referring to the volume of transactions, a relevant measure may be the flow of credit, due to these transactions, rather than the level of total accumulated housing debt. We specify an alternative system in which we replace the level of debt with the rate of change in the (log) level of debt as a proxy for the flow of credit. The results remain generally unchanged. An innovation to the interest rate is met by a negative response of MaP policy and no significant effect on the growth rate of debt. A shock to MaP measures is followed by an insignificant positive reaction of the interest rate and a delayed decline in the rate of change in debt, while the level of debt in the benchmark specification declined (marginally significant). As in the benchmark specification, the volume of transactions increases in reaction to a positive shock to the change in debt, while prices do not show a significant adjustment.

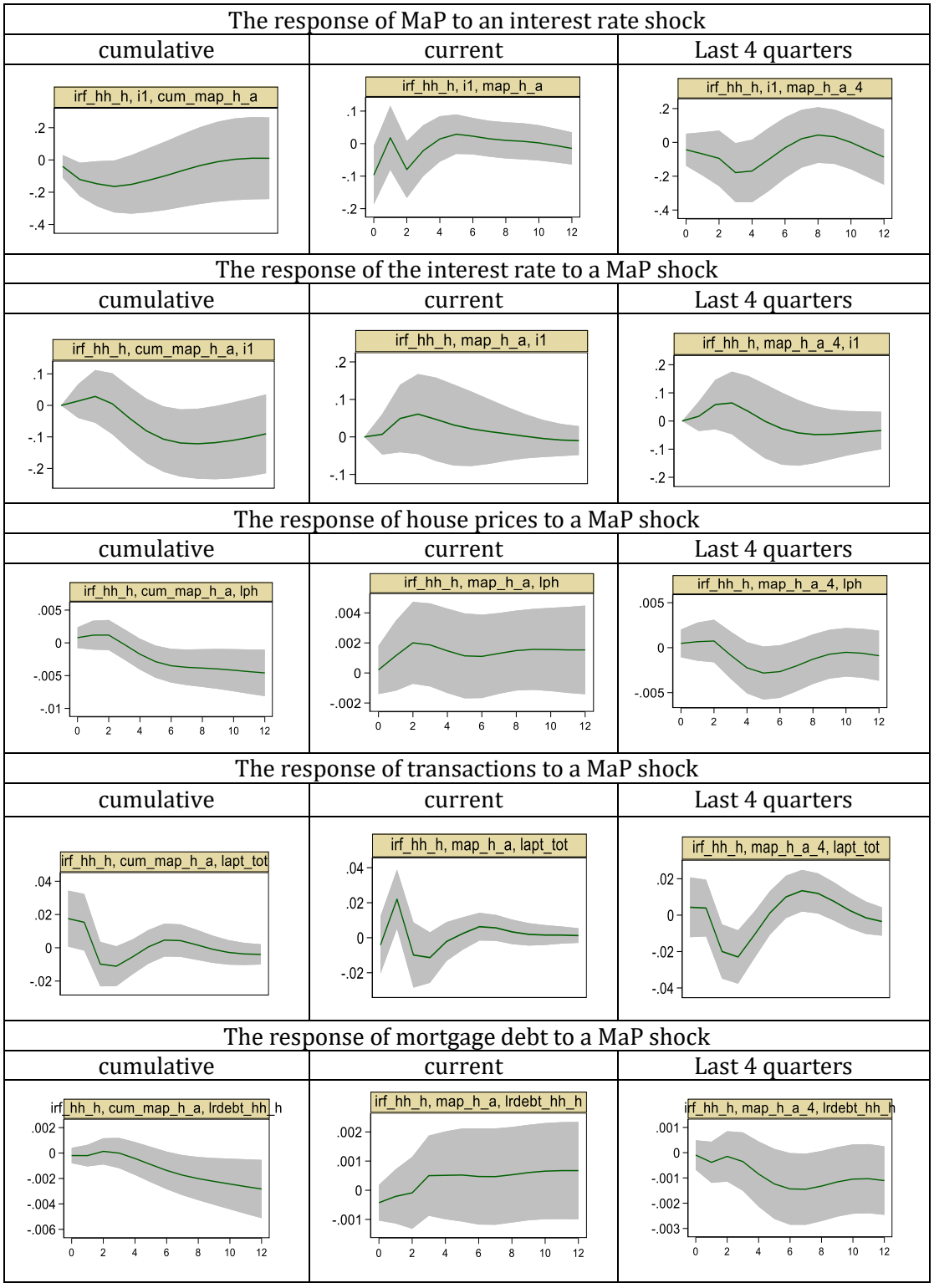
6.4 Alternative definition for the MaP measures index

Our index of MaP measures was constructed by cumulating the measures introduced over the whole period, assuming that the effect of a measure implemented any time in the past persists and accumulates as additional measures take effect. An alternative assumption may be that only measures that were implemented recently are expected to affect the evolution of prices and volumes in the housing and mortgage markets. We therefore construct 2 alternative indices—the first including only current new steps, and the other

cumulating the steps implemented in the past 4 quarters (including the current one). Generally the results remain qualitatively very similar.

MaP measures exhibit a negative (loosening) response to a positive (tightening) monetary policy innovation, and the response is seen earlier with only the current steps are taken into account. Monetary policy's reaction is similar and insignificant in all specifications.

Figure 16: <u>Alternative MaP indices</u>



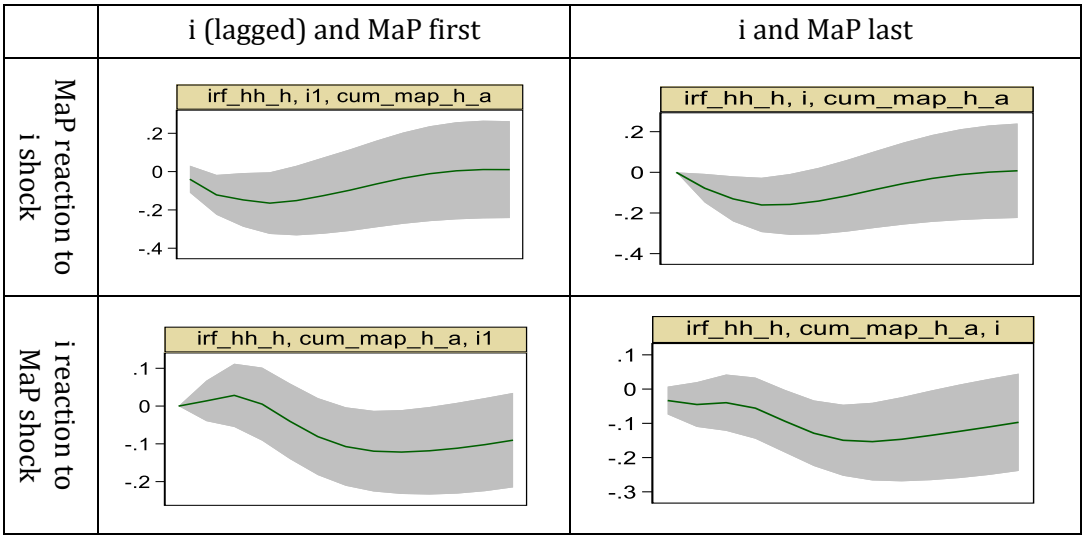
House prices and the volume of transactions tend to decline in response to tightening of MaP policy in the two cumulative specifications and less in the specification that takes into account only current measures. The response of debt is mostly insignificant for all specifications (Figure 16).

6.5 Additional Tests

In the baseline specification of the VAR system the interest rate (lagged one month) and MaP policy appear first and second, so that they are not affected contemporaneously by all other variables in the system, but are allowed to affect them instantly. We rearrange and place the interest rate (not lagged) and MaP measures last in the system—letting them react contemporaneously to other shocks, but assuming these measures cannot immediately affect the other variables.

We find that the change of ordering does not generally affect the qualitative results. As in the benchmark specification, the response of the MaP measures to a positive shock to the interest rate is significantly negative, while the response of the interest rate to a MaP shock is insignificant in the first periods and somewhat negative later on, as was the case in the benchmark specification. (Figure 17). The response of other variables to a MaP or interest rate shock, and the effect of other shocks on policy, is very similar to that in the benchmark specification.

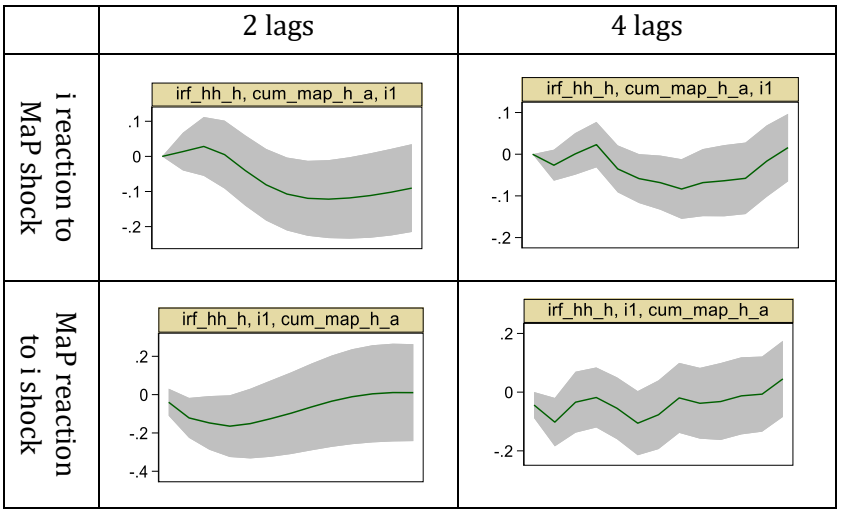
Figure 17: Response functions, different orderings, 2 lags, 2003-2019



Most tests for lag length of the VAR (HIC, HQIC, SBIC) guide us to choose a very short length of 2 lags, while the LR and AIC tests indicate a longer preferred lag.[19] Due to the short length of our sample, we chose to estimate our base model with 2 quarterly lags. We test for the dynamics of the model when 4 lags are included and find that the responses remain qualitatively very similar, while they are, as expected less smooth. We do identify a somewhat stronger and significant response of house prices and of MaP policy to a debt shock, when the specification of the system includes 4 lags. (Figure 18).

[19] The maximum lag length specified.

Figure 18: Response functions, 4 or 2 lags, 2003-2019



In an additional specification we replaced the MaP measures indicator based on the implementation date with the index based on the declaration date and did not find any change in results.

Unlike most studies similar to ours that do not include an analysis of the effect of policy on the volume of transaction in the housing market, this study analyzes the effect of policy on both prices and volumes of transactions in the housing market. In an additional robustness test we drop the volume of house transactions from the VAR and estimate a 7-variable system. The results, in this case as well remained generally unchanged.

6.6 Local Projections

An alternative approach is to employ the Local Projections method suggested by Jorda (2005). This approach is less restrictive, and makes it possible to estimate the reaction of the main economic variables without assuming anything about the structure of the contemporaneous reactions, as required in order to identify the structural VAR.

We can estimate the impulse response function (IRF) using this method by estimating the following set of h-steps-ahead predictive regressions:

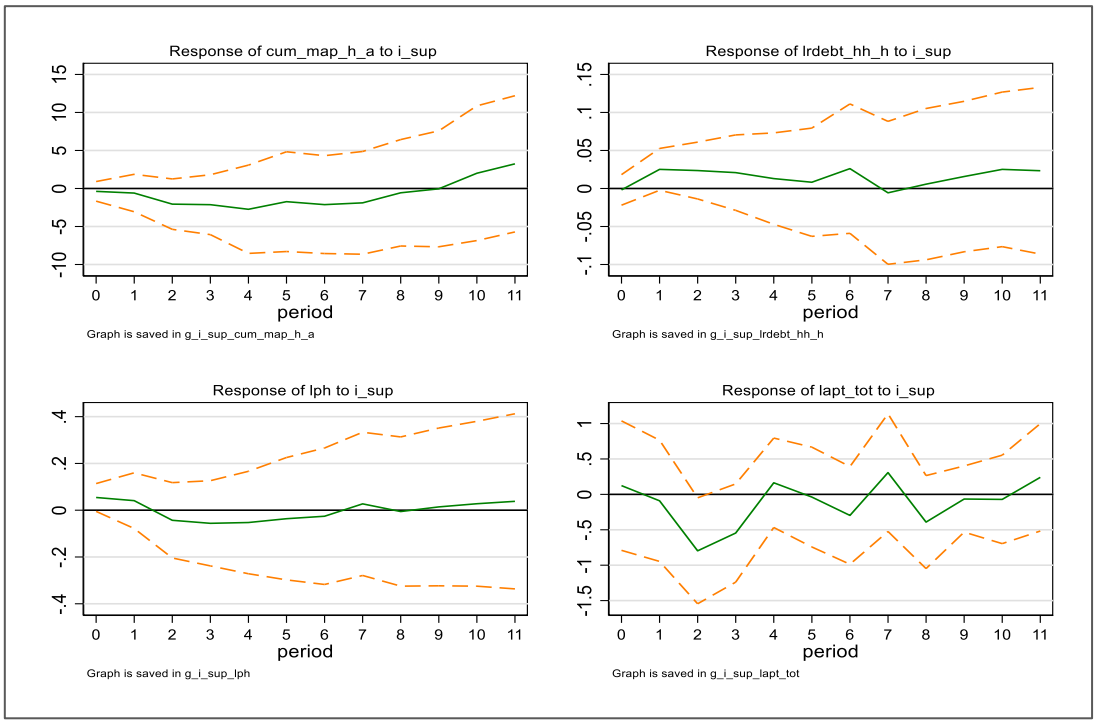
$$y_{t-1+h} - y_{t-1} = \alpha_{(h)} + \beta_{(h)}\varepsilon_t + \sum_{i=1}^{I} \gamma_{(h)} (y_{t-i} - y_{t-i-1}) + \delta_{(h)} x_t + u_{(h),t-1+h}, \quad (5)$$

for $h = 1, \dots H$ periods, where $y_{t-1+h} - y_{t-1}$ denotes the cumulative change from time $t-1$ of the variable in interest—debt, house prices or volume of transactions. ε_t is the policy innovation—monetary policy or MAP policy, at time t, and $\beta_{(h)}$for $h = 1, \dots H$ constructs the response function. We include 2 lags of the dependent variable. x_t are additional exogenous variables, which are identical to those included in the VAR system: the lagged growth rate of US output, current and lagged US interest rate, lagged 10-year real yield, and quarterly seasonal dummy variables. For monetary policy innovations we use the deviation of the actual change in the Bank of Israel's interest rate from the average

forecast of the professional forecasters.[20] In order to create a quarterly indicator for monetary surprises we follow Gertler and Karadi (2015), and imply a method similar to that used by Sandstrom (2018) in order to take into account the timing of the interest rate decision within the quarter. For the unexpected part of the MAP measures, we will have to assume that the measure at the time that it was introduced was unexpected, and refer to the dummy indicator of the measure taken at a specific date as the surprise.

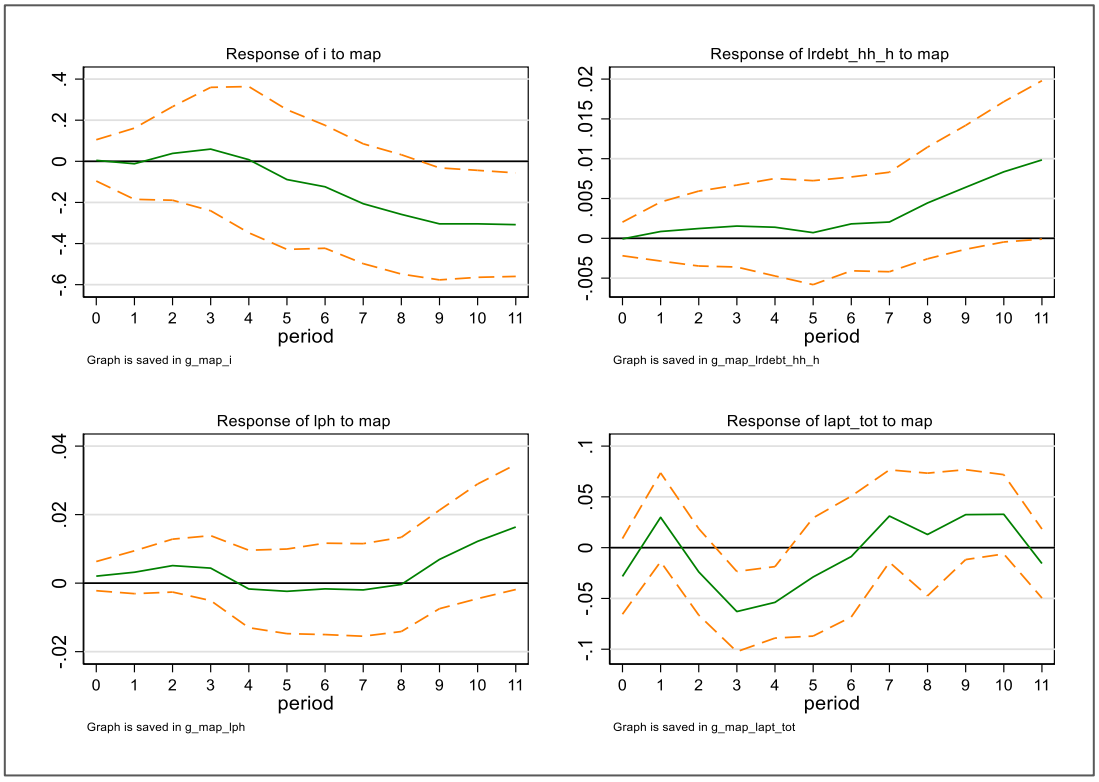
Using this alternative method we acquire similar results to those obtained for the VAR system although somewhat weaker. In response to a monetary policy innovation, MAP measures are relaxed (the negative response is insignificant), debt and house prices do not exhibit a significant response but the volume of transactions declines somewhat after a number of periods. (Figure 19). In response to an innovation to the MAP measures, we also see qualitatively similar results to those obtained with the VAR system. The interest rate does not initially respond to an innovation to MAP policy, but declines subsequently, debt does not move significantly, house prices increase initially and the volume of apartment transactions declines subsequently. (Figure 20).

Figure 19: <u>The response to a Monetary Policy Innovation, Local Projections, 2003-2019</u>



[20] The expected rate may be approximated by market-derived expectations or may be based on forecasts published by professional forecasters. Albeit, short term market instruments that hedge against changes in the policy rate exist in Israel only from 2007, and may be considered reliable only since around 2010, when the Telbor (interbank) market became institutional. This dramatically shortens the available sample period, and therefore we prefer to use the deviation of the actual interest rate from the professional forecasts.

Figure 20: The response to a MAP policy Innovation, Local Projections, 2003-2019



7. Concluding Remarks

The paper analyzes the interaction between housing market macroprudential (MAP) measures and monetary policy, and the housing market—house prices, the volume of transactions, and mortgages. This is done in the framework of a small structural VAR, which includes, in addition to policy variables and house market variables, output, inflation and the exchange rate. The inclusion of house transactions, which are usually not part of similar studies, enhances the analysis of the connection between policy and the housing market. We find, as is generally found in this literature, that MaP measures and monetary policy were effective in moderating house prices and volume of transactions. In addition, while monetary policy does not affect significantly the volume of housing debt, debt does respond after a few periods to restrictive MaP measures. We also find, that monetary policy reacted to a rise in house prices while MaP policy was more responsive to innovations to the volume of transactions. Policy's reaction to an innovation to house debt level was harder to identify. These results are qualitatively robust to the different specifications tested in the paper.

Consistent with the local experience in recent years, the results support the view that MaP policy was implemented in order to offset or weaken the effect of accommodative monetary policy on the housing market. This result is more pronounced in the latter period of the sample. We also find that monetary policy does become more accommodative in reaction to a restrictive innovation to MaP policy, although only after a few quarters and marginally significant.

References

Adrian, T. (2017), "Macroprudential policy and financial vulnerabilities", speech at the European Systemic Risk Board Annual Conference, European Central Bank, Frankfurt, September 22, 2017.

Akinci, O. and J. Olmstead-Rumsey, (2018), "How effective are macroprudential policies? An empirical investigation", *Journal of Financial Intermediation*, 33, p. 33-57.

Alam, Z., A. Alter, J. Eisenman, G. Gelos, H. Kang, M. Narita, E. Nier and N. Wang, (2019), "Digging deeper- Evidence on the effects of macroprudential policies from a new database", IMF Working Paper, WP/19/66.

Bank of Israel, Annual Reports

Bank of Israel, (2013), Monetary Policy Report for the second half of 2013. https://www.boi.org.il/en/NewsAndPublications/RegularPublications/Pages/IMF201302h.aspx

Benati, L. (2020), "Leaning against house prices: A structural VAR investigation", Universitat Bern Discussion Papers.

Benchimol, J., I. Gamrasni, M. Kahn, S. Ribon, Y. Saadon, N. Ben-Ze'ev, A. Segal, and Y. Shizgal (2020), "The interaction between domestic monetary policy and macroprudential policy – the Israeli case", *Economic Modelling*, 112.

Bruno, V., I. Shim and H. S. Shin (2017), "Comparative assessment of macroprudential policies", *Journal of Financial Stability*, 28, pp. 183-202.

Bussiere, M., J. Cao, J. de Haan, R. Hills, S. Lloyd, B. Meunier, J. Pedrono, D. Reinhardt, S. Sinha, R. Sowerbutts, K. Styrin, (2020), "The interaction between macroprudential policy and monetary policy: overview", Bank of England Staff Working Paper No. 886.

Cao, J., V. Dinger, A,. Grodecka-Messi, R. Juelsrud and X. Zhang, (2020), "The interaction between macroprudential and monetary policies: the cases of Norway and Sweden, *Review of International Economics,* Special issue.

Cerutti, E.. S. Claessens and L. Laeven (2017), "The use and effectiveness of macroprudential policies: New evidence", *Journal of Financial Stability*, 28, pp. 203-224.

Cerruti, E., R. Correa, E. Fiorentino and E. Segalla, (2017a), "Changes in prudential policy instruments – A new cross-country database" *International Journal of Central Banking*, 13, 477-503.

Ehrenbergerova D. and J. Bajzik, (2020), "The effect of monetary policy on house prices – how strong is the transmission? ", CNB Working Paper Series 14/2020.

Everett, M., J. de Haan, D.-J. Jansen, P. McQuade and A. Samarina, (2020), "Mortgage lending, monetary policy, and prudential measures in small euro-area economies: Evidence from Ireland and the Netherlands", *Review of International Economics,* Special issue.

Gambacorta, L. and A. Murcia, (2020), "The impact of macroprudential policies in Latin America: An empirical analysis using credit registry data", *Journal of Financial Intermediation*, 42, p. 1-19.

Gertler, M. and P. Karadi (2015). "Monetary Policy Surprises, Credit Costs, and Economic Activity", American Economic Journal: Macroeconomics, 7(1), 44-76.

Hulsweig, O. and H. Rottmann, (2021), "Euro area house price fluctuations and unconventional monetary policy surprises", ZBW Working Paper.

IMF (2014), Selected issues paper on Israel, *IMF Country Report* 14/48.

Jordà, O. (2005). "Estimation and inference of impulse responses by local projections", *American Economic Review*, 95(1), 161–182.

Kim S. and J. Oh, (2020), "Macroeconomic effects of macroprudential policies: evidence from LTV and DTI policies in Korea", *Japan and the World Economy,* Vol. 53, March 2020.

Kim S. and A. Mehrotra, (2018), "Effects of monetary and macroprudential policies – evidence from four inflation targeting economies", *Journal of Money, Credit and Banking*, Vol. 50 (5), p. 967-992.

Kim S. and A. Mehrotra, (2019), "Examining macroprudential policy and its macroeconomic effects – some new evidence", BIS Working Papers, No. 825, December 2019.

Kuttner K. N. and I. Shim (2016), "Can noninterest rate policies stabilize housing markets? Evidence from a panel of 57 economies", *Journal of Financial Stability*, 26, p. 31-44.

Lee J. and H. Jung (2020), "Demographic shifts, macroprudential policies, and house prices", BIS Working Papers No. 914.

Orfaig, D. (2017), "A structural VAR model for estimating the link between monetary policy and home prices in Israel", Bank of Israel Discussion Paper 2017.09.

Revelo, J. D. G., Y. Lucotte, and F. Pradines-Jobet (2020), "Macroprudential and monetary policies: The need to dance the Tango in harmony", *Journal of International Money and Finance,* 108, 102-156.

Richter B., M. Schularick and I. Shim, (2019), "The costs of macroprudential policy", Journal of International Economics, 118, p. 263-282.

Sandstrom, M. (2018). "The Impact of Monetary Policy on Household Borrowing – a High-Frequency IV Identification", Sveriges Riksbank Working Paper Series 351.

Tzur-Ilan N. (2019), Macroprudential Policy: Implementation, effects and lessons, Bank of Israel Occasional Paper 2019.01, June 2019.

Vandenbussche, J., U. Vogel and E. Detragiache, (2015), "Macroprudential policies and housing prices: A new database and empirical evidence for Central, Eastern and Southeastern Europe", *Journal of Money, Credit and Banking*, Supplement to Vol. 47(1) (March-April 2015), pp.343-378.

Appendix

Table A.1: List of MaP measures Targeted at the Housing Market and Dates of Closest Interest Rate decision*

Stability measures	Decision date	App. date	Closest interest rate decision
A 100 percent capital surcharge on groups of borrowers who buy properties collectively.	25/03/2010	30/06/2010	28/03/10
Banking corporations shall make a supplemental provision at the rate of at least 0.75 percent on account of outstanding housing loans that were issued on or after July 1, 2010, and in which the existing ratio in each case between the debt (prorated to the bank's share in the mortgage) and the value of the mortgaged property on the date of loan execution exceeds 60 percent. The foregoing shall apply from the financial statements as of September 30, 2010, and thereafter.	11/07/2010	Q3 2010	28/06/2010 26/07/2010
RWs increased on housing loans with LTVs above 60%, a floating component of more than 25% and mortgage value greater than NIS 800,000. A minimum risk weight of 100% is applied to these mortgages (banks could lower to 75%). This is a change from the previous 35–75% range.	28/10/2010	28/10/2010	25/10/2010
Limiting LTV ratio in housing loans: up to 75% for first-home buyers, up to 50% for investors, up to 70% for those upgrading their homes.	29/10/2012	11/2012	25/10/2010
RWs on some housing loans are increased, depending on their LTV. Loans with LTVs between 45-60% have a higher RW of 50% and those with LTVs between 60-75% are weighted at 75%	21/03/2013	02/2013	24/03/2013
Risk weight of 100% imposed on mortgages with Debt Service to Income (DSI) between 40% and 50%	29/08/2013	01/09/2013	26/08/2010
The maximum variable-rate portion of a mortgage loan cannot exceed 2/3, and the maximum variable-rate portion cannot change by more than 1/3 within 5 years since the date of approval.	29/08/2013	01/09/2013	26/08/2010
It was determined that a loan shall not be approved or granted if the term to final repayment exceeds 30 years	29/08/2013	01/09/2013	26/08/2010
A. The amendment to Directive 329 on September 28 provides that when calculating capital requirements pursuant to Proper Conduct of Banking Business Directive no. 201, banking corporations should increase their Common Equity Tier I Capital target by a rate that represents 1 percent of their outstanding housing loans. B. Banking corporations may reduce the risk-weight attributed to variable interest leveraged loans from 100% to 75%. This is a modification of the policy passed in October 2010 {Reduction} **As the first decision was more influential than the second, ultimately the decisions were declared to be a stringency.**	28/09/2014	01/01/2015	22/09/2014

* Source: Ben-Chimol et. al. (2020)