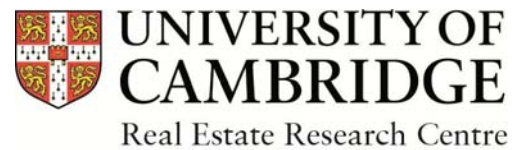


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**Title:** The Dynamics of House Prices in Israel and the Effect of the Investor's Fear Gauge

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# The Dynamics of House Prices in Israel and the Effect of the Investor's Fear Gauge

*Dotan Weiner and Franz Fuerst*

## Abstract

In this paper, we investigate the macroeconomic drivers of house prices in Israel, the OECD country with the highest growth rate in recent years, and test for the divergence of observed prices from underlying fundamentals using cointegration analysis and error correction models for the 1998 to 2013 period. While the recent surge in house prices is partially explained by fundamentals such as population growth, low unemployment, and interest rates along with supply constraints, the results suggest that prices have deviated from fundamental values by approximately 20% from 2009 onwards. Stock market volatility is found to be a key predictor of house prices in the short run, indicating a shift towards increased investment in the housing market when other asset classes, notably the stock market, are perceived as very risky.

House prices in Israel have attracted considerable attention in recent years. Israel, a developed economy and member of the OECD, has witnessed a protracted period of price appreciation since 2007. Despite the global effect of the financial crisis in 2007–2009, house prices have risen by roughly 62% in real terms, a sharp increase compared to the average growth rate of OECD countries over the same period (IMF, 2014). At the same time, there is a marked paucity of research on the underlying reasons for this price increase and the policy options for restoring affordability in the housing market. In this study, we seek to elucidate the drivers of the observed rapid price increase, and to identify whether this price movement is justified by macroeconomic fundamentals, or whether it is driven by investor expectations of future price increase and capital gains.

In general, housing markets have been identified as a key driver of economic cycles as they influence financial stability and the monetary policy of a national economy (Mishkin, 2007). Moreover, housing represents a large share of household wealth, savings, and investments and has a significant effect on consumer spending and output growth (Case, Quigley, and Shiller, 2005), especially in Israel with its 70% home ownership rate and high percentage of income spent on housing (Kahn and Ribon, 2013).

Research on the determinants of house prices has demonstrated that government policies and regulations can improve housing affordability and prevent market distortions (Malpezzi, 1996). Direct or indirect government interventions in the housing market, however, do not always yield positive results. For example, recent empirical evidence suggests that monetary policies such as quantitative easing may have fueled asset price bubbles and led to house prices diverging from fundamentals (Tsai, 2014).

In this study, we conduct an empirical investigation of the Israel housing market based on quarterly data over the 1998 to 2013 period to identify the underlying drivers and test

for significant deviation of house prices from fundamentals. Following Adams and Füss (2010) and Nagar and Segal (2011), we draw on the equilibrium model and asset pricing approach, primarily the equilibrium relation between interest rates, rents, and prices, and factors that drive existing housing supply and demand-shifting variables, to study the contribution of these factors to prices. We expand the analysis performed by Nagar and Segal (2011) by considering a longer time series, a larger set of explanatory variables, and a particular emphasis on the 2009–2013 time period when prices surged by 42% in real terms. Critically, in this analysis, we incorporate the stock market volatility index (VIX) to gain a better understanding of the linkages and substitution effects among asset classes, particularly the impact of stock market risk and volatility on house prices appreciation.

### Previous Research

One of the earliest attempts to develop a complete housing market model is the study by Smith (1969), who confirmed that house prices vary directly with permanent disposable income and housing-starts. The crucial role of long-term household income in price formation is also supported by Quigley (1999), Case and Shiller (2003), McCarthy and Peach (2004), and Arestis and González (2012), who all find that permanent income and employment levels explain real estate cycles of housing demand.

Monetary policy and the cost of external financing are two further key determinants for housing demand. A low interest rate environment and relaxation of credit standards allow more marginal households to switch from renting to owning a property and enable property owners to move up to a more expensive property. More specifically, the role of credit markets in relation to the housing market has been discussed by Kearl (1979), who found that constant payment mortgages led to distortions in the market in the face of anticipated inflation. Reichert (1990) found that U.S. house prices are sensitive to changes in mortgage interest rates. Baffoe-Bonnie's (1998) suggests that real estate cycles in the U.S. are primarily triggered by shocks in the form of fiscal and monetary policy. More recently, Miles (2014) reports that both mortgage rates and the central bank interest rate independently determine house prices, and mortgage rates do not simply act as a proxy for monetary policy (i.e., the impact of the central bank interest rate on long-term rates decreases over time).

Demographic factors are a further essential demand shifter. Case and Shiller (1990), Bar-Nathan, Beenstock, and Haitovsky (1998), Jud and Winkler (2002), Mikhed and Zemčik (2009), and Arestis and González (2013) all demonstrate empirically that a positive correlation between population growth and house prices exists, albeit with a relatively slow response of prices to changing demographic forces. Mesch and Mano (2010) and Arbel, Ben-Shahar, and Tobol (2012) demonstrate in a micro-economic framework the link between immigration to Israel and home ownership.

By contrast, empirical studies linking the stock market and the housing market arrive at more mixed conclusions. While some report that the wealth effect in the stock market can cause a concomitant rise in real estate prices, others conclude that there is a substitution effect marked by a negative correlation between equities and real estate

prices. Examples of a positive relation include Jud and Winkler (2002), who find a significant wealth effect transmitting stock market appreciation to a growth of housing prices via growing household net wealth, and Green (2002), who reports for Northern California that stock values influence housing consumption with a stronger correlation in high income areas where households are more likely to invest in stocks.

Conversely, Case and Shiller (2003) confirm the notion of a substitution effect. Following the 2000 stock market decline and high volatility, investors became more positive about real estate investment. A sharp downturn in stock prices and high volatility led to a flight to quality, which increased the demand for housing investments as housing is perceived to be a safer investment than other liquid financial assets during this phase.

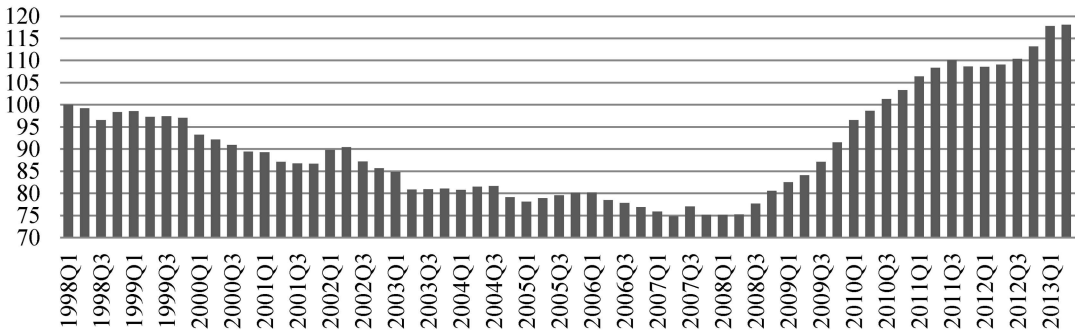
Pashardes and Savva (2009) find for Cyprus that the real estate investment decisions are influenced by competing returns achievable in the stock market. During periods of high returns from equities relative to rental income there was a lower demand for housing investments, resulting in a lower increase in house prices. Fuerst, McAllister, and Sivitanides (2015) also detect a flight to quality during periods of market crisis in increasing spreads between prime property and the rest of the market in the period following the global financial crisis. Since there are mixed results in the literature, we leave the relation between stock markets and house prices open for empirical examination in this paper.

The evidence on supply, both in terms of the existing housing inventory and new construction activity, in determining house prices is also contradictory. According to basic economic theory, increasing demand and rising prices should induce a positive supply response, resulting in a subsequent price adjustment. Empirical studies do not always confirm this relation, and in some cases even report a positive association between new supply and house prices (e.g., Ooi and Le, 2012). The extent to which prices will adjust depends on the price elasticity of supply, which in turn depends on factors such as expectations of demand and the size and structure of the house-building industry.

If supply is severely inelastic, the required price adjustment period may be so long that supply never responds adequately from a market equilibrium perspective, resulting in a largely demand driven market (Pryce, 1999). In a similar vein, Cameron, Muellbauer, and Murphy (2006) report that inelastic supply (i.e., a lack of house building in conjunction with strong demand) is a major driver of price appreciation. More recently, Caldera and Johansson (2013) find large variation in the responsiveness of housing supply to prices driven by spatial characteristics, land use, and planning regulations. Saiz (2010) finds that supply elasticities are a function of both physical and regulatory constraints and that most areas in which housing supply is regarded as inelastic are severely land-constrained by their geography.

For Israel, a geographically-constrained area, Bar-Nathan, Beenstock, and Haitovsky (1998) find the supply elasticity to be very low in the long-run (0.35), suggesting that price shocks have a long-run influence on future prices with supply responding inadequately. This confirms the relatively low supply elasticity of the Israeli housing market. Since there are no quantifiable data on physical and regulatory constraints in Israel, we provide a qualitative analysis of supply constraints and employ a macro-economic supply variable in the empirical analysis to econometrically investigate the elasticity of supply.

Exhibit 1. Real House Price Index: 1998:Q1–2013:Q4



Source: Central Bureau of Statistics.

### Background on the Israeli Housing Market

Several recent studies of the Israeli housing market appear to support the notion of a moderate deviation from house price fundamentals in the more recent past. These studies do not take into account, however, the period of exceptionally strong price growth after 2010. Dovman, Ribon, and Yakhin (2012) find that in the period up to 2010, actual prices were between 3% below and 10% above the fundamental price. They conclude that there is no evidence of a significant price misalignment. In a similar vein, Nagar and Segal (2011) find that observed house prices were 8% to 16% above their fundamental value, which again provides no evidence of a price misalignment.

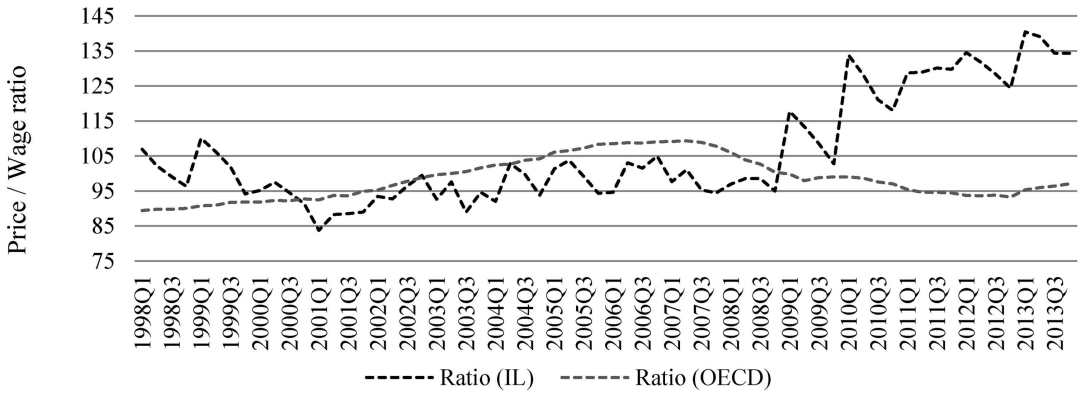
While rapid house prices appreciation has occurred in other OECD countries, the timing and magnitude of Israel's price boom appears out of sync with comparable other OECD countries. An analysis of the house price index reveals a cyclical movement of prices; a long cycle of bust and boom is distinguishable (Exhibit 1). From 1998:Q1 to 2007:Q1, house prices declined consistently, with an aggregate fall of 24% in real terms, while in the following period, 2007:Q2 to 2013:Q4, prices surged, with an upward adjustment of 62% in real terms.

This price growth rate, which is almost unparalleled among developed countries in recent years, with approximately double the growth rate of the second ranked country Turkey (OECD, 2014), has significantly impeded households' ability to purchase a property. A more in-depth comparison of price growth to population growth ratios across OECD countries reveals that Israel's price response to growth was more elastic and over time negatively correlated with the rest of the OECD countries.

### House Prices to Average Wage

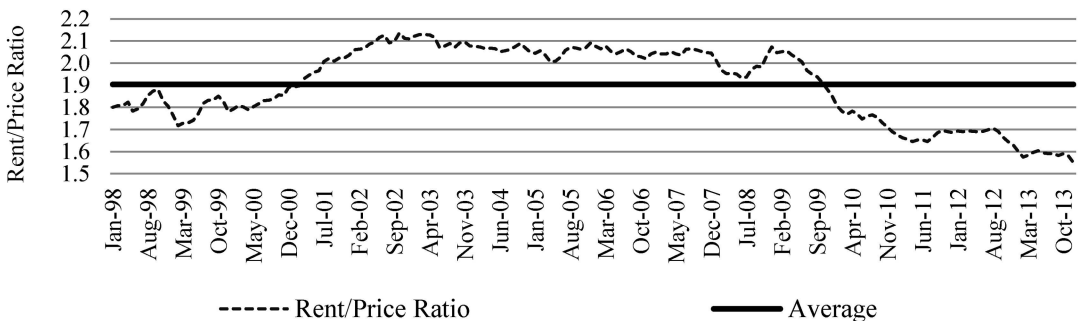
One of the key metrics of affordability is the earnings multiples of house prices. Exhibit 2 shows the evolution of the monthly earnings ratio in Israel and in the OECD countries. From 2009:Q4 onwards, the Israeli price to wage ratio deviates notably from all other OECD countries. In the same period, house prices in Israel rose by a cumulative 26% beyond the rise in real wage. These numbers signal a sharp drop in the purchasing power

**Exhibit 2. Prices to Average Wage Ratio: 1998:Q1–2013:Q4**



Sources: Bank of Israel and OECD statistics.

**Exhibit 3. Rent Index to House Prices Index Ratio: 1998:Q1–2013:Q4**



Source: Bank of Israel.

of households with regard to housing and may even amount to an affordability crisis for some cities and income groups.

### Rent to House Prices Ratio

A further key stability metric is the rent-to-price ratio, which is essentially a profitability measure. It is assumed that households will switch from renting to owning a property (and vice versa) when conditions are favorable. This mechanism ensures that prices readjust to equilibrium whenever there is an imbalance and a departure of prices from the fundamental investment value represented by rents. In the long-run, this ratio should remain relatively stable in a free market economy such as Israel. Exhibit 3 shows a deviation from the long-run average. Since 2010 prices have risen more steeply than rents, resulting in a lower return on investment.

Moreover, from 2007:Q2 to 2013:Q4, rents have only grown by 19% in real terms, while house prices grew by 62%. We acknowledge that to some extent this is a result of low

interest rates, favoring asset price growth, but it may also be indicative of fundamental price misalignment. McCarthy and Peach (2004) report that in the U.S., the last time the rent-to-price ratio fell below its long-run average was in the late 1980s, and house prices have subsequently declined. They suggest that among other factors, this was the result of a low return on the housing asset relative to competing assets and thus home prices readjusted to a level comparable with the competing returns.

### **Economic Activity/Business Cycle**

Since 2004, income tax reforms and constant growth of labor force participation rates contributed to increased purchasing power in Israel. Notwithstanding, house prices fell by 8% from 2004 to 2007 in the face of economic growth. In the following period, 2007:Q3 to 2013:Q4, the steep increase in real house prices (62%) appears again to be unrelated to the real GDP growth of only 8% over the entire period and an average wage increase of only 2%, suggesting that economic activity indicators and house prices are not contemporaneously correlated in Israel.

### **Monetary Policy**

Since February 2009, in response to the global financial crisis, the appreciation of the New Israeli Shekel (NIS), and in order to prevent an economic recession, the Bank of Israel (BoI) initiated two rounds of monetary easing. The easing supported economic growth, although it also boosted demand in the housing market. Since then, the BoI has introduced various macroprudential measures to address the risk of a house prices bubble such as capital surcharges aimed at reducing banks' incentives to extend a mortgage. Also, the variable component of mortgages was limited to one-third of the principal amount of the loan. To date, these measures have not been effective in containing house price inflation; in addition, recent direct regulations regarding loan-to-value limits and the second-home extended purchasing tax seem to have cooled, to some extent, the speculative investment element in the housing market.

### **The Housing Investment Market**

Investment activity in the housing market by non-owner occupiers has a considerable impact on house prices. In the 2003–2013 period, this market segment represented roughly 26% of the total national transactions on average and overseas investors' activity represented an additional 3.5% of total transactions (Ben-Naim, 2010; BoI, 2014). Exhibit 4 shows the investors involvement in the market.

In late 2008, the global financial crisis caused a continuous decrease in the value of financial assets and interest rates in Israel while strengthening the attractiveness of housing as an alternative investment asset. By 2009, investment activity accounted for one-third of the total transaction volume in the national residential market and by 2014 the number of households that owned two apartments or more increased to 9.1%, from 2.1% in 2006 (CBS, 2014). In a special report on the housing market for 2008–2013, the State Comptroller highlighted that although investors form a significant part of the demand in the housing market, the Ministry of Construction and Housing and the Ministry of Finance have systematically ignored examining the investors' effect on the housing market, to determine a rational policy (State Comptroller of Israel, 2015).



Exhibit 4. Investor Activity in the Housing Market: 2003:Q1–2012:Q4



Source: Adopted from the Bank of Israel.

### Stock Markets and Volatility

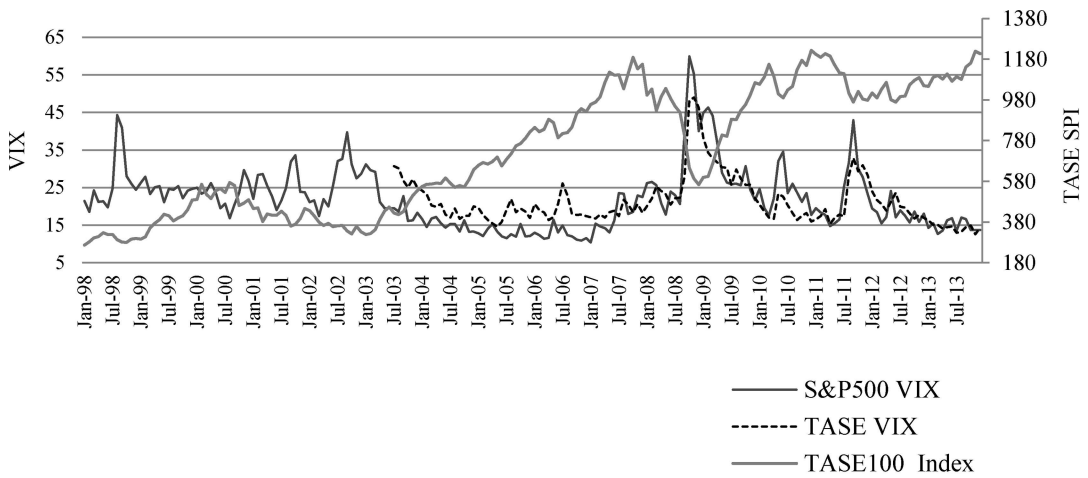
While a number of researchers have investigated the link between stock markets and housing markets, the role of stock market volatility has been largely neglected in this context. A suitable indicator for measuring the stock market volatility is the VIX index, which is sometimes referred to as the investors’ fear gauge since it is set by investors and expresses their consensus view about expected future market volatility and risk (Whaley, 2000).

The predictive power of the VIX index has been tested in previous studies. Banerjee, Doran, and Peterson (2007) find that implied volatilities, as measured by the VIX, hold meaningful economic information and strong predictive power with regard to risk and returns. Poon and Granger (2003) reviewed 26 papers comparing the volatility forecasting performance of historical volatility models and volatility implied from options. They found that 76% of the studies found ISD (option-implied standard deviation) to provide the best forecasting for the future volatility of stock prices; thus, confirming the rationale for using a forward-looking volatility measure rather than using the past stock price index volatility. In a similar vein, Eldor, Hauser, and Libal (2008) find that the TASE VIX is a significant predictor of the expected volatility of share prices in Israel. Connors (2002) reports that traders’ use the VIX as a market timing tool as it appears to predict market peaks and troughs.

Furthermore, long-term volatility appears to be mean-reverting. When the VIX begins its mean reversion, it is typically accompanied by a market rally. Along with the finding of Chadwick (2006) that the VIX is a good signal of five-month rallies of market returns, we infer that in fact, the VIX plays a significant role in determining the sentiment and



Exhibit 5. TASE 100, TASE VIX, and S&P 500 VIX



Sources: Bloomberg and Bank of Israel.

investment decisions of many professionals and represents a risk management and information tool with which investors assess capital market risks.

The correlation between the TASE index and the VIX, using the time period in the chart, is negative 0.31. Volatility in financial markets, proxied by the VIX index, signals investors' risk appetite. Therefore, when the VIX is low, investors expect future strong market returns, and vice versa, when it rises, risk-averse investors will translate high levels of the VIX into high-risk premiums. Thus, VIX movements may ignite a substitution effect.

Exhibit 5 shows how the violent stock market crash in late 2008 can be seen in the VIX graph as record peaking levels and the 2005–2007 stock market boom can be seen as the VIX record low level.

Apart from these cyclical developments, there is also a structural characteristic that is important for understanding the workings of the Israeli housing market and why housing supply appears to be inelastic. Israel has a complex bureaucratic structure with over-centralization at the national level and inherent conflicts at the local level. Around 93% of land in Israel is publicly owned; that is, either property of the State of Israel, the Jewish National Fund (JNF) or the Development Authority.

The Israel Land Authority (ILA) is the government agency responsible for managing this land and for determining the land availability for housing construction. The ILA releases land for housing construction, with detailed planning, and determines the price (by bids with a reserve price) as well as when and how developments will be executed. Therefore, the price of land depends, inter alia, on the rate at which the authorities release land and provide planning. As of 2013, it takes 13 years on average to develop a residential unit, from which the actual construction period is only two years. Furthermore, the National Master Plan #35, which determines regional and local planning, restricts the construction of new dwellings in high demand areas in order to prevent suburban sprawl.

It is well documented in the literature that low supply elasticities can be characterized as functions of both geographical and regulatory constraints (Glaeser, Schuetz, and Ward, 2006; Gyourko, Saiz, and Summers, 2008; Saiz, 2010), especially in an over-centralized and bureaucratic structures as seen in the case of Israel. Somkin and Gayer (2013) show that during the last decade, the ILA was consistently under-supplying the market; thus, contradicting government policy to increase land supply. The authors argue that the monopolistic nature of the ILA land marketing activity led to the inelasticity of supply and distortion in the market, reflected in a total surplus of NIS 356 billion (USD 96.2 billion) paid by households, and if the ILA release of land for developments had been in line with demand, prices today would be 35% lower.

## Data

The econometric model is estimated on a dataset covering the 1998:Q1 to 2013:Q4 period and includes 64 observations. The following variables are used in the estimation:

Variable	Symbol	Source
Real house price index	Hp	Central Bureau of Statistics
Real rent index	Rent	Central Bureau of Statistics
Real Stock-Price-Index	SPI	Bloomberg
Market volatility index	VIX	Bloomberg
Unemployment rate	Uemp	Bank of Israel
Real mortgage interest rate	Long	Bank of Israel
Short-term interest rate	IR	Bank of Israel
Housing-inventory-to-population	Hipop	Central Bureau of Statistics
Average real wage per-capita	Wage	Bank of Israel

The housing market is characterized by great heterogeneity of characteristics that affect prices; thus, estimating price trends by comparing the average or the median price of houses sold will affect the results of the estimation and yield index bias. Therefore, the Central Bureau of Statistics (CBS) uses the hedonic pricing method to calculate the house price index (the dependent variable). In the method, prices are set by the aggregative effect of quality parameters; consequently, the ability to measure their different effects on prices allows a more accurate estimation of the index. The CBS house price index used in this study is calculated on the basis of the Carman database, which covers approximately 85% of the total housing transactions reported to the tax authority, and includes over 40 house-specific and regional parameters, such as size, type, age, and location.

Data for the owner-occupied housing services (rent index) are retrieved from the CBS. Since 1999, the index is measured according to rental-equivalent methodology, which recognizes the rent in new and renewable contracts as a proxy for housing services costs, or equivalently the return to an investor from owning her home.

Indisputably, measuring new leases is a more accurate indicator, since it reflects the user costs of housing in current values, and therefore represents a better comparison with house prices. For the period of 1998, we use the rental values of existing leases, but any bias compared to new leases should be mitigated by using a two-year average of rental values. Prices and rents are generally only weakly correlated (0.13) over the entire sample period. Moreover, rents have grown only by 3.76% in real terms, while house prices grew by 20.81%.

Data for the unemployment rate are retrieved from the BoI and along with average wage represent the economic activity. Data for real disposable income does not exist for Israel, thus we include the quarterly average wage per employee from BoI Statistics. A housing-inventory-to-population ratio is created from the quarterly population growth data and the quarterly housing inventory, which is a synthetic variable based on the CBS housing inventory survey (1995), to which we add the quarterly construction completions.

Changes in underwriting standards, the supply of mortgage credit, the securitization, and subsequent house price movements have been studied, among others, by Anderson, Capozza and Van Order (2011), Mayer and Sinai (2009), and Mian and Sufi (2009). Since data series for these variables do not exist for Israel and since there is no mortgages securitization activity in the Israeli financial market, we employ the BoI data for the quarterly real long-term mortgage interest rates.

Data for the CPI-Indexed Fixed Mortgage Rates exist for periods of up to five years, 5–10 years, 10–15 years, 15–20 years, 20–25 years, and over 25 years. Following Nagar and Segal (2011) and the fact that households consider both short- and long-term rates to form their expectations, we use a weighted average of the CPI-Indexed Fixed Mortgage Rates. Furthermore, we use the central bank (BoI) interest rate underlying adjustable-rate mortgage (ARM) rates, which represented 57% of all mortgages in 2013.

Data for the Stock-Price-Index (TASE 100) and for the VIX index are retrieved from Bloomberg. The VIX time series for Israel exists only from 2003; therefore, the highly correlated (+0.869) S&P 500 VIX is used in this study. The CBOE Volatility Index was introduced in 1993 and since then is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices.

The VIX was originally designed to measure market expectations of 30-days volatility as implied by at-the-money S&P 100. Since 2003, the VIX is calculated using real-time S&P 500 Index (SPX) option bid/ask quotes. The VIX uses near-term and next-term out-of-the money SPX options and then weights them to yield a constant, 30-day measure of the expected volatility of the S&P500 Index (CBOE, 2014).

### **Empirical Analysis**

The empirical analysis for the estimated period of 1998:Q1 to 2013:Q4 is conducted in three steps: First, we test the variables for stationarity using unit root tests. Next, we apply a cointegration test to detect the long-run equilibrium relations and the variables long-run elasticities, and finally estimate an error correction model for the short-run dynamics using the ordinary least squares (OLS) method to estimate the variables in stationary form.


**Exhibit 6. Augmented Dickey-Fuller Test**

Variable	Level	Difference
log Hp	0.697	-4.253***
log Rent	-0.311	-5.804***
log SPI	0.990	-5.993***
Uemp	-1.298	-5.886***
Long	-1.539	-5.925***
IR	-1.925	-5.673***
log Hipop	3.588	-5.914*** <sup>c</sup>
log Const	-1.89	-12.623 ***
log Wage	-4.748*** <sup>c</sup>	
log Vix	-2.748* <sup>c</sup>	

Notes:

<sup>c</sup>Indicates a constant has been used.

\* Statistically significant and rejection of the null at the 10% level.

\*\*\* Statistically significant and rejection of the null at the 1% level.


**Exhibit 7. Granger Causality Test**

Variable	Lags	F-statistic	Prob.
SPI > Hp	3	2.3122	0.0866*
	4	2.9951	0.0271**
	5	2.7044	0.0315**
	6	3.4128	0.0085***
VIX > Hp	5	3.7213	0.0064***
	6	3.1657	0.0114**
	7	2.8649	0.0157**

Note:

\* Statistically significant and rejection of the null at the 10% level.

\*\* Statistically significant and rejection of the null at the 5% level.

\*\*\* Statistically significant and rejection of the null at the 1% level.

### Unit Root Tests

The standard augmented Dickey-Fuller (ADF) test is used for testing whether the time series data are stationary and follow a unit root process. The ADF test statistics are reported in Exhibit 6 and indicate that all the series, except *wage* and VIX are non-stationary. The finding of *wage* to be stationary is remarkable since wages are expected to increase over time, roughly in line with economic and productivity growth. For further analysis, we use the error correction model and first-difference the non-stationary series. As expected, first-differencing renders all the time series stationary.

### Causality Tests

The results of the Granger causality tests of the variables are given in Exhibit 7. We only present the Granger causality relationship between stock prices and VIX to housing

prices, since we focused on how capitals flow from the stock market to the housing market. As shown in Exhibit 7, the results of the Granger causality test reveal a strong channel of one-sided directional causality and confirms that changes in stock prices and VIX may lead to changes in housing prices.

We find no reverse causation from house prices to the stock market or VIX. The unidirectional Granger causality between VIX and housing prices is confirmed by the results in Yang and Lee (2013), who found the causality relation from the VKOSPI (Korea's representative implied volatility index) to the rent-to-house price ratio after the global financial crisis, but not vice versa. The unidirectional causality between equity prices and housing was also confirmed by the research result of Chen (2001).

A deviating finding is presented by Shirvani, Mirshab and Delcours (2012) who find bilateral causality between stock prices and home prices in the US, indicating a feedback effect of both the real estate market and the economy in general back to the stock market.

### Long-run Relations

Economic theory suggests that a short-run deviation from equilibrium prices should be corrected in the long run. Several specifications of potential long-run equilibrium relations to which house prices adjust were estimated using cointegration analysis for the period 1998:Q1 to 2013:Q4. All variables are  $I(1)$ . The results of the Engle-Granger cointegration test indicate that for log house prices, log rent, log Stock-Price-Index, unemployment, long-interest rates, interest rates, and house-prices-to-population-ratio, the estimated  $p$ -value is less than 10% (Engle-Granger cointegration test Prob.0.0739). Thus, the null hypothesis of no cointegration is rejected at a significance level higher than 7.39%. The VIX time series was included in the cointegration analysis, albeit not found to be cointegrated.

To derive the long-run coefficients, we estimate an OLS regression. We test the residual series from the estimated equation and find it to be stationary and significant. We conclude that the estimated relations can be regarded as a long-run equilibrium relation and can be used to estimate the error correction model.

Exhibit 8 shows the estimated long-run elasticities of the relevant variables with regard to house prices. Since all the variables are in logarithms or percentages, the elements of the coefficient show the average long-run percentage change of the dependent variable for a one percentage change in the independent variable, *ceteris paribus*. In cointegration analysis, statistical inference is not possible on parameters in a cointegration equation, which includes  $I(1)$  variables but the long-run elasticities can be obtained after making the included time series  $I(0)$  stationary (Brooks, 2008).

The estimated relations point to the supply variable (housing-inventory-to-population ratio) as the most important variable in explaining house prices in the long-run. The long-run elasticity of house prices with respect to housing-inventory-to-population ratio is  $-8.3019$ .

The strong elasticity is the result of the housing stock and adult population growing at different rates during the sample period. A decrease in the value of the housing-inventory-to-population ratio indicates that the market suffers from under supply; a 1% decrease in


**Exhibit 8. Cointegration Estimation**

Variable	Coeff.	Std. Error
Constant	-9.3945	2.2594
log Rent	1.4102	0.1861
log SPI	-0.0106	0.0325
Uemp	-2.6556	0.7848
Long	-1.6802	1.1773
IR	2.4212	0.3853
log Hipop	-8.3019	1.7826
Adj. R <sup>2</sup>	0.8812	
F-statistic	78.8766	
ADF <i>t</i> -value	4.4379	

Notes: The dependent variable is HP. There are 64 observations.

the ratio today would lead to 8.30% increase in prices in the long-run equilibrium level. This result is largely in line with previous research on the housing market in Israel. For example, Bar-Nathan, Beenstock, and Haitovsky (1998) documented the long-run elasticity of house prices with respect to housing stock to be  $-11.7$ .

The second strongest elasticity was found for unemployment, which exhibits an inverse relation to prices. The coefficient estimate indicates that a one percentage point increase in unemployment rate today would lead to 2.65% decrease in prices in the long run. Furthermore, in-line with asset pricing theory, rent was found to have a strong effect on prices. The coefficient estimate indicates that a 1% increase in rental values today would lead to 1.41% increase in prices in the long-run equilibrium.

The construction industry in Israel requires considerable financing, mainly for land acquisition, long planning process, and construction lead times (25–35 months). In addition, under the terms of the Assurance of Investments of Purchasers of Apartments Law—1973, developers are obliged to provide a financial guarantee that secures completion of the dwelling in the event of bankruptcy or liquidation of the business or failure to complete, all of which increases the cost of financing.

In terms of the effect of monetary policy on prices, we find that short-term interest rates exhibit strong and positive elasticity with respect to house prices. The coefficient estimate indicates that a one percentage point increase in the BoI interest rate leads on average to a 2.42% increase in house prices. In terms of long-term mortgage interest rates, the strong negative elasticity,  $-1.6802$ , reflects both capital switching due to higher interest rates and lower demand for home ownership due to higher mortgage costs.

Our findings confirm, for the first time, a significantly long-run inverse relation between the Stock-Price-Index and house prices, which supports a substitution effect. This is in contrast to studies of Israel that found no link between stocks and house prices for previous time periods.

To illustrate the expected link, consider a model in which a household attempts to maximize returns on its investment portfolio. When stock markets decline, the

substitution effect may cause households to reduce their liquid assets investment activity and increase demand for long-term stable housing investments. The household can now achieve a more diversified portfolio and returns from investing in less volatile assets. This increase in demand will lead to a rise in house prices, at least in the short to medium run, and in a supply-constrained market perhaps even permanently.

An important conclusion from the long-run analysis is the fact that efforts to alleviate supply-side constraints, specifically housing inventory, could be a more effective approach to constraining house price appreciation in the long-run than monetary authorities influencing the housing market.

### Short-run Dynamics

The error correction model captures the short-run dynamics and the correction of price deviations from the long-run equilibrium post an exogenous shock (Engle and Granger, 1987). It measures how long it would take for the Israeli housing market to return to equilibrium after an exogenous shock to the market. The estimated error correction model presented in Exhibit 9 is relatively strong and the coefficients and significances were found to be robust and consistent for different period estimations.

A considerable debate in recent years has proven the effect of behavioral factors on market movements. Perhaps the most popular model in finance and housing markets is simple extrapolation, occasionally called momentum trading, or backward-looking investors. In the housing economics context, expectations concerning future prices play a role in explaining short-run price movements. Investors use the recent growth rate from past prices to infer the present and future growth rate in fundamentals (Glaeser and Nathanson, 2014).

In line with the ideas presented in Piazzesi and Scheider (2009) and Glaeser (2013), we assume that the expectations concerning future housing price movements are backward-looking expectations and are explained by lagged house prices, which take the role of sentiment in house prices dynamics. Hence, lagged house prices changes take the effect of expected appreciation of price movement into account, obviating the need for an explicit expectations variable. Moreover, lagged house prices are influenced by the moving average of all the lagged explanatory variables and therefore amplify their influence on future prices.

The results confirm these behavioral explanations. The backward-looking expectation based on lagged price growth rates was found to be significant in determining positive price appreciation. This finding is supported by the fact that lagged house prices explained 40% of price growth in the 2009–2013 period.

These results highlight the role of expectations and inertia in the formation of prices and the fact that during periods of booms investors' and households' assume that past price increases reflect expectations about future price increases and this speculative behavior contributes to further price hikes. A 1% house price increase entails a further 0.363% price increase after one quarter and 0.317 after three quarters (the short-run cumulative effect was found to be 0.68%). These results are supported by Nagar and Segal (2011), who found the lagged house prices elasticities to be 0.394 after one quarter and 0.316 after four quarters.




**Exhibit 9. Error Correction Estimation**

Variable	Coeff.	t-Stat.
Constant	-0.0074***	-4.17
$\Delta \log Hp(-1)$	0.3632***	3.33
$\Delta \log Hp(-3)$	0.3173***	3.48
$\Delta \log Rent(-1)$	-0.6138***	-6.14
$\Delta \log SPI(-4)$	-0.0274**	-2.05
$\Delta Uemp(-4)$	-1.0372***	-3.05
$\Delta Uemp(-5)$	-0.9446***	-2.74
$\Delta Long(-2)$	-1.5283***	-2.72
$\Delta Long(-3)$	-1.3631**	-2.64
$\Delta \log Hipop(-4)$	-3.4222**	-2.12
$\Delta IR(-1)$	-0.7038***	-3.62
$\log Wage(-2)$	0.1420**	2.39
$\log Vix(-5)$	0.0293***	4.90
ECT(-1)	-0.1332***	-3.09
Adj. R <sup>2</sup>	0.7391	
Centered VIFs	5	
F-statistic	13.4220	
Prob (F-statistic)	0.0000	
Durbin Watson stat.	2.1562	
Breusch-Pagan-Godfrey	0.6685	
Ramsey RESET	0.8911	
Lagrange-multiplier stat.	0.4650	

Notes: The dependent variable is HP. There are 58 observations. Numbers in parentheses indicate the lags of the variables.

\*\* Statistically significant and rejection of the null at the 5% level.

\*\*\* Statistically significant and rejection of the null at the 1% level.

Backward-looking expectations may also assist in explaining why buyers often miss the signals new construction and supply should have on prices and typically lead to buyers failing to predict that supply will eventually cause prices to converge. It is presumably harder for investors to correctly quantify factors such as the workings of supply and demand, the imperfect information flow from the news media, and the positive sentiment that is spread by investors' success stories that may tint their perception of market fundamentals and fair value of assets. As described in the literature on economic cycles, investors tend to not make full and effective use of all the available information and are thus prone to ignoring "red flags" in the housing markets (Glaeser and Nathanson, 2014; Shiller, 2014).

We suspect that while throughout the entire sample period the supply variable (housing-inventory-to-population ratio) seems to be the strongest and most stable contributor to the positive price appreciation, the lesser contribution of supply in the short run means that backward-looking expectations cause buyers to miss the signals new construction and supply should have on prices. In the shorter 2009–2013 period, the housing-

inventory-to-population ratio was only the third most important contributor to price appreciation, explaining only 11% of the price increase at that period.

The error correction term (ECT) demonstrates how long it would take for the housing market to return to equilibrium after an exogenous shock. The ECT coefficient,  $-0.1332$ , suggests a 13.32% adjustment towards equilibrium following a shock to the model in the previous quarter. These results are similar to the finding of Nagar and Segal (2011) who found the adjustment rate to be 20.6% per quarter, although their model specification and dataset differed from the present study. According to the IMF (2014), the adjustment rate has significant macroeconomic effects, notably a slow adjustment rate may allow the economy to avoid a recession while a rapid correction may lead the economy into a recessionary episode, with economic activity recovering as late as two years after a temporary shock.

The housing equilibrium value ( $bp^f$ ) is derived from the long-run equation. Misalignment in house prices is given by:  $M_t = bp_t - bp^f$ . If  $M_t > 0$ , then house prices are above their equilibrium value. Further analysis of the cointegration relation reveals that the positive accumulative price deviation from equilibrium, in the 2009:Q3–2013:Q4 period, is  $M_t = 19.5\%$ . These results are similar to the findings of the IMF (2014), suggesting that prices are 26% above their fundamental value.

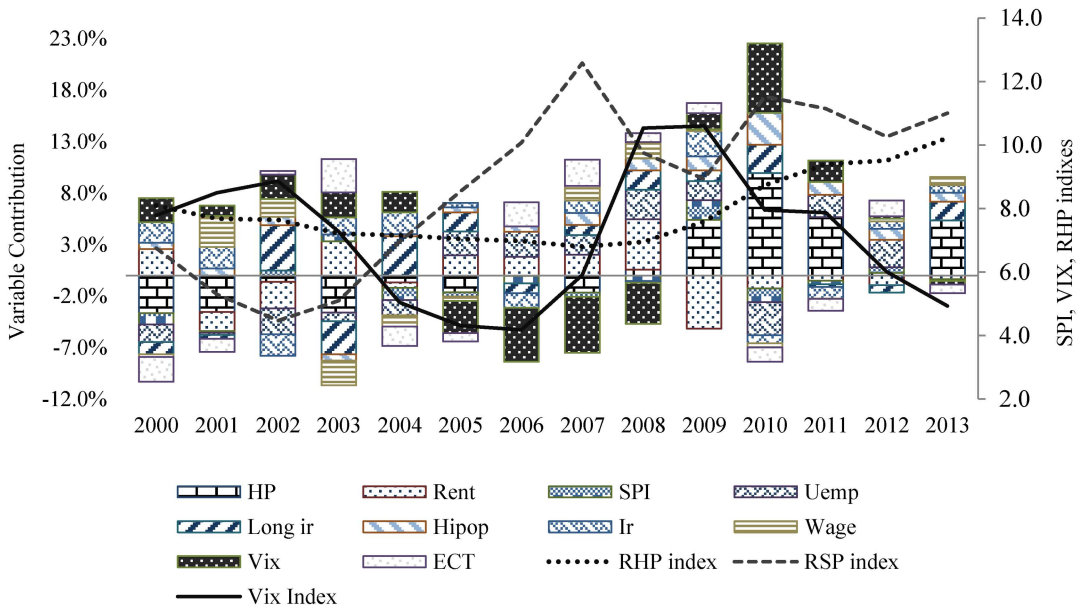
We find interest rates to be significant in explaining and influencing house prices movement, but as suggested by Glaeser (2013), interest rates play a supporting role and provide only partial explanation of the great shift in prices between 2009 and 2013. The predicted impact of interest rates on prices is in line with the empirical results presented by Glaeser, Gottlieb, and Gyourko (2013), suggesting that lower interest rates can explain only one-sixth of the rise in prices.

Our results show that a one percentage point change in long-term interest rates results in a decrease of 1.53% in prices after two quarters and 1.37% after three quarters, explaining only 7% of the 2009–2013 price inflation. The BoI interest rate effect was found to be somewhat smaller, an increase of one percentage point change to the BoI interest rate results in a decrease of 0.70% in prices after one quarter, explaining only 3% of the 2009–2013 price inflation. We find these results to be consistent with Miles (2014), who found the long-term rates to have an independent and sometimes greater effect on house prices than the central bank interest rate.

Unemployment and wages are significant with the expected sign and the contribution of wages to price appreciation was found to be very low and amounted to only 1.20% of the price appreciation in the 2009:Q1–2013:Q4 period.

Regarding rental rates, contrary to the long-run positive elasticity, the short-run result seems counterintuitive. The coefficient is significant but negative ( $-0.6137$ ), which implies that in the short run, an increase in rental values reduces house prices after one quarter. Nagar and Segal (2011) documented similar results, and suggested that the negative coefficient might be explained by the interaction between lagged house prices, rent, and the ECT. An economic explanation might be that marginal homebuyers are diverted to the rental market, leaving fewer potential buyers in the market, thus reducing

**Exhibit 10. Variables Estimated Contributions to House Prices: 2000:Q1–2013:Q4**



the short-term demand for homeownership while increasing the demand for rented accommodation.

Regarding the short-run relation of the Stock-Price-Index to house prices, the findings suggest a negative lagged substitution effect as hypothesized above. The lagged effect of the VIX (which represents investors' sentiments toward risky assets) on prices was also found to be highly significant and robust, further strengthening the substitution effect hypothesis. The lagged effect of both Stock-Price-Index and VIX on prices is explained by the period of time it takes from the moment a potential investor decides on a housing investment to the time the purchase is executed and recorded in the house price index (3–5 quarters later). These findings appear to suggest that investors are generally more successful in analyzing and applying the information provided in the stock market than they are in the housing market where buyers regularly tend to ignore the negative signals of new supply in anticipation of price increases. This is in line with previous research (Shiller, 2000, 2014) and possibly attributable to better information and more transparent and efficient pricing in the stock market. The impact that new supply should have on prices and expectations of future price increase is the more important motivating factor. Research suggests that investors are able to extrapolate recent stock market trends and apply the information provided for investment decisions (Shiller, 2000; Shiller, 2014).

Exhibit 10 illustrates the contribution of all the variables to house price misalignment. In relation to the research conducted by Nagar and Segal (2011), who report lagged house prices, population-to-housing-inventory, monetary policy, and mortgage-rates (in order of importance) as the main contributors in 2009/10, we find that lagged house prices and

the VIX are the two most dominant explanatory variables, explaining 60% of the price appreciation during that period.

Furthermore, for the extended period of 2009:Q1 to 2013:Q4, lagged house prices explain 40% and the VIX explains 15% of the positive prices misalignment, while interest rates and supply constraints explain the remaining variation. In the 2005–2007 period, while the Stock-Price-Index peaked, VIX, which was at its all-time low, had a strongly negative effect on prices, explaining 44% of the negative prices misalignment in the period prior to the global financial crisis. This negative contribution to prices is the result of investors' expectations of future strong stock market returns, which ignited the substitution effect, shifting investors' investment portfolio composition away from real estate towards financial assets, thus reducing the demand for housing investments by 15% (compared to the previous period).

Inversely, since 2008 when the Stock-Price-Index was at its lowest point and the VIX reached its all-time peak, signaling expectations of future negative market returns, investor activity in the housing market increased by 19% and house prices increased by 22% five quarters later. Furthermore, it is also evident that the introduction of macroprudential measures, in 2011, aimed to reduce investor involvement in the market, resulted in a 26% decrease in investment activity during 2011–2012, which significantly reduced the effect of both lagged house prices and the VIX on prices during 2012.

These findings support the hypothesis that investor activity, pursuing 'safer returns' accompanied by expectations of further price appreciation, are the main explanation of price misalignment with fundamentals. Furthermore, our analysis demonstrates the critical role of housing investment activity (rather than purchases by owner occupiers) and the magnitude by which the interaction of high demand for investments, insufficient supply, and monetary easing may result in a marked departure of house prices from fundamentals. These results also support the much earlier study by Bar-Nathan, Beenstock, and Haitovsky (1998), who argue that house prices in Israel respond sharply to demand shocks and that the subsequent price misalignments display considerable persistence.

## Conclusion

This study was prompted by the recent rapid surge in Israeli house prices, along with speculations about a potential housing bubble. Using quarterly data from 1998:Q1 to 2013:Q4, we employed a cointegration technique to model the long-run equilibrium relation between house prices and macroeconomic factors and found that the positive accumulative price deviation from the fundamental value is roughly 20% over the last four years of the study period.

The results, however, suggest that in the long-run the lack of sufficient supply of housing along with projected population growth may justify most of the increase in house prices. The trio of low interest rates, low unemployment rate, and growing rents also contributed to the price increase.

Efforts to alleviate supply-side constraints, specifically increasing the housing stock, could be a more effective approach to constraining house price appreciation in the long-run

than other macro-financial factors. The most interesting finding for the long-run relation involves the stock market-price-index movement. We found empirical evidence for a substitution effect in which the stock market and the housing market act as an independent alternative investment market for households and investors.

We also examined the short-run dynamics of house prices and the correction of price deviation from the long-run equilibrium level. The estimated error correction model results imply that, following an exogenous shock, house prices adjust around 13% per quarter towards their long-run equilibrium. We find that prices respond sharply to demand shocks and the deviation from equilibrium displays considerable persistence. Furthermore, the housing market appears vulnerable to interest rate fluctuations.

One of the key contributions of this study is the inclusion of the market volatility index, the VIX (i.e., the predicted risk of investing in the stock market), as an explanatory variable aimed to represent the driving force behind the substitution effect. The results indicate that along with the inertia in house prices, the VIX is the second most dominant explanatory variable to the short-term prices misalignment, followed by supply constraints and interest rates. We find that long-term investment decisions such as housing were significantly influenced by the expected stock market instability represented by long periods of low or high VIX, confirming that households' investment decisions are driven by the perception of "safer returns" with little tolerance for episodes of sharp volatility in stock markets.

The results point to the importance of understanding the role of rationality and behavioral factors in house prices formation and suggest that short-term house price changes are not driven entirely by observable changes in fundamentals. In contrast to long-run dynamics, the boom and bust cycles in Israel appear to be mainly affected by the expectations of future price appreciation and investor activity. Therefore, the model implies that in the short-run demand-side policies would work more rapidly on prices than would supply-side policies.

In terms of policy recommendations aimed to stabilize the housing market, it seems evident that concerted efforts to alleviate supply-side constraints mainly by the government and the Ministry of Housing and Construction making sure sufficient land is planned and marketed for housing construction in demand areas will improve housing affordability.

In 2014, the Ministry of Housing and Construction introduced the Target Price Program (Mechir Matara) to facilitate the increase of supply, reduce prices, and demonstrate to the public that the government is determined to make housing more affordable, even at the cost of relinquishing some of its revenues from selling the land. The program allows first-time home buyers and those looking to improve their present housing situation to purchase a new apartment, at values roughly 20% to 30% below the market price of a similar apartment in the area. The main condition for the success of these programs in the years ahead will be the ability to market land at sufficient quantities for large projects in areas of high demand.

In the short-run, empirical evidence shows that macroprudential measures, such as the Ministry of Finance intervention with limiting mortgages loan-to-values and introducing

the second home extended purchasing tax, both aimed at limiting non-owner-occupier investment activity were effective in reducing only some of the speculative investment element in the market during 2011–2012, but did not result in halting price appreciation.

Further measures, such as the 2013 application of capital gain tax on housing investors' sales profits and the 2015 second home further extension of the purchasing tax, were somewhat effective in cooling investors' activity. However, since the price increase was not halted completely, additional macroprudential policies in the form of further tax restrictions on investors may be necessary to stabilize and reduce house prices.

## References

- Adams, Z. and R. Füss. Macroeconomic Determinants of International Housing Markets. *Journal of Housing Economics*, 2010, 19, 38–50.
- Arbel, Y., D. Ben-Shahar, and Y. Tobol. The Correlation among Immigrant Homeownership, Objective and Subjective Characteristics, and Civic Participation: New Evidence from the Israeli Experience. *Urban Studies*, 2012, 49:11, 2479–99.
- Arestis, P. and A.R. González. Modeling the Housing Market in OECD Countries. Working paper 764. Annandale-on-Hudson, NY: Levy Economics Institute of Bard College, 2013.
- Baffoe-Bonnie, J. The Dynamic Impact of Macroeconomic Aggregates on Housing Prices and Stock of Houses: A National and Regional Analysis. *Journal of Real Estate Finance and Economics*, 1998, 17:2, 179–97.
- Banerjee, P.S., J.S. Doran, and D.R. Peterson. Implied Volatility and Future Portfolio Returns. *Journal of Banking & Finance*, 2007, 31, 3183–199.
- Bar-Nathan, M., M. Beenstock, and Y. Haitovsky. The Market For Housing in Israel. *Regional Science and Urban Economics*, 1998, 28, 21–49.
- Ben-Naim, G. Purchasers of Investment Properties—Characteristics and Trends Multi-year Analysis. Jerusalem: State Revenue Administration, February 2010.
- Bank of Israel (BoI). Transactional Data and Prices of Residential Apartments Based on Real Estate Index Prices and Ads for the Sale of Apartments. Jerusalem: Bank of Israel, 2014.
- Brooks, C. *Introductory Econometrics for Finance*. Second edition. Cambridge: Cambridge University Press, 2008.
- Caldera, A. and Å. Johansson. The Price Responsiveness of Housing Supply in OECD Countries. *Journal of Housing Economics*, 2013, 22:3, 231–49.
- Cameron, G., J. Muellbauer, and A. Murphy. Was There A British House Price Bubble? Evidence from a Regional Panel. Centre for Economic Policy Research Discussion Paper 5619, 2006.
- Case, K.E., J.M. Quigley, and R.J. Shiller. Comparing Wealth Effects: The Stock Market Versus the Housing Market. *The B.E. Journal of Macroeconomics, De Gruyter*, 2005, 5:1, 1–34.
- Case, K.E. and R.J. Shiller. Forecasting Prices and Excess Returns in the Housing Market. *Real Estate Economics*, 1990, 18:3, 253–73.
- . Is There a Bubble in the Housing Market? *Brookings Papers on Economic Activity*, 2003, 34:2, 299–362.
- Chicago Board Options Exchange (CBOE). The CBOE Volatility Index—VIX. Available from: <http://www.cboe.com/micro/VIX/vixintro.aspx>. Accessed July 2, 2014.
- Central Borough of Statistics (CBS). Housing in Israel—Findings from the 2014 Household Expenditure Survey. 2014.



- Chadwick, S. Can the VIX Signal Market Direction? Credit Suisse Quantitative Trading & Derivatives Strategy. Available from: <http://www.cboe.com/micro/vix/pdf/vix.pdf>. (Accessed July 2, 2014.) 2006.
- Chen, N.K. Asset Price Fluctuations in Taiwan: Evidence from Stock and Real Estate Prices 1973 to 1992. *Journal of Asian Economics*, 2001, 12, 215–32.
- Connors, L. Timing Your S&P Trades With the Vix. *Futures: News, Analysis & Strategies for Futures, Options & Derivatives Traders*, June 2002, 31:7.
- Dovman, P., S. Ribon, and Y. Yakhin. The Housing Market in Israel 2008–2010: Are House Price a “Bubble”? *Israel Economic Review*, 2012, 10:1, 1–38.
- Eldor, R., S. Hauser, and Y. Libal. Israel’s Fear Index Examining the Relationship Between the Fear Index and the Volatility of the Stock Price Index. Available from: [http://sentiment.ono.ac.il/uploads/vix\\_paper\\_3.pdf](http://sentiment.ono.ac.il/uploads/vix_paper_3.pdf). (Accessed June 10, 2014.) 2008.
- Engle, R.F. and C.J. Granger. Co-Integration and Error Correction: Representation, Estimation and Testing, *Econometrica*, 1987, 55:2, 251–76.
- Fuerst, F., P. McAllister, and P. Sivitanides. Flight to Quality? An Investigation of Changing Price Spreads in Commercial Real Estate Markets. *Studies in Economics and Finance*, 2015, 32:1, 2–16.
- Glaeser, E.L. A Nation of Gamblers: Real Estate Speculation and American History. *American Economic Review*, 2013, 103:3, 1–42.
- Glaeser, E.L., J. Schuetz, and B. Ward. Regulation and the Rise of Housing Prices in Greater Boston. Cambridge: Rappaport Institute for Greater Boston, Harvard University and Boston: Pioneer Institute for Public Policy Research, 2006.
- Glaeser, E.L., J.D. Gottlieb, and J. Gyourko. Can Cheap Credit Explain the Housing Boom? In: *Housing and the Financial Crises*. E. Glaeser and T. Sinai (eds.). National Bureau of Economic Research. Chicago, 2013, 301–60.
- Glaeser, E.L. and C.G. Nathanson. Housing Bubbles. NBER Working Paper 20426. National Bureau of Economic Research, Inc., 2014.
- Green, R.K. Stock Prices and House Prices in California: New Evidence of a Wealth Effect? *Regional Science and Urban Economics*, 2002, 32, 775–83.
- Gyourko, J., A. Saiz, and A.A. Summers. A New Measure of the Local Regulatory Environment for Housing Markets: The Wharton Residential Land Use Regulatory Index. *Urban Studies*, 2008, 45, 693–729.
- International Monetary Fund (IMF). Israel Selected Issues, IMF Country Report No. 14/48. Washington, D.C., 2014.
- . Israel, 2013 Article IV Consultation. Washington, D.C., 2014.
- Jud, D.G. and D.T. Winkler. The Dynamics of Metropolitan Housing Prices. *Journal of Real Estate Research*, 2002, 23:1–2, 29–45.
- Kahn, M. and S. Ribon. The Effect of House and Rent Prices on Private Consumption in Israel—A Micro Data Analysis. *Israel Economic Review*, 2013, 11:1, 97–143.
- Kearl, J.R. Inflation, Mortgage, and Housing. *Journal of Political Economy*, 1979, 87:5, 1115–38.
- Malpezzi, S. Housing Prices, Externalities, and Regulation in U.S. Metropolitan Areas. *Journal of Housing Research*, 1996, 7:2, 209–41.
- Mayer, C. and T. Sinai. U.S. House Price Dynamics and Behavioral Economics. In: *Policy Making Insights on Behavioral Economics*. C.L. Foote, L. Goette, and S. Meier (eds.). Boston, MA: Federal Reserve Bank Boston, 2009, 261–95.
- McCarthy, J. and R.W. Peach. Are Home Prices the Next “Bubble”? *FRBNY Economic Policy Review*, 2004, 10:3, 1–17.



- Mesch, G. and R. Mano. Housing Attainment of Immigrants from the Former Soviet Union in Israel: A Cost/Benefit Approach. *Housing Studies*, 2006, 21:3, 423–40.
- Mian, A. and A. Sufi. The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis. *Quarterly Journal of Economics*, 2009, 124, 1449–96.
- Mikhed, V. and P. Zemčík. Do House Prices Reflect Fundamentals? Aggregate and Panel Data Evidence. *Journal of Housing Economics*, 2009, 18, 140–49.
- Miles, W. The Housing Bubble: How Much Blame Does the Fed Really Deserve? *Journal of Real Estate Research*, 36:1, 2014, 41–58.
- Mishkin, F.S. Housing and the Monetary Transmission Mechanism. Proceedings of the Economic Policy Symposium in Jackson Hole. Federal Reserve Bank of Kansas City, 2007, 359–413.
- Nagar, W. and G. Segal. What Explains the Developments in Home Prices and Rents in Israel in 1999–2010. *Bank of Israel Survey*, 2011, 85, 7–59.
- OECD. Economic Outlook, Analysis and Forecasts, Focus on House Prices. OECD Publishing, 2014.
- . OECD Economic Outlook, Vol. 2014/2. OECD Publishing, 2014.
- Ooi, J.T. and T.T. Le. New Supply and Price Dynamics in the Singapore Housing Market. *Urban Studies*, 2012, 49:7, 1435–51.
- Pashardes, P. and C.S. Savva. Factors Affecting House Prices in Cyprus: 1988–2008. *Cyprus Economic Policy Review*, 2009, 3:1, 3–25.
- Piazzesi, M. and S. Martin. Momentum Traders in the Housing Market: Survey Evidence and a Search Model. Working paper 14669. National Bureau of Economic Research, 2009.
- Poon, S.H. and C.W. Granger. Forecasting Volatility in Financial Markets: A Review. *Journal of Economic Literature*, 2003, 41:2, 478–539.
- Pyrce, G. Construction Elasticities and Land Availability: A Two-stage Least-squares Model of Housing Supply Using the Variable Elasticity Approach. *Urban Studies*, 1999, 36:13, 2283–2304.
- Quigley, J.M. Real Estate Prices and Economic Cycles. *International Real Estate Review*, 1999, 2:1, 1–20.
- Reichert, A.K. The Impact of Interest Rates, Income, and Employment upon Regional Housing Prices. *Journal of Real Estate Finance and Economics*, 1990, 3, 373–91.
- Saiz, A. The Geographic Determinants of Housing Supply. *The Quarterly Journal of Economics*, 2010, 125:3, 1253–96.
- Shiller, R.J. Measuring Bubble Expectations and Investor Confidence. *Journal of Psychology and Financial Markets*, 2000, 1, 49–60.
- . Speculative Asset Prices; Nobel Prize Lecture. Cowles Foundation Discussion Paper No. 1936, 2014.
- Shirvani, H., B. Mirshab and H. Delcours. Stock Prices, Home Prices, and Private Consumption in the U.S.: Some Robust Bilateral Causality Tests. *Modern Economy*, 2012, 3, 145–49.
- Smith, L.B. A Model of the Canadian Housing and Mortgage Markets. *Journal of Political Economy*, 1969, 77, 795–816.
- Somkin, S. and K. Gayer. The Loss of Economic Welfare as a Result of Marketing Residential Land in Israel. Herzlia: The Israeli Institute for Economic Planning, 2013.
- State Comptroller of Israel. The Housing Crisis, Special Report. 2015.
- Tsai, I.C. Monetary Policy and Bubbles in the National and Regional U.K. Housing Markets. *Urban Studies*, 2014, 52:8, 1471–88.
- Whaley, R.E. The Investor Fear Gauge. *The Journal of Portfolio Management*, 2000, 26:3, 12–17.

Yang, J.Y. and S.H. Lee. A Study of Changes in Risk Appetite in the Stock Market and the Housing Market before and after the Global Financial Crisis in 2008 Using the vKOSPI. *Modern Economy*, 2013, 4, 712-22.

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