Bank of Israel **Research Department**

A Structural VAR Model for Estimating the Link between Monetary Policy and Home Prices in Israel[1]

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מודל VAR מבני לאמידת הקשר בין המדיניות המוניטרית למחירי הדירות בישראל[1]

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תמצית

בשנים האחרונות עקב העלייה המשמעותית במחירי הדירות בישראל עולה הצורך בהבנת השפעתה של המדיניות המוניטרית על מחירי הדירות, רמתה והימשכותה. מחקר זה מוצא כי בתגובה לזעזוע חיובי של נקודת אחוז בריבית המוניטרית של בנק ישראל מחירי הדירות הנומינאליים יורדים ב-2.6%, ומחירי הדירות הריאליים ב- 1.1% (באופן סימטרי לזעזוע שלילי). מהשוואה בין לאומית נרחבת עולה שזעזוע מוניטרי משפיע על מחירי הדירות בישראל באופן דומה לממוצע במשקים אחרים בעולם. מחקר זה מצטרף לבסיס מחקרי עולמי רחב ומציע, ככל הנראה לראשונה בישראל, בחינת VAR מבני של הקשרים הדינאמיים בין המדיניות המוניטרית למחירי הדירות, הלוקחת בחשבון את המשתנים העיקריים במשק המשפיעים ומושפעים מקשר זה. המסקנה העיקרית העולה מהתוצאות, בדומה למתקבל במחקרים אחרים בעולם, הינה שזעזועים מוניטריים כשלעצמם לא היוו גורם דומיננטי בהסבר השינויים מחירי הדירות במדגם שתחילתו ברבעון השני של 1995 וסיומו ברבעון הראשון ב-2015.

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[1] אני מודה למכון אלרוב לחקר הנדל״ן באוניברסיטת תל אביב על התמיכה. תודות על הערותיהם המועילות של נתן זוסמן, עקיבא אופנבכר, סיגל ריבון, יוסי יכין, איתמר כספי ואלון בנימיני.

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הדעות המובעות במאמר זה אינן משקפות בהכרח את עמדת בנק ישראל.

A Structural VAR Model for Estimating the Link between Monetary Policy and Home Prices in Israel*

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Abstract

In recent years, the marked increase in home prices in Israel has prompted the need to understand the impact of monetary policy on home prices, including the magnitude and persistence of that impact. This paper finds that in response to a positive shock of 1 percentage point in the Bank of Israel's monetary interest rate, nominal home prices decline by 2.6 percent, and real home prices decline by 1.1 percent (and in a symmetrical manner to a negative shock). A broad international comparison indicates that the impact on home prices in Israel of a monetary shock is similar to the average impact worldwide. This paper adds to a wide global research base, and proposes—apparently for the first time in Israel—a structural VAR examination of the dynamic links between monetary policy and home prices. The VAR structure takes into account the main variables in the economy that affect, and are affected by, this link. The main conclusion is that monetary shocks, on their own, were not a dominant factor in explaining the changes in home prices in the research period—from the second quarter of 1995 through the first quarter of 2015.

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1 Introduction

1.1 Overview

Home prices in Israel have increased markedly in recent years, apparently due to, among other things, the low interest rate environment. The increase in home prices has thus become a major concern for monetary policy makers. It is important to understand the nature and duration of monetary policy's impact on home prices, based on an understanding of the relationships between these variables and the economy's main macro variables (GDP, inflation and the exchange rate). One of the statistical approaches most commonly used by central banks and academic researchers involves Vector Autoregression (VAR) models.[1] The VAR system makes it possible to answer these questions and to better understand the macroeconomic relations in the economy, with emphasis on the home prices variable. While in many countries, research has been conducted using structural VAR models to test the relationship between monetary policy and home prices, this study is apparently the first of its kind in Israel.

This study examines the impact of a monetary shock on home prices. At first glance, a shock seems to be a complicated theoretical concept, so it may appear more natural to examine the impact of a change in the monetary interest rate on home prices. To understand the significance and importance of examining the effect of shocks rather than changes in the interest rate, note that a relationship, i.e. correlation, between two economic variables may be due to the presence of a third variable in the system. To illustrate, consider an example that is relevant to the current research—a financial crisis is likely to cause a flow of capital from securities toward real investments, such as real estate, which in turn is likely to cause a rise in home prices. In parallel, such a crisis is likely to lead to a reduction of the monetary interest rate. A simple examination may point to a very strong link between interest rate reductions and home price increases. During periods when there is no financial crisis, this strong relationship does not exist, as the relationship obtained simply by measuring the

[1] For example, Sims (1980), Bernanke and Blinder (1992), Christiano et al. (1996), Bernanke and Mihov (1995) and other researchers have used VAR models in the analysis of monetary policy in the US.

changes is not a direct causal link. Figure 1 describes the development of home prices and the monetary interest rate: it appears that during certain periods, the two variables move in opposite directions while in others they move in the same direction (subsection 1.3). If the structural shock is appropriately identified using the VAR system, it is possible to solve this problem, and to "cleanly" observe the effects of the variables based on an analysis of the relationships in the domestic and global economic systems. Examining a monetary shock makes it possible to isolate the net effect of monetary policy. That is, it becomes possible to examine changes in home prices that are only the result of changes in monetary policy, rather than a response to other variables. Thus, one can avoid the incorrect interpretation of an observed relationship that is the result of changes in a third variable which influences both home prices and monetary policy. Furthermore, in contrast to a study that examines the effect of changes in the monetary interest rate, the current study is able to differentiate between changes in the interest rate as a result of shocks to different variables (GDP, inflation or world trade), where it is reasonable to assume that each of the shocks has a different effect.

There has been increasing interest in the relationship between home prices and monetary policy in many countries, and as a result of the housing crisis and the recent financial crisis in the US, central banks are increasingly viewed as responsible for maintaining stability in the markets. They therefore need to be concerned about the impact of an increase in asset prices, including the price of homes. According to this approach, central banks can prevent or weaken bubbles in asset prices by "leaning against the wind" and thus promote financial stability (Taylor 2007, Taylor 2009, and Kuttner 2012).

The suggested approach rests on the assumption that the monetary tool, i.e., the interest rate, has an effect on asset prices.[2] Nonetheless, it is important to note that the interest rate can be used to achieve various targets of monetary policy (economic activity, inflation, asset prices, etc.) and since in some cases each target requires a different monetary action,

[2] Although this assumption does not necessarily imply that monetary policy can create bubbles in the housing market and there is no consensus in the economic literature on this question (Kuttner, 2012; Del Negro and Otrok, 2007; Goodhart and Hofmann, 2008; Jarocinski and Smets, 2008; Sa et al., 2011).

the decisions of monetary policy makers reflect various considerations.

In general and according to the standard asset pricing theory, the relationship between home prices and monetary policy is that home prices will be high in periods of low interest rates. This study examines the impact of monetary policy on home prices, and more precisely, the magnitude and duration of the impact of a monetary shock on home prices. This is done through a dynamic analysis, in which the examined variables are seen as part of an economic system, with other variables playing influential roles in the examined relationship.

1.2 The theory behind the effect of the interest rate on home prices

According to economic theory, the relationship between the interest rate and home prices can be explained through standard asset pricing models (Poterba, 1984, Himmelberg et al. 2005). In these models, the yield on owning a home must, in equilibrium, be equal to the alternative yield—the interest rate. Thus, the nominal long-term interest rate is one of the basic factors impacting on the price of a home.[3] With that, it is important to note, in the context of Israel, that in a small and open economy a particularly strong relationship is not expected between monetary policy and the prices of long term assets, such as homes, due to global effects (Rogoff 2006).

1.3 Home prices in Israel[4]

The data for Israel indicate that in recent years, with monetary interest rate reductions, the interest rate on mortgages has decreased (see Figure 1). As a result, the alternative of purchasing a home has become more attractive relative to renting and the demand for homes has risen. The increase in demand leads to a rise in home prices (Figure 1) until theoretically the two options—buying and renting a home—become equally attractive.

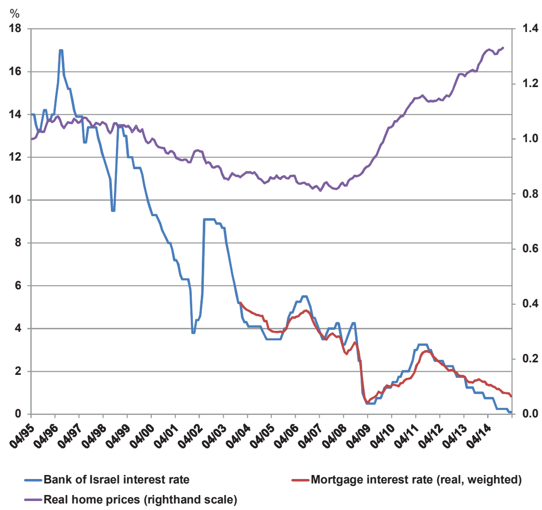
[3] For further details, see Appendix 1.

[4] For further details on the housing market in Israel in recent decades, see Appendix 2.

Figure 1

Real home prices, weighted real mortgage interest rate, and Bank of Israel interest rate

(monthly data, April 1995–March 2015, 1995=1)



Due to the steep increase in home prices in recent years, the Bank of Israel decided to adopt several macroprudential measures to support the stability of the banking system and reduce the risk to households that take out a mortgage. In recent years, the Bank of Israel has adopted several measures related to housing credit.

It is important to note that the increase in home prices is not unique to Israel, and it is not exceptional in comparison to other countries. It appears that low interest rates have affected home prices in many countries.

1.4 Review of the Literature

Due to the interest in home prices worldwide, there is a growing body of research that attempts to estimate the effect of a monetary shock on home prices using structural VAR models. In order to compare this study's results with those reached in worldwide research on other economies, the results from a number of studies, and the conclusions derived from them, are surveyed. However, it is important to note that the results of the comparison should be treated with caution since the specification of the model (variables estimated, sample period, statistical assumptions, etc.) varies among different studies. In addition, there are differences in how variables are measured in each country. For example, in some countries there is no hedonic adjustment of home prices (which adjusts for differences in home characteristics, such as location and the number of rooms), as there is for Israeli data on home prices.

Table 1 summarizes the response of real home prices to an increase of one percentage point in the monetary interest rate, according to the various studies carried out in other countries (for more detailed information on the studies appearing in Table 1, see Appendix 3). The main conclusion from surveying the literature is that studies worldwide find differences in the sensitivity of home prices to monetary policy, such that a positive shock to the monetary interest rate of one percentage point leads to a decline of 0.2–4.0 percent in real home prices, with an average change of about 1.9 percent.[5] The differences among the various estimates—including among some economies that were studied in more than one paper—suggest that the specification of the model affects the results.

[5] In the cases that the results are reported in the form of confidence intervals, the midpoint was used to calculate the average. This average is intended to provide a general indication and should not be viewed as a firm indicator, since it is affected by the economies/studies that enter into the calculation.

Table 1: Summary of research findings from various countries—response of home prices to a positive monetary shock

The researchers	**Country**	**Rate of decline in real home prices in response to a positive shock to the monetary interest rate of one percentage point**
Aoki et al. (2004)	UK	1.6 percent
Elbourne (2008)	UK	0.75 percent
Guiliodori (2005)	Spain, Sweden and Belgium	<1 percent
	France, Finland and UK	>2 percent
	Ireland, Italy and Holland	1.5–1.8 percent
Iacoviello (2002)	Italy	2.6 percent
	UK	3.0 percent
	France	1.2 percent
	Germany	0.2 percent
Robstad (2014)	Norway	Confidence interval depending on the structural simultaneity assumptions: 0–3 percent, 2–5 percent
Bjornland and Jacobsen (2010)	Norway	Confidence interval: 2–4 percent
Assenmacher-Wesche and Gerlach (2008)	Norway	Confidence interval: 0.5–3 percent
Musso et al. (2011)	Sweden	1 percent
	Euro bloc	0.5–1.5 percent
Assenmacher-Wesche and Gerlach (2008)	OECD countries	0.5–2 percent
Goodhart and Hofmann (2008)	OECD countries	2.5–4 percent
Musso et al. (2011), Jarocinski and Smets (2008)	US	1–4 percent
Del Negro and Otrok (2007)	US	0.9 percent
Vargas-Silva (2008)	US	Unclear (dependent on specification)

Studies in other countries have examined the effect of home prices on other variables in the economy. For example, Chirinko et al. (2004) used a structural VAR model to test the effect of home prices on GDP and found that a positive shock of 1.5 percent to home prices leads to an increase of 0.4 percent in GDP. Case et al. (2005) also tested the effect of home prices on the economy but did so using panel data, and found that a positive shock of 10 percent to home prices leads to an increase of 0.6 percent in consumption.

A number of VAR studies have been conducted on the Israeli economy but they did not directly examine this paper's research question—the impact of monetary policy on home prices. Azoulay and Ribon (2010) present a basic VAR model for the Israeli economy that includes economic activity, the exchange rate, the central bank interest rate, inflation, and inflation expectations. Djivre and Yakhin (2010) present a structural VAR model, the main goal of which is to predict inflation and to analyze the effect of monetary policy on inflation. They estimated four models that are differentiated by the number of economic assumptions imposed on the relations between the variables according to Neo-Keynesian theory. They found that the structural model without rational expectations is the most adequate for forecasting.

Various aspects of the housing market in Israel have been examined in a number of studies. Nagar and Segal (2014) examined the factors explaining the development of home prices and rent during the period 1999–2010. The short-run dynamic between the two prices was explained using an error correction model and a difference equation model. They found that the main factor behind the increase in housing prices in 2009–10 was the reduction in the monetary interest rate, where a reduction of one percentage point raised nominal home prices by 6.5 percent. It should be noted that the abovementioned study, unlike the current one, does not propose a structural VAR analysis and does not differentiate between changes in the interest rate resulting from different shocks, such as to GDP, inflation or world trade and the dynamic between them, where it is reasonable to assume that the shocks differ in their effect on home prices. Therefore, a different interpretation is required for their results. The current study examines the effect of a monetary shock—that is, the "net" effect of monetary policy, and allows for long-term effects between all of the main variables in the Israeli economy that have an effect (and are themselves affected) in the

VAR system. Nagar and Segal (2014) test the effect of each change in the interest rate (without differentiating by the cause of the change) while the rest of the variables are kept constant (including inflation expectations and unemployment). In addition, they do not include all of the main economic variables (such as GDP), though they do include more variables that are specifically related to the housing sector.

Another recent study of the housing market in Israel was carried out by the IMF in its 2014 annual report. It found that home prices are about 25 percent higher than expected (based on the fundamental variables). One-half of the excess is explained by the shortage in the supply of housing while the other half is explained by the sharp rise in the volume of mortgages (demand), which is primarily the result of the low monetary interest rate. It also found that home prices relative to income are 26 percent higher, and that home prices relative to rent are 22 percent higher, than the long-term levels. In addition, they found that the probability of a crash in home prices exceeds 20 percent.

In contrast to the conclusions reached by the IMF report, the studies of Dovman, Yakhin and Ribon (2012) and Caspi (2015) tested whether a bubble had developed in home prices. The two studies both arrived at the conclusion that there is no evidence of a bubble in prices, and found that the increase in home prices is for the most part explained by fundamental factors.

Other studies of the Israeli housing market did not relate directly to the impact of monetary policy on home prices, but rather to various questions raised against the background of housing market developments. The study by Benita and Naor (2013) examined the risk to borrowers in the mortgage market in view of the sharp rise in home prices (54 percent) during the period 2008–12 relative to the more moderate rise in average household income (20 percent). They conclude that in recent years mortgage holders' risk has increased. The study by Friedmann and Ribon (2014) analyzed the changes in the composition of financing a home purchase during the period of rapidly increasing home prices and found that the main change was in the size of a mortgage, but since repayment periods were extended and the interest rate on mortgages had declined, the monthly mortgage payment had not changed significantly. The study by Kahn and Ribon (2013) focused on the manner in which the housing market affects consumption. They examined the effect of home prices and rents on private consumption in Israel and found that an increase in housing prices works to increase the consumption of home owners.

2 The method

2.1 The VAR model

In order to estimate the relationship between monetary policy and the housing market in Israel, it is necessary to understand the links between the variables that affect and are affected by these two specific variables. A VAR model facilitates the analysis and estimation of a system of economic variables (that are related one to the other); its main advantage is the ability to estimate the dynamic effects between the variables over time and thus facilitate the analysis of the effect of shocks to the monetary policy variable in Israel on the main macro variables. This section presents a description of the VAR model: endogenous variables, exogenous variables, sample period, number of lags and stationarity tests.

The study uses quarterly data for the sample period of 1995:Q2–2015:Q1. Quarterly data are used because it is not expected that the mechanisms through which policy variables theoretically impact on the main macro variables act rapidly, so their effect will likely persist for more than several months. Furthermore, some of the variables, such as GDP, are published on a quarterly basis. Thus, the use of quarterly data avoids the potential lack of precision resulting from the assumptions needed to change the frequency of the data.[6] The VAR equation is the following:

$$(1)\quad Y_t = \sum_{i=1}^{i=p} A_i Y_{t-i} + BX_t + e_t$$

where Y_t is a vector of endogenous variables, A_i is a coefficient matrix of the endogenous variables at various lags (p), X_t is a vector of exogenous variables, B is a coefficient matrix

[6] Quarterly data was also used by Aoki et al. (2004), Del Negro and Otrok (2007), Iacoviello (2002) and many others who also examined the effect of monetary policy on the housing market. Djivre and Yakhin (2010) also used quarterly data in a VAR model for Israel.

of the exogenous variables and e_t is a vector of residuals.

2.1.1 The endogenous variables

The vector of endogenous variables Y_t is composed of the following variables: the growth rate of seasonally adjusted real GDP (dlgdpsa); the rate of change in the shekel-dollar exchange rate.[7] (dlex); the rate of change in the Consumer Price Index (dlcpi); the change in the Bank of Israel interest rate (dr)[8][9]; and the rate of change in the nominal home price index taken from the Survey of Home Prices (dlhp). All the endogenous variables in the system appear as the logarithmic change in the quarterly averages, except for the Bank of Israel interest rate.

Vector Y't is the following:

Y't = [dlgdpsa, dlex, dlcpi, dr, dlhp].

It is important to note that as a result of the large number of equations to be estimated in the VAR system, the shorter the sample period the more difficult it becomes to add variables, particularly endogenous ones, without weakening the statistical significance of the results. Therefore, it was decided, among other things, that the long-term interest rate will not be included in the estimation. Additional reasons for this are the similarity between the two interest rate variables (monetary and long-term) and the fact that the long-term interest rate is not generally included in studies of this type (Aoki et al., 2004; Iacoviello, 2002; Giuliodori, 2005; Chirinko et al., 2004; Iacoviello and Minetti, 2008; Case et al., 2005; and others). The sensitivity of the results to the inclusion of the long-term interest rate is examined later in the paper.

[7] The exchange rate selected for the estimation is the shekel-dollar exchange rate, which is linked to the Israeli housing market through the indexation of contracts that prevailed during the sample period. It was also chosen for its compatibility with the exogenous variable of "import prices" that is published in dollar terms by the Central Bureau of Statistics. In any case, the data for the nominal effective exchange rate are only available starting from 1999.

[8] There are studies that assume the stationarity of the interest rate as a level rather than using its changes. The reasons to choose the change in the interest rate in the estimation will be presented later (Section 2.1.5). Also described further on is the sensitivity of the results to this assumption.

[9] The interest rate appears in the estimation in the form of non-logarithmic changes since the interest rate itself is presented in percent, which makes it easier to interpret the results.

2.1.2 The exogenous variables

The vector of exogenous variables includes the following: the change in the US federal funds rate[10] (dfr); the change in an index of the security situation in Israel which is based on the number of civilians and soldiers killed in security incidents in Israel[11] (ddead); the log of rate of change in the number of immigrants arriving in Israel (dlim); the log of rate of change in the import prices of consumer goods and factors of production (dlimpp); the proportion of home sale contracts denominated in shekels (as opposed to those denominated in foreign currency) (pdol); the S&P500 as a global financial indicator[12] (snp); dummy variables for the quarters in order to adjust for possible seasonality in the series (seas(1), seas(2), seas(3)); and a constant.

Due to the lack of data on home sale contracts denominated in shekels (as opposed to foreign currency), the proportion of rental contracts denominated in shekels was used, on the assumption that the processes in these two markets have similar timing. The data exist for the period 2005–14 and therefore an extrapolation was made based on the assumption that the figure for 2005 is also appropriate for the period of 1995–2005 and that the figure for the first quarter of 2014 is also appropriate for the period up to the first quarter of 2015. This assumption appears to be reasonable based on an examination of the data, which shows a dramatic increase within a short period of time starting from the end of 2007.[13] This variable was included as a level in order to neutralize the indexation trend in the estimation. Its inclusion as a logarithmic change that makes the variable stationary would not have made it possible to do this.

The X't vector is the following:[14]

[10]The US federal funds rate appears in the estimation in the form of non-logarithmic changes, as in the case of the Bank of Israel interest rate.

[11]The number of fatalities, as representative of the security situation, appears in the form of a non-logarithmic change due to the nature of the data and in order to prevent a major loss of data. The figures were collected manually from data of the B'Tselem organization.

[12]An examination of the history of this variable over time justifies its treatment as a kind of dummy variable for the global crisis in 2008.

[13]In addition, a comparison was made to another study that calculated the proportion of sale contracts denominated in shekels and no major differences were found (Ben-Shahar and Golan, 2014).

[14]In the case of small and open economies, it is usually the convention to include as exogenous variables

X't = [dfr, ddead, dlim, dlimp, pdol, snp, seas(1), seas(2), seas(3), c]

We will test whether the selected exogenous variables have explanatory power, that is, whether they contribute to the estimation such that their omission will affect the results. One of the conventional tests used for this purpose is the Likelihood Ratio Test (LR) (Hamilton, 1994). The test is used to determine whether a restricted model (a model without one of the exogenous variables, which is equivalent to giving it a zero coefficient) differs in statistical significance from a non-restricted model (which includes the exogenous variable). The difference has a chi-squared distribution and is tested against the critical values of this distribution. It is the convention to use this test also to determine the optimal number of lags, as is done in this study. The test was carried out for each of the exogenous variables, where the restricted model included all of the exogenous variables apart from the exogenous variable being tested. The results of the tests appear in Appendix 4. As can be seen from the results, all of the variables were found to be necessary for the estimation at a confidence level of 5%. Therefore, the estimation results presented in the paper will include all of the exogenous variables. In addition, the sensitivity of the results to the omission of all of the exogenous variables will be examined later in the paper.

Note that the addition of other exogenous variables such as the stock of homes, demographic variables, etc. doesn't notably impact the estimation. This is because the role of the exogenous variables is first and foremost to assist in the accurate identification of the monetary shock. That is, it is important to include variables that affect the monetary interest rate (a coefficient that is significantly different from zero in the interest rate equation) in the estimation, since their omission will lead to biases in finding the shocks. In contrast, the variables that theoretically are not meant to have a coefficient very different from zero in the interest rate equation are not important and their inclusion may adversely impact the estimation and reduce the statistical significance of the estimates due to the increased number of variables. In addition, note that the abovementioned variables may not be completely exogenous to the system. In other words, they are affected by the

the interest rate abroad and also indices of economic activity abroad, as is done in this study (Cushman and Zha, 1997; Smets and Peersman, 2001).

endogenous variables, contrary to the definition of an exogenous variable, and clearly this may lead to errors in estimation.

2.1.3 The sample period

The sample period runs from 1995:Q2–2015:Q1 and includes 80 observations. There are several reasons for starting the sample period in 1995: first, the data for GDP as it is currently measured are available starting from 1995, and previous years' data is concatenated. In addition, the data for home prices as it is currently measured in the Home Prices Survey is also available starting from mid-1994.[15] The concatenation of the data is likely to reduce the accuracy of the results. Second, it is important to have a recent sample, in view of the structural changes in the Israeli economy in recent decades. Thus, it would be difficult to reach conclusions regarding the current situation based on the Israeli economy in the 1980s. In addition, it was only in 1997 that the exchange rate band lost its significance and an inflation targeting regime was adopted. Therefore, it is reasonable to assume that the effect of the macroeconomic variables differed between then and now.[16]

2.1.4 Number of lags

In estimating a VAR model such as Equation 1, the number of lags in the system must be set. The number of lags is chosen so as to achieve three goals: to avoid serial correlation in the residuals, to maintain the largest possible degrees of freedom and to ensure that the number of lags reflects the duration of the expected response between the variables according to economic theory. There are various tests, each of which relies on a different choice criterion, that can be used to choose the number of lags. Table 2 presents the results of five tests for determining the optimal number of lags.

[15] The data from the Survey of Home Prices were first published in mid-1994. From then until 1999, an almost identical statistic was published in the Survey of Home Prices and the owned dwellings services component of the CPI. During the period until 1994, home prices were published only as part of the CPI in the owner-occupied home component (and it is unclear whether the method of calculation was the same as it is today).

[16] The sample period selected in Djivre and Yakhin (2010) started from 1997 for similar reasons. In the current study, shortening the sample period by beginning in 1997 led to overly high standard deviations which adversely impacted the identification of the shocks.

Table 2: Number of lags – the results of various tests

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1191.7	NA	0.0	-30.0	-28.5	-29.4
1	1252.2	97.1	0.0*	-31.0	-28.7*	-30.1*
2	1274.0	32.1	0.0	-30.9	-27.8	-29.7
3	1289.5	20.8	0.0	-30.6	-26.8	-29.1
4	1302.5	15.7	0.0	-30.3	-25.7	-28.5
5	1324.1	23.2	0.0	-30.2	-24.9	-28.1
6	1353.1	27.5	0.0	-30.3	-24.2	-27.9
7	1404.9	42.3*	0.0	-31.1	-24.1	-28.3
8	1450.0	30.8	0.0	-31.6*	-23.9	-28.5

* Indicates the number of lags selected according to the criterion.
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

It can be seen that all of the tests point to one lag as the optimal order, except for the Akaike test which indicates eight lags and the LR test which indicates seven lags. Nonetheless, if one lag is chosen, the LR test indicates that at the 5% level of confidence the null hypothesis of a lack of serial correlation in the residuals is rejected, while if two lags are chosen it is not. In addition and based on the need to allow for the rigidities in the economy, the dynamic between the variables and a slower response among some of the variables, it would appear that a lag of only one quarter is insufficient. Therefore it was decided to adopt two lags (i.e. two quarters). Later on in the analysis, the sensitivity of the results to the number of lags will be examined.

2.1.5 Stationarity tests

When using a VAR, each of the variables generally should be stationary[17] , or alternatively long-term constraints should be imposed to reflect the cointegration between the levels of the variables. This analysis looks at short- and medium-term effects and uses a relatively short sample period and therefore it would not appear to be correct to fix stable long-term relations; rather it is preferable to use variables in terms of differences in order to obtain stationary variables. In order to facilitate the identification of the shocks, we will use contemporaneous constraints that are derived from economic theory (to be presented further on in this paper) (Faust and Leeper, 1997; Elbourne, 2008).

Appendix 5 presents stationarity tests for the endogenous variables. The ADF (Augmented Dickey-Fuller) test uses the null hypothesis of nonstationarity (unit root) at the level examined and the acceptance of the null hypothesis indicates the need to add a difference in order to obtain stationarity (H0: I(1)), while the null hypothesis in the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test is stationarity (H0: I(0)).

The levels of the endogenous variables (in log terms): GDP, the exchange rate, the CPI, the interest rate (not logged) and home prices were found to be I(1)[18] and their differences were found to be I(0) as expected, at least according to the ADF test.[19]

[17] Nonetheless, there are certain studies in the literature that estimate VAR models using levels, despite the lack of stationarity in the variables. In this study, the first differences of the variables (which are stationary) are used, as in Gali (1992), Gerlach and Smets (1995) and Smets and Peerson (2001).

[18] The logged exchange rate (lex) was found to be stationary in level terms by the KPSS test (i.e., the null hypothesis of stationarity was not rejected), but was found not to be stationary according to the ADF test (i.e., the null hypothesis of nonstationarity was not rejected). As a result and as is customary with Israeli data, it was decided not to relate to the levels as stationary (Djivre and Yakhin, 2010; Azoulay and Ribon, 2010).

[19] The null hypothesis of stationarity was rejected for the difference of the logged CPI (dlcpi) in the KPSS test (which indicates nonstationarity in the first differences I(1)), but the null hypothesis of nonstationarity was rejected for the first difference in the ADF test. Apparently, the rejection in the KPSS test does not justify relating to this variable as I(2), which makes interpretation difficult and leads to a lack of uniformity in the number of differences between the variables (such that some will be I(1) while others will be I(2)). This approach is in line with Robstad (2014) who related to this variable as I(1) and also tested the relationship between monetary policy and home prices. In previous studies that used Israeli data, when the two tests yielded different results with respect to stationarity of the differences, the variables were treated as I(1) (Azoulay and Ribon, 2010; Djivre and Yakhin, 2010).

Unlike this paper, there are other studies that assume stationarity of the interest rate level and that do not use changes in the interest rate. Due to the short sample period and in view of the unequivocal test results[20], it would be difficult to assume the stationarity of the interest rate level in this sample. According to Hamilton (1994), even in the case that the tests incorrectly indicate nonstationarity in levels, it is preferable to assume nonstationarity (unit root) as is done in the current study, for several reasons. One reason is the downward bias in a small sample, such that even if a coefficient of less than unity is found, we prefer to assume a unit coefficient. The second is that in all of the distributions of the tests (such as the t-test), stationarity in the variables is assumed; if stationarity is assumed when it does not actually exist in the sample, the use of these distributions may lead to errors when testing hypotheses. Another claim made for the use of changes in the interest rate is that according to economic theory changes in macro variables are affected by changes in the interest rate, rather than its level.

Similar to the current research, in recent years the use of changes in the interest rate in Taylor rules has become widespread and accepted in the academic world and at central banks. For example, Orphanides and Wieland (2012) compare eleven models using alternative interest rate rules for the eurozone, and find that, among other things, the use of changes in the interest rate is robust. Orphanides and Williams (2011), as well, find that use of a first-difference policy rule would have been highly effective at stabilizing inflation and unemployment. Fischer (2017) describes 3 interest rate rules used by the Fed, with one of them being an interest rate rule in which the interest rate appears as changes, similar to the current research.

The sensitivity of the results to this assumption is examined further on in this paper and it is found that even if we use the level of the interest rate, the estimates of the impact of monetary policy on home prices does not change markedly. Nonetheless, an examination of the impulse response function of the interest rate to an interest-rate shock yields results that do not converge and the shock persists even after a prolonged period (as would be

[20] The rejection of the stationarity hypothesis in the KPSS test at the 1% confidence level and the acceptance of the nonstationarity hypothesis in the ADF test.

expected for non-stationary variables). In general, a shock in the VAR system is defined as a temporary change and the lack of convergence observed in the results when using the level of the interest rate indicates a change that is not temporary, which contradicts the basic definition required in a VAR analysis. It should be noted that even when the inflation target is added as an exogenous variable in order to neutralize the effect of inflation trend from the level of the interest rate, the problem of convergence is not resolved (in this case, as well, the estimates of the effect remain similar to the presented results). Therefore, the interest rate variable was used in terms of changes (and not a level) and is stationary at a 1% confidence level and it has an impulse response to an interest-rate shock that converges as required (as is the case for all of the impulse response functions).

Appendix 6 presents the results of these tests (ADF and KPSS) for the exogenous variables—the change in the US federal funds rate, the change in a security-situation index, the rate of change in immigration, the rate of change in import prices, and proportion of home sale contracts denominated in shekels, the S&P 500. Stationarity of the levels of the exogenous variables were found to be I(1) and their differences were found to be I(0), as expected.[21][22]

2.2 The model – the structural matrix

The VAR system as presented by Sims (1980) is an alternative to a macroeconomic model. It is not based on a large number of economic assumptions, but rather on the data itself and facilitates a dynamic continuum of responses. In view of these characteristics, the VAR model is also useful in the examination of phenomena in the housing market. The structural VAR model (SVAR) makes it possible to use economic theory in order to decide which (contemporaneous) constraints are needed in order to identify the effect of monetary

[21] The fatalities variable which represents the security situation was found to be stationary also in terms of level. Therefore, and in order to maintain uniformity between the variables (all of which are in terms of changes), it was decided to use the variable in the form of changes. It was found that the results were not sensitive to this decision.

[22] As already mentioned, the variable for home sale contracts' denomination in shekels was included as a level (nonstationary) in order to neutralize the effect of this trend.

and other shocks (Blanchard and Quah, 1989; Sims, 1986; Bernanke, 1986), where the Cholesky structure is the standard method for examining the effect of contemporaneous shocks. However, there are cases in which the VAR approach combined with a Cholesky structure is too simplistic and is liable to be problematic, due to, among other things, the implicit assumption in the Cholesky structure that there cannot be a contemporaneous effect between two variables that are determined together, such as the exchange rate and the monetary interest rate. In particular, in the Cholesky structure only one of the following two effects is possible: a contemporaneous effect (within the same quarter) of the exchange rate on the monetary interest rate or alternatively a contemporaneous effect (within the same quarter) of the monetary interest rate on the exchange rate. Yet it is likely that the two abovementioned effects occur contemporaneously. Thus the Cholesky model creates only a partial identification of the transmission (Christiano, et al. 2001). The structural model presented below makes it possible to deal with this issue (Grilli and Roubini, 1996).

In the first stage, we estimate the VAR model in its reduced form as an autoregression as seen in Equation 2:

(2) $Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + BX_t + e_t$

where Y_t is the vector of endogenous variables, A_i is the coefficient matrix of the endogenous variables with various lags (in this case two), X_t is the vector of exogenous variables, B is the coefficient matrix of the exogenous variables and e_t is the vector of reduced-form residuals. The goal is to determine the effect of a structural shock to one variable on the other variables. This cannot be achieved using Equation 2 since the residuals of each variable are not independent of the other variables. In order to do so, we need to define a structural matrix that assumes the contemporaneous relations, such that the residuals of each variable will not be correlated with the other variables and it will be possible to isolate the effect of a structural shock (a shock to the error of a variable that is not explained by the other variables). Contemporaneous relations have been added to Equation 3 by multiplying both sides by the matrix A_0:

(3) $A_0 Y_t = C_1 Y_{t-1} + C_2 Y_{t-2} + DX_t + U_t$

where

$C_i = A_0 A_i$; $D = A_0 B$; $U_t = A_0 e_t$

We will use the equation $U_t = A_0 e_t$ and multiply it by A_0^{-1}:

$A_0^{-1} U_t = e_t$

For the sake of simplicity, we will make the conventional assumption that the standard deviation of the structural shocks is 1, i.e., $E(U_t U_t^{'}) = I$. The connection between the reduced form and the structural matrix is expressed in Equation 4, in which the variance of the reduced-form residuals, $\sum$, is expressed by means of the structural matrix A_0.

(4) $\sum = E(e_t e_t^{'}) = E(A_0^{-1} U_t U_t^{'} A_0^{-1'}) = A_0^{-1} E(U_t U_t^{'}) A_0^{-1'} = A_0^{-1} A_0^{-1'}$

However, this equation does not enable the identification of A_0.[23] A necessary (though not sufficient)[24] condition is the Order Condition, which determines the minimal number of constraints needed for the identification of the structural matrix. In the case of five variables, we must impose at least 10 constraints—that is, at least 10 parameters in the structural matrix have to be set to zero. Setting a specific parameter to zero in the matrix is equivalent to the lack of a contemporaneous effect of the endogenous explanatory variable on the dependent endogenous variable between which we imposed the constraint.

2.2.1 The structural coefficients matrix

The structural matrix presented below is similar to the standard Cholesky matrix, except for the contemporaneous (within a quarter) effect of the interest rate on the exchange rate and the lack of a contemporaneous (within a quarter) effect of GDP on the monetary interest rate. In addition, as noted, a home prices variable was added in the last row (after the monetary interest rate).

[23] A_0^{-1} has numerous solutions, among them the Cholesky Decomposition of $\sum$. Note that we can include any matrix C for which $CC' = I$ such that $\sum = A_0^{-1} CC' A_0^{-1}{}'$. In other words, there are many solutions that are differentiated one from the other by the matrix C and which lead to the same $\sum$.

[24] In order for the identification to be possible, the Rank Condition must also be fulfilled.

Following is the contemporaneous structural matrix, A_0 , which is described in Equation (5), and an explanation of each equation derived from it:[25]

$$(5)\quad \begin{bmatrix} u^{d\lg dp} \\ u^{d1ex} \\ u^{d1cpi} \\ u^{dr} \\ u^{d1hp} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & a_{24} & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ 0 & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} e^{d\lg dp} \\ e^{d1ex} \\ e^{d1cpi} \\ e^{dr} \\ e^{d1hp} \end{bmatrix}$$

- Equation 1 describes the slow response of real economic activity to changes in the nominal variables (the exchange rate, the CPI, the interest rate and home prices). In other words, GDP does not respond contemporaneously to the rest of the variables.
- Equation 2 allows for the exchange rate to respond contemporaneously to changes in the interest rate and GDP and with a lag to changes in home prices. It is reasonable to assume that the contemporaneous causal relationship between the exchange rate and the housing market operates such that the exchange rate affects rents and home prices.
- Equation 3 allows for changes in GDP and the exchange rate to contemporaneously affect the CPI. Changes in the interest rate can affect the CPI also with a lag. It is generally assumed that the effect of the interest rate on the CPI is not contemporaneous (in quarterly terms)[26] and that the indirect effects of changes in the interest rate on inflation, through the exchange rate, are structurally taken into account through the structure of the VAR system.
- Equation 4 allows for the interest rate to contemporaneously respond to changes in the exchange rate and inflation and allows for only a lagged response to changes in home prices and GDP, an assumption that is the result of the delay in the publishing of data.

The information that is actually known to monetary policy makers on the day of the interest rate decision is generally viewed as a condition for a contemporaneous response, rather than assuming the accuracy of the forecast of unknown variables. Therefore, in

[25] The variables appearing in the matrix were described in detail in Section 2.1.1.
[26] Based on a meta-analysis of 67 studies, the average lag is 29 months (Havranek and Rusnak, 2012).

these cases a lagged response of monetary policy is assumed (McCallum, 1999; Elbourne, 2008).[27]

- Equation 5 allows for home prices to respond contemporaneously to the following: changes in GDP; changes in the exchange rate—due to, among other things, the indexation to the exchange rate that prevailed in the past; changes in the CPI—due to the effect on the real interest rate as an alternative investment to a real estate asset and the effect of rent which is included in the CPI; and changes in the interest rate.

3 Results

3.1 Estimation results

The coefficients of the explanatory variables in the estimation of the endogenous dependent variables in the VAR system are based on the historical relationship between each variable and the past developments, as they are reflected in other variables included in the system. Appendix 7 summarizes the results of the five estimation equations that correspond to each of the endogenous variables (the reduced form, without the contemporaneous response).

We can aggregate the estimated coefficients of the two lags for each of the variables and thus gage the direction of their accumulated effect. Based on the estimated coefficients as they are reflected in the equation for the Bank of Israel monetary interest rate, it was found that the following variables lead to a monetary expansion: appreciation of the exchange rate and a slowdown in inflation; and from among the exogenous variables: a decline in the US

[27] With regard to home prices, the data are not available for the quarter in which the interest rate decision is being made. For example, when the interest rate decision for July is being made only the home price data for March-April is available.

With respect to GDP, the Central Bureau of Statistics publishes three estimates: The first is published two months after the end of the quarter, i.e. there is no contemporaneous effect of GDP on the interest rate (given that actual growth is not known when the decision is made). In addition, even if we treat the forecasts of growth as actual growth and assume that the interest rate responds to the forecasts, there is no contemporaneous response. In any case, even when we do estimate this coefficient, in a standard Cholesky method, the coefficient for the contemporaneous effect of GDP on the monetary interest rate is very low and not significantly different from zero.

It should be noted that in Israel, at a quarterly frequency, a contemporaneous response of monetary policy to actual inflation is possible (even if partial).

federal funds rate and a slowdown in the rate of increase in import prices. Furthermore, we can observe the reaction of the macroeconomic variables to a monetary expansion: an increase in home prices, acceleration of inflation and growth, and depreciation of the exchange rate.

3.2 The impulse response function

The analysis of the impulse response function makes it possible to identify the effect of structural shocks. Apart from the reduced-form results analyzed in the previous section, it includes the assumptions on the contemporaneous response as presented in Section 2.2.1 (Equation (5)).

The following graphs present the impulse response[28] of the endogenous variables to a shock in the other variables. The blue line represents the results of the impulse response over the subsequent ten periods (quarters) while the red lines represent the confidence interval of the result. It can be seen that after ten periods, all of the responses approach zero, which implies that the variables are indeed stationary and a shock that occurs in period zero does not have a permanent effect (all of the variables return to their original rates of change). In addition, the cumulative impulse responses of the variables are presented.

It should be noted that the variables in the VAR system are responding to shocks, which are defined as change that is not explained by the rest of the variables in the system (whether endogenous or exogenous). In general, there is an advantage in relating to a

[28] Two results were obtained, depending on the starting point for the solution process, and the result more consistent with economic theory was chosen (the process of selecting the structural matrix is in general based on economic assumptions, as described previously). A number of hypothetical explanations were considered and rejected, such as a low convergence threshold that identifies one point as two and differences in sign that are the result of the solution of the quarterly equations (Christaino, Eichenbaum and Evans, 1999). In this case and even though ten zero constraints were imposed as required, two results were obtained for the A0 matrix that solve the $\sum$ equation (which is not because of a lack of identification that creates infinite solutions). After imposing an additional sign constraint on the negative effect of the interest rate on the exchange rate, the presented result is obtained. It is important to note that this is not erroneous identification that results from a local maximum being mistakenly identified as a global one since one can express the likelihood function that is being maximized as a function of $\sum$ that is derived from the reduced form independently of the contemporaneous structural matrix. Furthermore, when the length of the sample period is changed, only one result—which is almost identical to the one that was chosen—is obtained.

monetary shock rather than a general change in the interest rate since one can isolate a net monetary effect and distinguish it from changes in the interest rate that are the result of shocks to other variables.

It is also worth noting that the described responses of the variables are in contrast to the variables' rate of change in the situation that the shock did not occur. For example, when it is stated that a variable declines in response to a shock, the intention is that the variable's rate of change has declined relative to the baseline situation in which the shock did not occur.

3.2.1 Response of the endogenous variables to a positive monetary shock[29]

Response of home prices

Figure 2 presents the response of home prices to a positive monetary shock of one standard deviation. Figure 3 shows the cumulative response.

Figure 2
Response of the rate of change in home prices to a positive monetary shock of 1 standard deviation

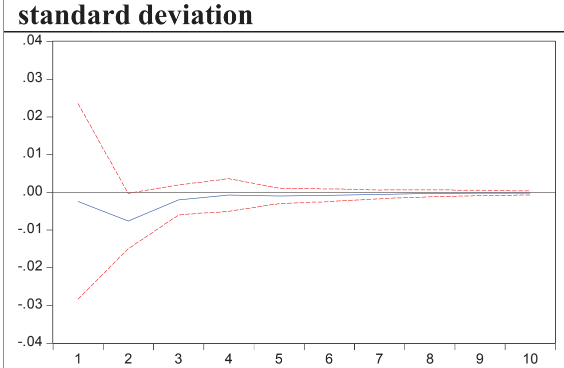
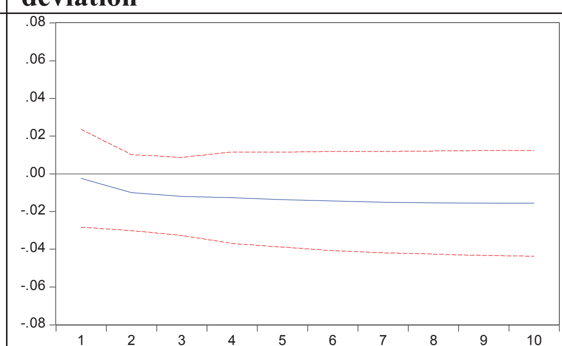


Figure 3
Cumulative response of home prices to a positive monetary shock of 1 standard deviation



It can be seen that the rate of change in home prices declines in response to a positive monetary shock, which is in line with economic theory. The decline is statistically significant

[29] Appendix 8 presents the impulse responses of the exchange rate and GDP to a monetary shock.

in the second quarter after the shock. It can also be seen that the effect of the shock continues for about three quarters.

In absolute terms, a positive shock of one percentage point in the Bank of Israel monetary interest rate reduces the rate of change in nominal home prices by 2.58 percent (cumulative response after 10 periods) and at its peak—in period 2—there is a significant decline of 1.25 percent.

Response of the CPI

Figure 4 presents the response of the rate of inflation to a monetary shock of one standard deviation. Figure 5 presents the cumulative response.

Figure 4
Response of inflation rate to a positive monetary shock of 1 standard deviation

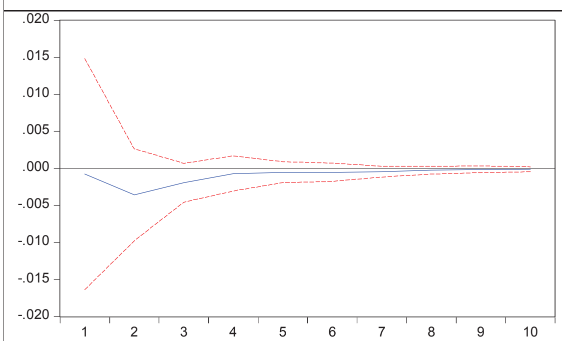
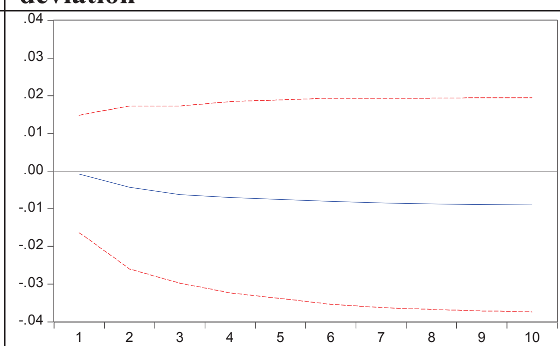


Figure 5
Cumulative response of inflation rate to a positive monetary shock of 1 standard deviation



It can be seen that the inflation rate declines (not statistically significant) in response to a positive monetary shock, which is in line with economic theory.

In absolute terms, a positive shock of one percentage point in the Bank of Israel monetary interest rate reduces the CPI by 1.48 percent (cumulative response after 10 periods).

The change in real home prices can be calculated as the difference between the decline in nominal home prices and the decrease in inflation in response to a positive monetary shock of one percentage point.[30] This calculation shows that real home prices drop by 1.1

[30] In an exact calculation (without the use of approximation), a similar result is obtained. In a direct

percent in response to a positive monetary shock of one percentage point. This is consistent with the results in the global economic literature reviewed in the Introduction. According to those results, a positive shock to the monetary interest rate of one percentage point leads to an average decline of 1.9 percent in real home prices.

3.2.2 Response of the monetary interest rate to shocks in the endogenous variables

Response of the monetary interest rate to a shock in the rate of change of home prices

Figure 6 presents the monetary interest rate's response to a shock in the rate of change of home prices of one standard deviation. Figure 7 presents the cumulative response.

Figure 6
Response of monetary interest rate to a positive shock of 1 standard deviation in the rate of change in home prices

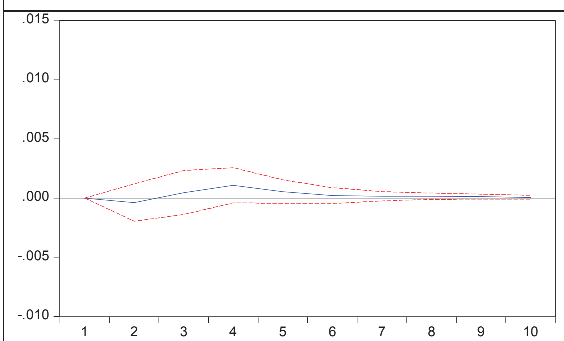
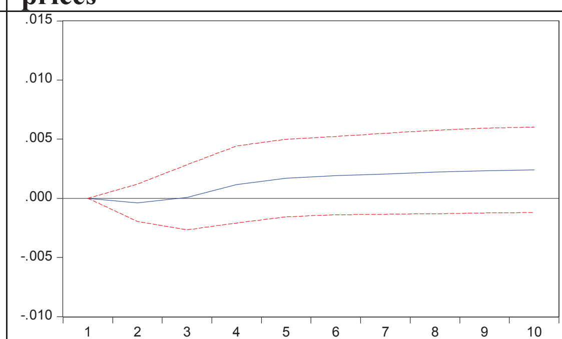


Figure 7
Cumulative response of monetary interest rate to a positive shock of 1 standard deviation in the rate of change in home prices



It can be seen that the monetary interest rate increases slightly (not statistically significant) in response to a positive shock in the rate of change of home prices. This empirical finding provides some support for the claim that monetary policy becomes more contrac-

test of the response of real home prices, by replacing the nominal home prices variable with a real variable, a similar result is obtained.

tionary in response to an increase in asset prices. In contrast, support is also obtained for the response not being substantial.

In absolute terms, a positive shock of one percentage point in home prices raises the Bank of Israel monetary interest rate by 0.19 percentage points (cumulative response after 10 periods).[31]

Appendix 9 presents the rest of the impulse response functions, which were not expanded on here, while Appendix 10 presents the cumulative impulse response functions.

3.3 Variance decomposition

Variance decomposition is a tool used to interpret the VAR model by assessing various shocks' relative importance to fluctuations in the examined variable. In other words, the decomposition of variance reveals the proportion of the variance of the estimated variable's residual that can be explained by shocks to the other variables.

Table 3 presents the decomposition of the variance of home prices. It can be seen that a significant portion (about 15 percent) of the volatility of home prices in the long term is explained by monetary shocks, although in the short term (one quarter) it accounts for only about 2 percent. The proportion of the variable's volatility that can be explained by its own shocks is about 50 percent. Inflation shocks also explain part of the volatility in home prices (11 percent), as do shocks to the exchange rate (19 percent).

Table 3 – Decomposition of the variance of home prices in the short and long terms

Period	Shock to the rate of growth	Shock to the rate of change in the exchange rate	Shock to the rate of inflation	Monetary shock	Shock to the rate of change in home prices
1	0.04	27.18	14.41	1.94	56.43
5	4.09	19.03	11.39	15.34	50.15
25	4.27	18.87	11.34	15.43	50.09

[31] The impulse response function of monetary policy to a shock in the rate of inflation, as presented in Appendix 9, shows that, as expected, the monetary interest rate increases in a statistically significant manner in response to a positive shock in the rate of inflation.

It is important to note that the result of the variance decomposition should be treated with caution for a number of reasons: First, 100 percent of the variable's volatility is explained solely by the endogenous variables while it could be that the exogenous variables also play a part in determining its volatility, such as the effect on home prices of a shock in the US federal funds rate.[32] Second, the strength of the VAR system lies in its ability to shed light on the dynamic relations between the macro variables in the economy rather than just those specifically related to home prices. However, the VAR system does not relate to all the supply and demand factors that affect home prices. Thus, the share of the variable's own shock (50 percent) likely captures the effect of the missing variables as well. Indeed, in the relevant literature, (i.e., the studies appearing in Table 1 which examined a similar question using a VAR system), in the vast majority of cases the results of variance decomposition are not reported.

Table 4 presents the variance decomposition of the monetary interest rate, which indicates that a large proportion of its volatility (about 65 percent) is explained by the variable's own shocks. A small proportion (about 3 percent) of the volatility of the monetary interest rate is explained by shocks to home prices. Exchange-rate shocks and inflation shocks explain a major portion (17 and 14 percent, respectively) of the volatility of the monetary interest rate. (Appendix 11 presents the variance decomposition for the rest of the endogenous variables.

Table 4 – Decomposition of the variance of the monetary interest rate in the short and long terms

Period	Shock to the rate of growth	Shock to the rate of change in the exchange rate	Shock to the rate of inflation	Monetary shock	Shock to the rate of change in home prices
1	0.00	1.55	1.61	96.84	0.00
5	1.05	16.98	13.66	65.30	2.70
25	1.14	16.98	13.65	65.38	2.85

[32] A test showed that the Fed rate had a significant effect on home prices in Israel. Similarly, Elbourne (2008) found that the Fed rate had a large effect on home prices in the UK.

3.4 Sensitivity tests

This section is devoted to testing the findings' sensitivity to the estimation assumptions. In the course of the estimation, various assumptions were made (the reasoning behind the choice of assumptions was discussed in the Method section). It is important to check whether a change in any of those assumptions changes the results significantly. The results of the sensitivity tests are presented in Appendix 6.12. The differences between the results of the sensitivity tests and the research's findings are analyzed in the context of the main relationship being examined—between monetary policy and home prices. The following were tested: 1) the response of home prices to a positive monetary shock of one percentage point (cumulative response after 10 periods); 2) the response of the interest rate to a positive shock of one percent in home prices (cumulative response after 10 periods); 3) the proportion of home price volatility explained by monetary shocks (after 10 periods), and 4) the proportion of monetary interest rate volatility explained by home price shocks (after 10 periods).

The estimation results are stable, and the various modifications noted above only caused small changes in the results vis-á-vis the basic estimation. The low sensitivity of the results to the estimation assumptions strengthens the reliability of the estimation results. The following sections will provide details of the tests.

3.4.1 Structural matrix of the contemporaneous response

A comparison of the presented results to the results of an estimation in which the contemporaneous matrix is defined to have a Cholesky structure yielded only negligible differences. The Cholesky estimation was carried out with the following order of variables (similar to the order of the structural matrix that was presented): the growth rate, the rate of change in the exchange rate, the inflation rate, the change in the monetary interest rate and the rate of change in home prices.

3.4.2 Number of lags

Two lags (two quarters) were chosen in the basic estimation, based on the test results and the need to avoid serial correlation in the residuals, as well as the expected response time between the macro variables as derived from economic theory. Using three or four lags was found to create only minor differences in the estimation results relative to two lags.

3.4.3 The exogenous variables

Two sensitivity tests were conducted. In one, the dummy variables for seasonality were omitted. In the second one, world trade was added as an exogenous variable. In both cases, the results were very similar to those of the basic estimation.

3.4.4 The Bank of Israel interest rate as a level

The basic estimation used changes in the interest rate, rather than its level. The reasons were presented in detail in Section 2.1.5. There were only small differences between the results of the basic estimation and the estimation using the Bank of Israel interest rate as a level. The response of home prices to a monetary shock is larger, and a larger part of the volatility of home prices is explained by the monetary shock, when the estimation uses the interest rate as a level. Results were also similar when the inflation target was added as an exogenous variable in order to neutralize the effect of inflation on the interest rate level. However, as previously noted, the impulse response function of the variable to its own shock (and in particular a monetary shock) shows results that do not converge and the shocks persevered even after long periods of time. In general, a shock in the VAR system is defined as a temporary change and the lack of convergence observed in the results when using the level of the interest rate indicate a non-temporary change, which conflicts with the basic definition required in a VAR analysis. It should be noted that when the inflation target is added as an exogenous variable in order to remove the effect of inflation from the level of the interest rate, the convergence problem is not resolved.

3.4.5 Addition of the long-term interest rate to the estimation

The monetary interest rate, rather than the long-term interest rate, was used in the basic estimation for the reasons presented in the Method section. A sensitivity test for the addition of the 10-year real interest rate as an endogenous variable resulted in only negligible differences.[33] As expected according to economic theory, a long-term interest rate shock has a larger effect than a monetary shock on home prices, such that in response to a positive shock of one percentage point in the long-term interest rate, nominal housing prices decline by 2.6 percent (as opposed to a decline of 2.4 percent in response to a monetary shock of similar size).

3.4.6 Changing the sample period

The sample period was chosen based on, among other things, limitations in the data, and therefore it is important to check that the results are not sensitive to changing the sample period or its duration. To this end, three different variations of the estimation were checked: a shorter sample period where the first two and last two quarters are omitted; a shorter sample period where the first three and last three quarters are omitted; and a third sample period up to the end of 2013. The results of the first and third variations showed no substantial differences with those of the basic estimation. The second variation, in which the sample was shortened by three quarters at both the beginning and the end, indicated that a monetary shock of one percentage point leads to a cumulative decline of only 1.8 percent in the rate of change in home prices, a slightly smaller response than that found previously.[34]

[33] The test was done in a structural VAR where the structural matrix that was chosen for estimation is similar to the standard Cholesky matrix, apart from two changes (as in the case of the basic estimation results): the possibility of a contemporaneous effect of the interest rate on the exchange rate and the lack of a contemporaneous effect of GDP on the monetary interest rate. The order of the variables (as in the case of the structural matrix that was presented) is as follows: the rate of growth, the rate of change in the exchange rate, the rate of inflation, the change in the monetary interest rate, the change in the long-term interest rate and the rate of change in home prices.

[34] An attempt to test the sensitivity of the results to larger changes in the sample period was unsuccessful since it led to overly large standard deviations. As a result, the monetary shock was far from statistically significant even for the monetary interest rate itself and therefore it was not possible to test the effect of a

4 Discussion and conclusions

The steep increase in home prices in Israel (of more than 95 percent in nominal terms from the beginning of 2008 through the end of the sample) generated a need to better understand the impact of monetary policy on home prices. A number of studies have been carried out in Israel looking at various aspects of the increase in home prices, including the search for factors that can explain it. This study is part of a broad international research effort and proposes—apparently for the first time in Israel—the use of a structural VAR system to examine the dynamic relationship between monetary policy and home prices, while taking into account the main variables in the economy that affect, and are affected by, this relationship.

The analysis was carried out, as mentioned, using a structural VAR system with quarterly observations and two lags in a sample period of 1995:Q2–2015:Q1. The endogenous variables include: real growth, the rate of change in the shekel-dollar exchange rate; inflation; changes in the monetary interest rate; and the rate of change in the nominal home price index (taken from the Home Prices Survey). Exogenous variables include: the change in the US federal funds rate; an index that reflects changes in Israel's security situation; the rate of change in the S&P 500 Index; the change in the number of immigrants to Israel; the rate of change in import prices; the proportion of home sale contracts denominated in shekels (as opposed to a foreign currency); seasonal dummy variables; and a constant.

The structural matrix chosen for estimation is similar to the standard Cholesky matrix, with two modifications: the possibility of a contemporaneous effect of the interest rate on the exchange rate and the lack of a contemporaneous effect of GDP on the monetary interest rate.

The results of the impulse response function showed that home prices in Israel decline by 2.6 percent in nominal terms and 1.1 percent in real terms, over a period of three quarters, in response to a positive monetary interest shock of 1 percentage point. This finding

monetary shock. The large standard deviations, which derived from the high level of heterogeneity when using longer sample periods, likely is the result of the major changes in Israel's economy during those years.

is consistent with the findings in other countries found in the global economic literature reviewed in the introduction, according to which a positive shock to the monetary interest rate of one percentage point leads to an average decline of about 1.9 percent in real home prices.

It should be noted that the response of home prices relates to a monetary shock. There is an advantage to relating to a monetary shock, since it is then possible to isolate the "net" monetary effect and to differentiate it from changes in the interest rate that are the result of shocks to other variables.

A decomposition of the variance of home prices indicates that some of the volatility in home prices (15 percent) is explained by monetary shocks. It is important to note that the result of the variance decomposition should be treated with caution because, , among other reasons, the entire volatility of the home prices variable is explained by the endogenous variables only, though the exogenous and other variables clearly play a part in explaining its volatility.

In the other direction, it was found that home prices had an effect on monetary policy. Thus, the Bank of Israel monetary interest rate rises by 0.19 percentage points in response to a positive shock of one percentage point in home prices. This empirical finding provides some support for the idea that a rise in asset prices indeed leads to tighter monetary policy. In addition, about three percent of the volatility in the monetary interest rate is explained by home price shocks.

To strengthen the estimation findings, tests were carried out on the explanatory power of the exogenous variables and to determine the sensitivity of the results to changes in the estimation assumptions. It was found that there was low sensitivity of the results to changes in the structure of the structural matrix, the omission of exogenous variables, changes in the number of lags, the use of the interest rate as a level, the addition of a long-term interest rate variable and changing the sample period.

As presented in the literature review, there are studies of other economies that examined the response of home prices to a monetary shock, finding that it varies from one economy to another (see, for example, Giuliodori 2005). That is, economies differ from one another in the sensitivity of home prices to monetary policy. The current study's findings indicate that in Israel, the effect on home prices of a monetary policy shock is similar to the average in other economies. Thus, the steep rise in Israeli home prices apparently does not result from an unusually high sensitivity of home prices to monetary policy.

The main conclusion arising from the results, similar to what is seen in research carried out in other countries, is that monetary shocks on their own are not a dominant factor in explaining changes in home prices during the sample period. The results indicate that nominal home prices rise by 2.6 percent in response to a negative monetary shock of one percentage point. Home prices have increased by more than 95 percent from the beginning of 2008 through the end of the sample, while the interest rate has declined by 4 percentage points (and it certainly cannot be claimed that all of the reductions in the interest rate during the period represent monetary shocks). Therefore, it appears that there are other variables, both internal and external, that may also be reflected in changes in the monetary interest rate and which have affected home prices.

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6 Appendixes

6.1 Appendix 1 –Theoretical Background

The relationship between the interest rate and home prices is described by an equation that is derived from the standard theoretical asset-pricing models (Poterba, 1984; Himmelberg et al., 2005):

$$\frac{R_t}{p_t} = (i_t + \tau_t^p)(1 - \tau_t^y) + \sigma_t + \delta - \frac{\dot{p}_t^e}{p_t}$$

On the left side is the ratio of annual rent to the price of a home ($\frac{R_t}{p_t}$)which expresses the annual yield on owning a home. The risk premium for owning a home (σ_t), the tax rate on owning a home (τ_t^p) and the rate of depreciation of a home (δ) are all subtracted from this yield or alternatively added to the right side of the equation. The expectations of an increase in home prices ($\frac{\dot{p}_t^e}{p_t}$) are added to the yield (or subtracted from the right side of the equation). At this point, the return on purchasing a home should be equal to the alternative return, i.e., the nominal long-term interest rate (i_t)[35] in annual terms less the tax rate on capital gains (τ_t^y). The equation shows that the nominal long-term interest rate is one of the fundamental factors affecting home prices.

For the sake of convenience, there are models that add and subtract from the equation's right hand side the inflation expectations variable (π_t^e), thus yielding the long-term real interest rate (in the square brackets, along with the other factors) and the expected increase in real home prices (in curly brackets).

$$\frac{R_t}{p_t} = \left[(i_t + \tau_t^p)(1 - \tau_t^y) + \sigma_t + \delta - \pi_t^e\right] - \left\{\frac{\dot{p}_t^e}{p_t} - \pi_t^e\right\}$$

These two equations imply that the long-term interest rate has a negative effect on

[35] In the models of Himmelberg et al. (2005), Poterba (1984) and others the long-term interest rate is used as the relevant interest rate.

home prices, which can be seen from the following first-order derivative:

$$\frac{\partial p_t}{\partial i_t} = -\left\{ \frac{(1-\tau_t^y)R_t}{\left[(i_t + \tau_t^p)(1-\tau_t^y) + \sigma_t + \delta - \frac{\dot{p}_t^e}{p_t} \right]^2} \right\}$$

The effect of the monetary interest rate on home prices can be viewed as an adjustment process between the yield on owning a home and the yield on other assets in the economy. The adjustment mechanism is as follows: Yields on assets in the economy decline following a reduction in the monetary interest rate; the resulting increase in the relative yield on owning a home leads to higher demand for homes and an increase in home prices, such that the yield on owning a home (the ratio of rental payments to the price of a home) is reduced, thus bringing it in line with the yield on other assets.

This asset pricing model illustrates the principles of the conceptual framework, but leaves several variables outside the system, such as the credit channel. The purchase of a home generally involves a loan (mortgage), which adds two components to the decision making process: First, the interest rate that will appear in the abovementioned equations will be the weighted average of the rate of interest on capital and the interest rate paid on mortgages, with the weights determined according to loan to value ratio (the proportion of the mortgage relative to the home value).[36]

In addition, when a mortgage is needed to finance the purchase of a home, the issue of credit constraints becomes relevant. The bank will approve a mortgage only if the risk profile of the applicant indicates a high probability of repayment, such as a reasonable payment-to-income (PTI) ratio. A reduction in the interest rate reduces monthly mortgage payments for homebuyers, or in other words, reduces their cost of credit. This will somewhat loosen the bank's restrictions on credit and will enable additional individuals to

[36] As presented in detail in the study by Dovman, Yakhin and Ribon (2012). The replacement of the interest rate in the equations with the weighted interest rate requires additional modifications to the equations.

purchase a home. However, it should be noted that the constraint on the loan to value (LTV) ratio will remain unchanged.

6.2 Brief survey of the housing market in Israel during the sample period

The beginning of the sample period in 1995 through the end of the 1990s can be viewed as the end of the period of home price increases that began in 1989 with the absorption of the largescale immigration from the Soviet Union. At the end of the 1990s, the upward trend reversed direction and the excess supply that began to accumulate led to the beginning of a major decline in real home prices (in nominal terms, home prices declined moderately).

The most recent cycle began in 2007–08, when the excess supply in the market had been absorbed and the upward trend in home prices began again, continuing until today. The rate of increase has not been uniform during this period: Until mid-2011, there was a rapid real increase in home prices which was followed by a subsequent slowdown in the second half of 2011 and even a marginal drop in prices (apparently as a result of the social protest in the summer of 2011). Since the second half of 2012, the rate of increase again accelerated. Overall, home prices have increased by 95 percent from the beginning of 2008 through the end of the sample. At the end of the period, the proportion of investors within total home buyers declined and the proportion of first-time home buyers increased.

6.3 A detailed survey of the studies used for comparison (Table 1)

Following is a more detailed description of the studies that have used a VAR model to examine the relationship between monetary policy and home prices and which were used for comparison in this study (Table 1).

Aoki et al. (2004) examined, among other things, the relationship between monetary policy and home prices in the UK by means of a VAR model. To do so, they used the following quarterly data: credit to households, real home prices, investment in housing, GDP, the CPI, consumption and the Bank of England (BOE) interest rate. The results indicate that real home prices drop by 80 basis points (at the peak, i.e., after 5 quarters) in response to a 0.5 percentage point increase in the interest rate. Elbourne (2008) also used UK data in a VAR model to examine the role of the housing market in the monetary policy transmission mechanism. The variables used include: M0 – the quantity of money, retail sales as a proxy for consumption, the short-term interest rate, real home prices, the nominal exchange rate, the CPI and the interest rate on government bonds. The results indicate that an increase of 100 basis points in the BOE interest rate leads to a decline in retail sales (the proxy for consumption) of 0.4 percent and a decline of 0.75 percent in real home prices.

Giuliodori (2005) also used VAR estimation to study various European economies and found that in response to a 1 percentage point increase in the interest rate, real home prices declined (at the peak) by less than 1 percent in Spain, Sweden and Belgium; by more than 2 percent in France, Finland and the UK; and by 1.5–1.8 percent in Ireland, Italy and the Netherlands. Iacoviello (2002) found that monetary policy had a statistically significant effect on home prices in various countries. He used a structural VAR model that included the following variables: GDP, real home prices, the short-term interest rate and inflation. The estimation was carried out using data for France, Italy, Spain, Sweden and the UK. The results showed that a positive monetary shock of 50 basis points leads to a decline in home prices. Italy and the UK had the highest short-term sensitivity, followed by Sweden and Spain and finally France and Germany. Six quarters after the shock, the level of real home prices had declined as follows: 1.3 percent in Italy; 1.5 percent in the UK; 0.6 percent in France; and 0.1 percent in Germany. Thus, there appear to be statistically significant differences between countries in certain cases.

A study that examined the response of real home prices and credit to a monetary shock in Norway using a Bayesian VAR system found a larger response of home prices than studies in other countries (Robstad, 2014). However, the results of the study were highly dependent on the structure of the assumptions on the contemporaneous responses. The results showed that at the peak of the response to a reduction of one percentage point in the interest rate the confidence interval was 0–3 percent when the interest rate was located last in the Cholesky structure, and 2–5 percent when home prices were located last. In another study for Norway, Bjornland and Jacobsen (2010) found a similar response of 2–4 percent (the confidence interval at the peak of the response to a negative interest rate shock of one percentage point). They concluded that the role of home prices in the monetary policy transmission mechanism is becoming stronger and that the response of home prices to a monetary shock is strong and immediate. A different study in Norway found a smaller effect of 0.5–3 percent to the same shock (Assenmacher-Wesche and Gerlach, 2008). In contrast, a smaller effect was found in Sweden, where a negative shock to the interest rate of one percentage point raised home prices by 1 percent (at the peak) (Musso et al., 2011).

Other studies have examined the response in the eurozone and in OECD countries. In the former, it was found that real home prices increased by 0.5–1.5 percent at the peak of the response to a negative shock to the monetary interest rate of one percentage point (Musso et al., 2011). In the OECD countries, the response to a similar shock is 0.5–2.0 percent at the peak (Assenmacher-Wesche and Gerlach, 2008). Meanwhile, another study of the OECD countries showed a higher response of 2.5–4.0 percent at the peak to a similar shock (Goodhart and Hofmann, 2008).

Vargas-Silva (2008) estimated the relationship between monetary policy and the housing market in the US using a VAR model. They included the following variables in the estimation system (with a monthly frequency and 12 lags): housing starts, investment in housing, regional variables, GDP, home prices, the GDP deflator, the CPI, the interest rate on government bonds, inflation expectations and expectations of home prices. According to the results, a positive monetary shock has a negative effect on housing starts and on investment in housing. The effect is similar across the various regions of the US, in contrast to the effect of monetary policy on home prices which is stronger in the Midwest. In comparing the results to the standard Cholesky structure, important differences were found. The results lead the author to conclude that the relationship between these two variables in the US is not that clear. Other studies in the US indicate that a monetary shock in which the monetary interest rate rises by one percentage point leads to a decline in real home prices at the peak of 1–4 percent (Jarocinski and Smets, 2008; Musso et al., 2011). Another study of the US economy showed that in contrast to other economies the response in the US is more immediate, such that a negative monetary shock of 25 basis points causes a statistically significant immediate drop of 0.9 percent in real home prices that subsequently diminishes over time (Del Negro and Otrok, 2007).

6.4 Tests of exogenous variables

Exogenous variable omitted	Conclusion	Critical value, chi-squared, 5%	Results of likelihood ratio test	Log likelihood
The proportion of home sale contracts denominated in shekels—pdol	The exogenous variable is necessary, at the 5% confidence level—the null hypothesis is rejected	11.1	15.7	1323.1
The rate of change in import prices—dlimp	The exogenous variable is necessary, at the 5% confidence level—the null hypothesis is rejected	11.1	53.3	1304.3
The rate of change in number of immigrants to Israel—dlim	The exogenous variable is necessary, at the 5% confidence level—the null hypothesis is rejected	11.1	12.5	1324.7
The S&P 500 as a global financial indicator—snp	The exogenous variable is necessary, at the 5% confidence level—the null hypothesis is rejected	11.1	24.1	1318.8
The change in the security index—ddead	The exogenous variable is necessary, at the 5% confidence level—the null hypothesis is rejected	11.1	19.4	1321.2
The change in the US federal funds rate—dfr	The exogenous variable is necessary, at the 5% confidence level—the null hypothesis is rejected	11.1	36.0	1312.9
Without omitting exogenous variables				1330.9

6.5 Stationarity tests for endogenous variables

KPSS stationarity test **H_0: I(0)**	**ADF unit root test[1]** **H_0: I(1)**	
R***	NR	lgdpsa
NR	NR	lex
R***	R***	lcpi
R***	NR	r
R***	NR	lhp
Rates of change (first differences):		
NR	R***	dlgdpsa
NR	R***	dlex
R**	R**	dlcpi
NR	R***	dr
NR	R***	dlhp

***Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level

[1] With a constant, without a trend. The number of lags in the equation was determined by the Schwarz Info Criterion, with the maximum number of lags being 11.

6.6 Stationarity tests for exogenous variables

KPSS stationarity test H_0: I(0)	ADF unit root test[1] H_0: I(1)	
R***	NR	fr
NR	R***	dead
R**	NR	lsnp
R***	NR	lim
R***	NR	limp
R***	NR	pdol
Rates of change (first differences):		
NR	R***	dfr
NR	R***	ddead
NR	R***	dlsnp
NR	R**	dlim
NR	R***	dlimp
NR	R*	dpdol

***Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level

[1] With a constant, without a trend. The number of lags in the equation was determined by the Schwarz Info Criterion, with the maximum number of lags being 11.

6.7 Estimation results

Vector Autoregression Estimates **Sample:** 1995Q2 2015Q1 **Included observation**s: 80					
	DLRGDPSA	DLEX	DLCPI	DR	DLHP
DLGDPSA(-1)	0.06	-0.20	**0.22**	-0.06	0.37
DLGDPSA(-2)	0.15	-0.31	-0.10	**-0.14**	-0.15
DLEX(-1)	-0.06	0.02	-0.01	0.04	**-0.22**
DLEX(-2)	0.02	-0.11	0.03	-0.02	0.10
DLCPI(-1)	**-0.40**	-0.12	**0.37**	**0.44**	0.19
DLCPI(-2)	**0.29**	0.45	0.09	-0.09	0.15
DR(-1)	-0.07	**-1.35**	**-0.53**	**0.20**	**-1.24**
DR(-2)	-0.13	0.56	0.12	**-0.22**	0.31
DLHP(-1)	0.10	-0.05	0.07	-0.03	**0.40**
DLHP(-2)	0.01	0.20	0.10	0.03	0.16
C	**0.01**	**0.02**	0.00	0.00	0.00
@SEAS(1)	0.00	0.00	0.00	0.00	0.01
@SEAS(2)	0.00	-0.01	**0.01**	0.00	0.00
@SEAS(3)	0.00	**-0.03**	-0.01	0.00	**-0.03**
DFR	**0.91**	1.34	-0.47	**0.54**	-0.96
DDEAD	0.00	0.00	0.00	**0.00**	0.00
DLSNP	0.01	**-0.12**	-0.01	**-0.05**	0.01
DLIM	-0.01	**0.05**	**0.02**	0.00	**0.04**
DLIMP	0.02	**-0.58**	0.05	**0.12**	-0.07
PDOL	0.00	0.00	0.00	0.00	0.00
R-squared	0.51	0.55	0.62	0.66	0.57
Adj. R-squared	0.36	0.41	0.50	0.55	0.44

Bold figures are statistically significant to at least the 10% level.

6.8 The impulse response function of the exchange rate and GDP to a monetary shock

Response of exchange rate

Figure 1 presents the response of the exchange rate to a monetary shock of one standard deviation. Figure 2 shows the cumulative response.

Figure 1
Response of the exchange rate to a positive monetary shock of 1 standard deviation

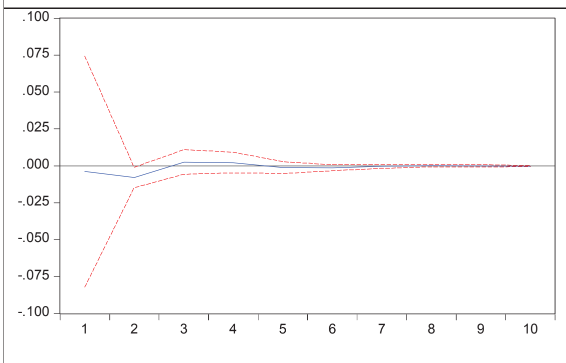
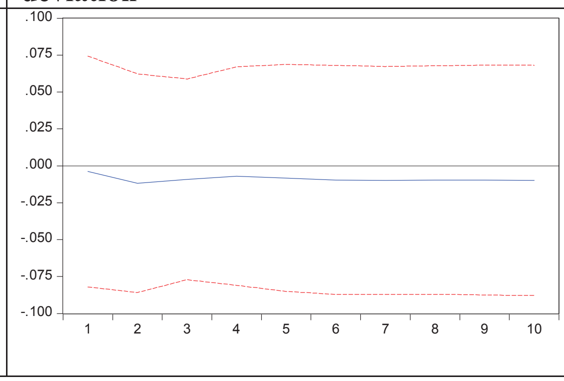


Figure 2
Cumulative response of the exchange rate to a positive monetary shock of 1 standard deviation



It can be seen that the rate of appreciation increases (not statistically signicant) in response to a positive monetary shock, in line with economic theory.

In absolute terms, a positive shock of one percentage point in the Bank of Israel monetary interest rate reduces the rate of change in the exchange rate by 1.63 percent (cumulative response after 10 periods).

Response of GDP

Figure 3 presents the response of the rate of growth to a monetary shock of one standard deviation. Figure 4 presents the cumulative response.

Figure 3
Response of the GDP growth rate to a positive monetary shock of 1 standard deviation

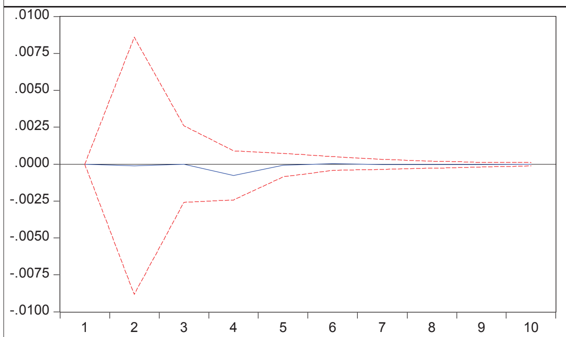
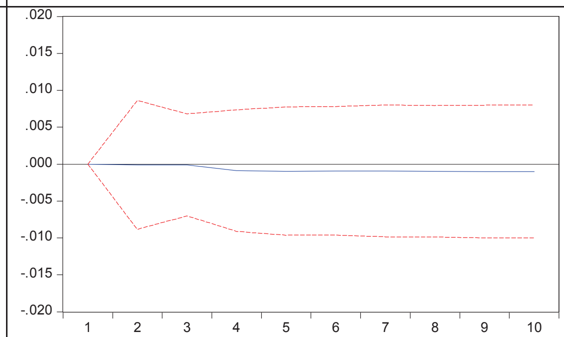


Figure 4
Cumulative response of the GDP growth rate to a positive monetary shock of 1 standard deviation

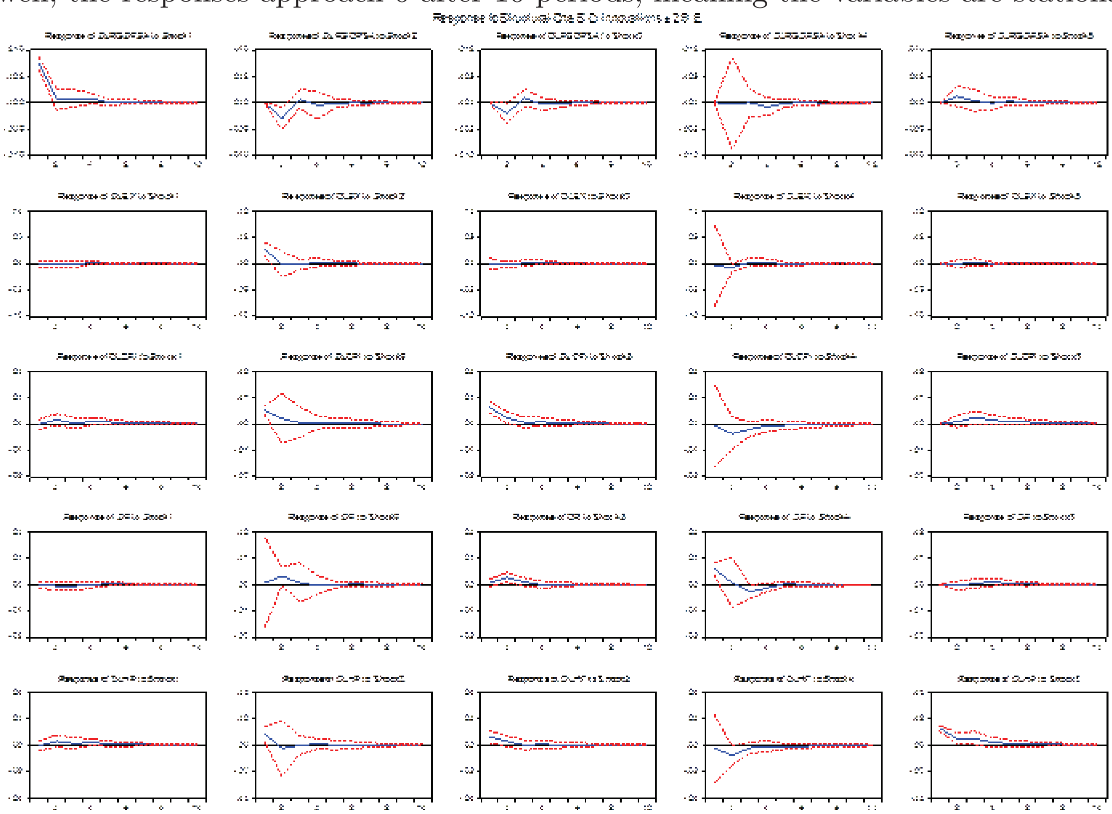


It can be seen that the rate of growth declines (not statistically significant) in response to a positive monetary shock, in line with economic theory.

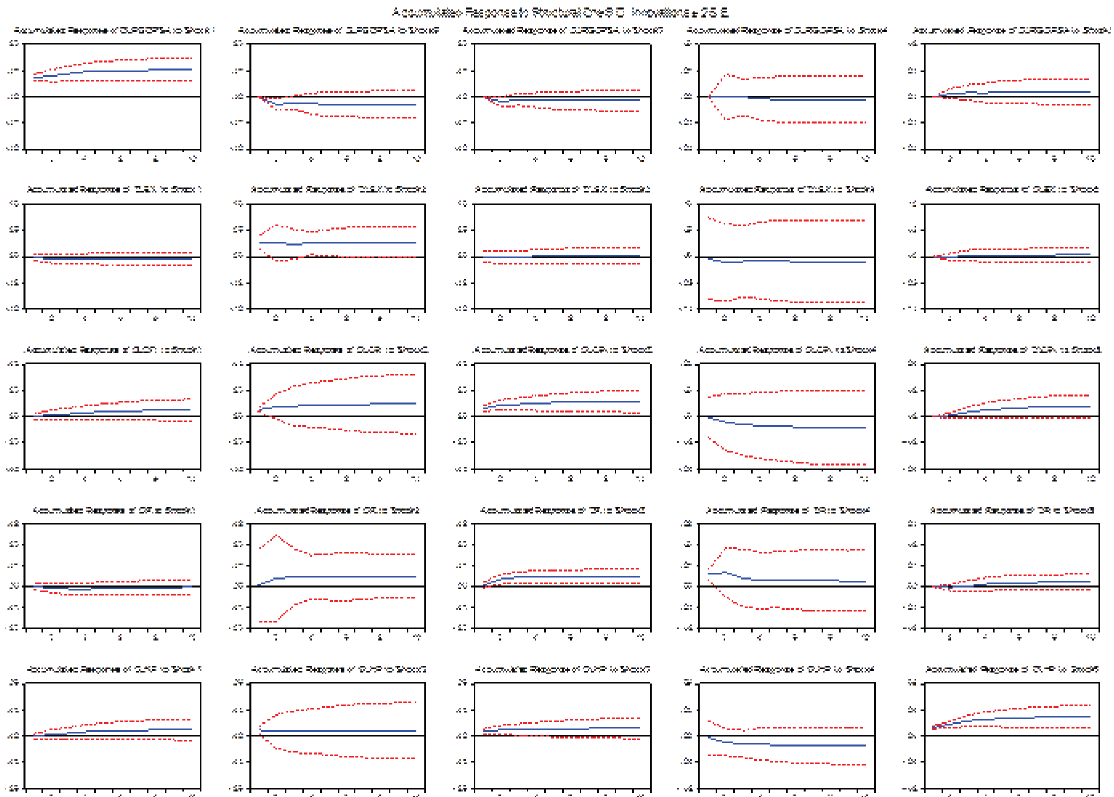
In absolute terms, a positive shock of one percentage point in the Bank of Israel monetary interest rate reduces the rate of change of real GDP by 0.17 percent (cumulative response after 10 periods).

6.9 The impulse response function of the endogenous variables

The Appendix presents the impulse response function of the endogenous variables to a shock in each of the endogenous variables. (Each column shows the response of the five variables to a shock of one of the variables.) It can be seen that in other response functions as well, the responses approach 0 after 10 periods, meaning the variables are stationary.



6.10 The cumulative impulse response function of the endogenous variables



6.11 Short term and long term variance decomposition

Real GDP:

Periods	Growth-rate shock	Shock in rate of change in exchange rate	Inflation-rate shock	Monetary shock	Shock in rate of change in home prices
1	100.00	0.00	0.00	0.00	0.00
5	77.35	12.96	6.39	0.82	2.48
25	77.35	12.95	6.39	0.83	2.48

CPI:

Periods	Growth-rate shock	Shock in rate of change in exchange rate	Inflation-rate shock	Monetary shock	Shock in rate of change in home prices
1	0.00	41.02	58.16	0.83	0.00
5	3.69	29.64	41.96	15.86	8.84
25	3.98	29.14	41.27	16.04	9.57

Exchange rate:

Periods	Growth-rate shock	Shock in rate of change in exchange rate	Inflation-rate shock	Monetary shock	Shock in rate of change in home prices
1	0.64	97.37	0.03	1.96	0.00
5	1.50	86.15	1.31	10.28	0.76
25	1.53	85.83	1.32	10.46	0.87

6.12 Sensitivity tests

	Impulse response: Response of home prices to a positive monetary shock of 1 percentage point - cumulative response in percent (10 periods)	Impulse response: Response of interest rate to a positive shock of 1 percentage point in home prices – cumulative response in percentage points (10 periods)	Variance decomposition of home prices—share of monetary shocks (after 10 periods)	Variance decomposition of monetary interest rate— share of home price shocks (after 10 periods)
Cholesky estimation	-2.39	0.19	15.20	2.84
3 lags	-2.83	0.33	18.16	5.46
4 lags	-2.89	0.44	16.51	7.69
Without seasonal dummy variables	-2.63	0.21	13.25	3.16
With addition of change in world trade variable	-2.50	0.16	17.84	3.23
Bank of Israel interest rate as a level	-3.39	1.17*	23.76	5.26
Bank of Israel interest rate as a level and inflation target as exogenous	-3.47	-0.16*	26.91	0.32
Addition of long term interest to estimation	-2.41	0.26	12.79	4.93
1995:Q4 – 2014:Q3	-2.73	0.28	14.12	5.23
1996:Q1 – 2014:Q2	-1.81	0.26	11.42	4.26
1995:Q2 – 2013:Q4	-2.16	0.21	13.78	2.92
Basic estimation presented	**-2.58**	**0.19**	**15.43**	**2.84**

*The result reflects the change in the interest rate level variable, between the interest rate level in the period preceding the shock and the level 10 periods after the shock. This result is similar to the other results in the column, which reflect the total changes in the interest rate, in a schema over 10 periods.