

# Cobweb model in the Housing Sector of Israel 1960 – 2010

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The residential construction sector was, primarily as a result of waves of immigration, and still is a principal factor in the structure of the business cycles in Israel. Some view it as a leading factor in the creation of the cycle, seeing as it accounts for about 10% of the gross domestic product. The increasing population, financing methods, higher income and the investment needs of individuals have converged and came to be reflected **on the side of demand** for housing. On the other hand, technology, private and public entrepreneurship, the housing inventory and the availability of workforce have converged **on the supply side**.

In view of the instability that has characterized the sector over the years and the unclarity concerning its position in the cycle in the near term, the question that needs to be asked is:

Can the position and direction of the housing sector in the business cycle be **identified** by using a simple mathematical structure and elementary statistical-diagrammatical tools?

This paper aims to positively answer this question and suggest the method for achieving this. The strong fluctuations of the housing market in both prices and quantities is reminiscent of similar past phenomena that had occurred in connection with agricultural products. However, unlike agricultural products, inventories of housing can be accumulated, the duration of the production and consumption periods is significantly longer, and accordingly the financing methods and volumes in the sector are different. Nevertheless, this should not hinder us from using similar methodical tools, which are differences equations that may be diagrammatically expressed in a **cobweb** model (diagram 2).

The central concept of this paper is that the determining factor in the instability and fluctuations of the system stems from **non-simultaneous** movements in the supply and demand of the sector. Such non-simultaneous movements originate, in the opinion of the author, in the financing methods that are prevalent in the housing sector, which primarily relies on government funding that is subject to macroeconomic constraints. (to date, in 2011, the government's involvement is very limited.)

First stage of the cycle - rapid increase in demand, following waves of immigration or investments, which results in rapid price hikes (in view of the high elasticity of housing demand curve in relation to that of housing supply curve); as a result of the increased demand and the price hikes, manufacturers are disposing of the inventories that had been accumulated in the preceding period and the sector moves along the supply curve. The mathematical solution (to the price and quantity in the first stage) in the near term will be provided by differences equations of the “agricultural” type. In the second stage, following the depletion of inventories and the recovery in demands, manufacturers begin to prepare for expanding the supply alongside the introduction of technological improvements into the sector, and the sector behaves pursuant to the “inventory” formula.

The subsequent period is characterized by the movement of the supply curve along the demand curve, when the housing prices drop and the equilibrium increases in line with the elasticities of the supply and demand, and the sector moves from point to point on the demand curve. Over time, an “alternating” route is formed, when a buyers’ market is followed by a sellers’ market that in turn is followed by a buyers’ market etc. ... .

The stable solution for each individual period is provided in the applicable differences equation, in the “agricultural” version of which the manufacturers today determine a supply policy based on the price in the preceding period, whereas in the “inventory” version the price in the subsequent period is comprised of the price for the preceding period with the addition of the effect of changes in inventory.

In order to stabilize the system (avoiding an “alternating” route), the supply and the demand must move **simultaneously** in the same period at the same pace and in the same direction, a movement the key to which, in the opinion of the author, lies in the financing market. The convergence or non-convergence of the system in the short and long run into stable solutions depends, first and foremost on the econometric coefficients of the demand and supply function in the housing sector.

### **Data and reality 1960-2010**

Table 1 and diagrams 1 and 2 clarify the occurrences of the past 50 years in the housing sector, both in terms of quantity and price. Table 1 shows that, over the past 20 years, housing prices have risen by a 50% more than the Consumer Price Index (CPI). This is indicative of substantial demand surpluses over the years, although the rate of change in real housing prices is subject to strong cyclical fluctuations - while the cycle of the 1960s and 1980s has generated good returns, the 1970s and 1990s were characterized by relatively low returns that reached almost null in the 2000s.

**Table 1: Prices and quantity in the housing sector 1960-2010**

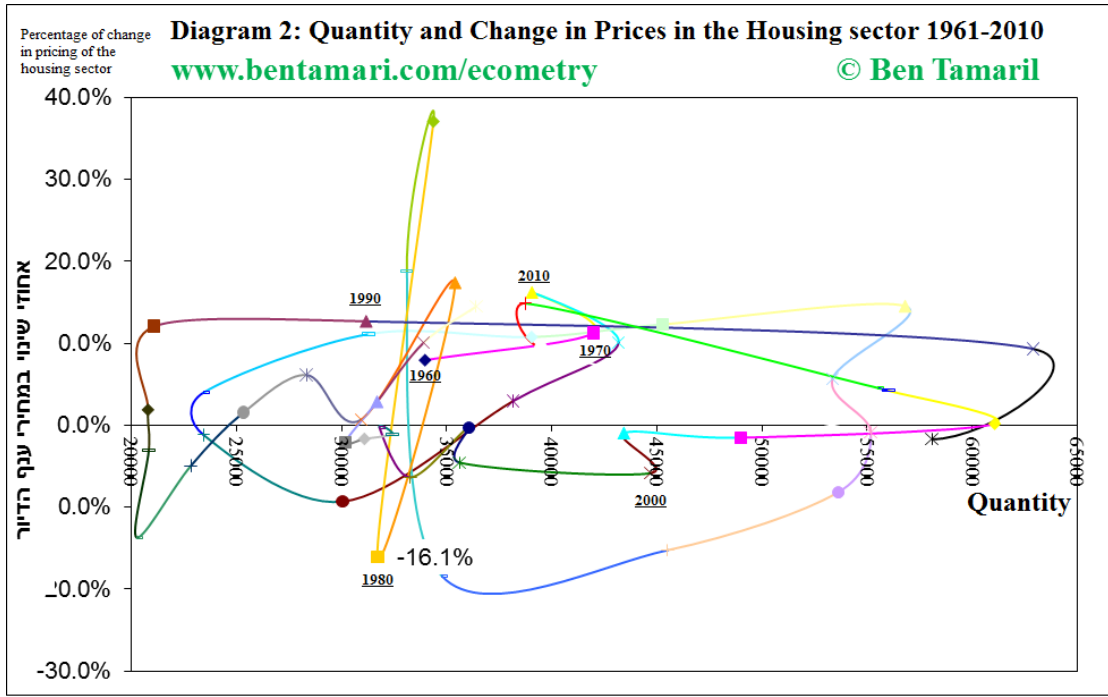
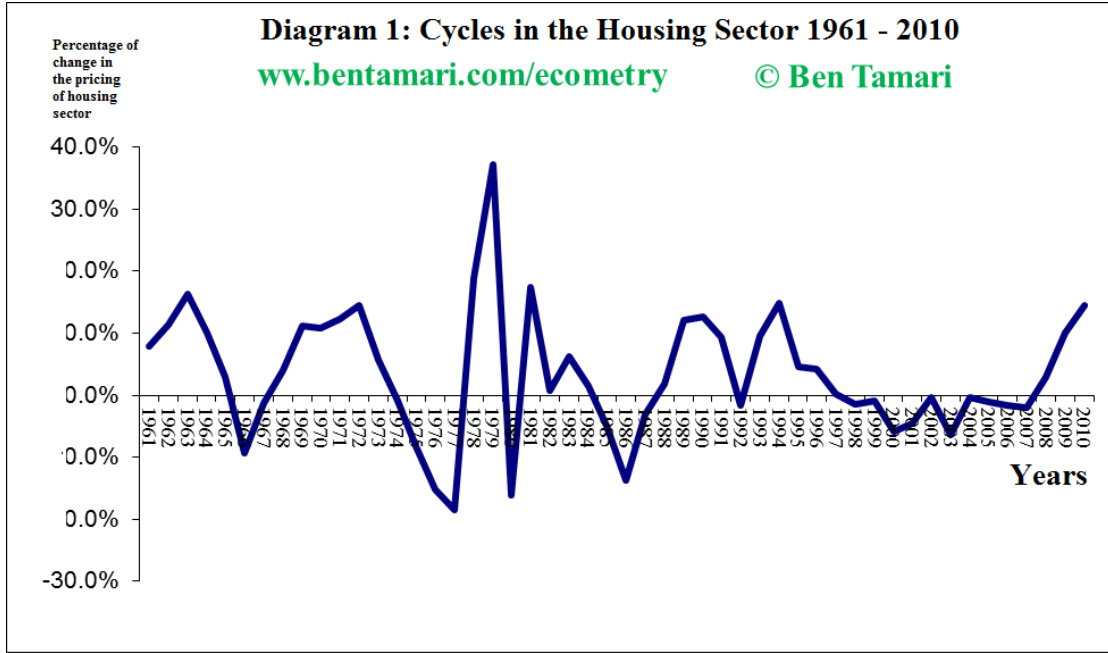
Year	<u>Housing units</u>			<u>Price indexes</u>		<u>Rates of real change in housing pricing</u>	
	Beginnings	Completions	Average	Consumer	Housing	Cumulative	Annual
1960	26,920	30,990	28,955	0.0000270	0.00001	0.36	na
1961	41,580	26,360	33,970	0.0000288	0.00001	0.39	7.9%
1962	45,710	38,280	41,995	0.0000315	0.00001	0.43	11.3%
1963	38,420	39,690	39,055	0.0000336	0.00002	0.50	16.2%
1964	48,380	37,980	43,180	0.0000353	0.00002	0.56	10.1%
1965	37,880	38,420	38,150	0.0000381	0.00002	0.57	2.9%
1966	22,500	37,580	30,040	0.0000411	0.00002	0.52	-9.3%
1967	18,980	27,900	23,440	0.0000418	0.00002	0.51	-1.2%
1968	24,260	22,610	23,435	0.0000426	0.00002	0.53	4.0%
1969	36,950	25,630	31,290	0.0000437	0.00003	0.59	11.1%
1970	46,700	31,380	39,040	0.0000464	0.00003	0.66	10.8%
1971	51,830	38,730	45,280	0.0000519	0.00004	0.74	12.3%
1972	66,270	47,340	56,805	0.0000586	0.00005	0.84	14.5%
1973	55,820	50,870	53,345	0.0000704	0.00006	0.89	5.6%
1974	58,630	51,710	55,170	0.0000983	0.00009	0.88	-0.9%
1975	51,620	55,610	53,615	0.0001369	0.00011	0.81	-8.2%
1976	35,390	55,640	45,515	0.0001798	0.00012	0.69	-15.2%
1977	26,730	42,830	34,780	0.0002420	0.00014	0.56	-18.4%
1978	30,770	35,450	33,110	0.0003644	0.00024	0.67	18.9%
1979	38,230	30,500	34,365	0.0006497	0.00059	0.91	37.1%
1980	32,690	30,760	31,725	0.0015008	0.00115	0.77	-16.1%
1981	37,400	33,400	35,400	0.0032537	0.00293	0.90	17.4%
1982	28,520	33,330	30,925	0.0071678	0.00650	0.91	0.7%
1983	26,210	30,460	28,335	0.0176114	0.01695	0.96	6.1%
1984	23,260	27,410	25,335	0.0834428	0.08155	0.98	1.6%
1985	20,880	24,790	22,835	0.3376097	0.31366	0.93	-4.9%
1986	18,810	21,710	20,260	0.5000000	0.40085	0.80	-13.7%
1987	21,710	19,950	20,830	0.5992500	0.46579	0.78	-3.0%
1988	21,950	19,640	20,795	0.6969500	0.55196	0.79	1.9%
1989	19,850	22,320	21,085	0.8377500	0.74349	0.89	12.1%
1990	42,380	19,960	31,170	1.0000000	1.00000	1.00	12.7%
1991	83,510	42,270	62,890	1.1900000	1.30100	1.09	9.3%
1992	46,030	70,120	58,075	1.3328000	1.43240	1.07	-1.7%
1993	35,800	43,140	39,470	1.4794080	1.74037	1.18	9.5%
1994	43,620	33,900	38,760	1.6613752	2.24507	1.35	14.9%
1995	72,876	38,172	55,524	1.8291741	2.58408	1.41	4.5%
1996	59,325	52,716	56,021	2.0358707	2.99753	1.47	4.2%
1997	53,828	68,306	61,067	2.2190991	3.27331	1.48	0.2%
1998	44,274	53,697	48,986	2.3389305	3.39769	1.45	-1.5%
1999	38,421	48,431	43,426	2.4605549	3.54039	1.44	-1.0%
2000	45,964	43,465	44,715	2.4876210	3.37046	1.35	-5.8%

2001	32,049	39,169	35,609	2.5149848	3.25249	1.29	-4.5%
2002	33,500	38,591	36,046	2.6558239	3.42487	1.29	-0.3%
2003	31,858	34,691	33,275	2.6744147	3.22965	1.21	-6.4%
2004	30,283	33,323	31,803	2.6637170	3.20705	1.20	-0.3%
2005	32,341	32,515	32,428	2.6983454	3.21346	1.19	-1.1%
2006	31,275	30,900	31,088	2.7577090	3.22953	1.17	-1.7%
2007	30,833	29,519	30,176	2.7714975	3.17786	1.15	-2.1%
2008	32,930	30,450	31,690	2.8989864	3.41937	1.18	2.9%
2009	35,063	32,732	33,898	2.9946529	3.88783	1.30	10.1%
2010	39,675	33,128	36,402	3.0755086	4.57208	1.49	14.5%

Table 2 presents the centers of gravity and clearly depicts the long-run trend of decline in the relative housing price, when the relative price may be interpreted in terms of the real rate of return on investment in housing in the long run (excluding the rent proceeds). Under this interpretation, the real return in the housing sector was about 6% in the 1960s, dropped to about 3% by the 2000s and decreased to 1% to date.

**Table 2: Centers of gravity in the housing sector 1960-2010**

Center of gravity	Years	Housing prices (% change)	Quantity (apartments)
First cycle	1961-1970	6.4	34,360
Second cycle	1971-1980	3.0	44,371
Third cycle	1981-1990	3.1	25,697
Fourth cycle	1991-2000	3.3	50,893
Fifth cycle	2001-2010	1.1	33,241



### The mathematical structure, cobweb model [Chiang (1974) ch. 16]

The problem: determining the relative price of housing that will prevail in the coming year as a dependent variable (function) of the relevant independent variables that are known to us in the year that recently ended; for this purpose we will use the following mathematical structure, which is an equilibrium function that is derived from the following supply and demand functions:

Demand function:  $Q_{dt} = \alpha - \beta P_t \quad (\alpha, \beta, > 0)$

Supply function:  $Q_{st} = -\gamma + \delta P_{t-1}$  "agricultural" ( $\gamma, \delta, > 0$ )  
 $= -\gamma + \delta P_t$  "inventory"

The market:  $P_{t+1} = P_t - \sigma(Q_{st} - Q_{dt}) \quad (\sigma > 0)$

The "agricultural" version  $P_{t+1} = (p_0 - p^*)\left(-\frac{\delta}{\beta}\right)^t + P^* \quad \text{iff} \quad \frac{\partial p}{\partial t} > 0$

The "inventory" version  $P_{t+1} = (p_0 - p^*)[1 - \sigma(\delta + \beta)]^t + P^* \quad \text{iff} \quad \frac{\partial p}{\partial t} < 0$

When  $P^* = \alpha + \frac{\gamma}{\beta + \delta}, \quad \frac{1}{\beta + \delta} < \sigma < \frac{2}{\beta + \delta}, \quad \delta < \beta$

P, relative housing prices;  $\alpha, \beta$ , coefficients of the demand function;  $\gamma, \delta$ , coefficients of the supply function; t time;  $\sigma$  coefficient of inventory in the supply function; d, coefficient of demand; s, coefficient of supply.

### Conclusion

The theoretical work and the empirical findings suggest, at least to the author, that the problem of cycles in the housing sector is the result of **non-simultaneous movements** in the demand and supply in the sector. Although, in the long run a trend of capital intensity is evident in the sector alongside a reduction in the real return of the capital invested.

The dominant reason, in my opinion, for this irregularity of the matching of supply and demand to the changes in the economy, is the structure and the arrangements that are applied in the Israeli capital market, and in particular the financing arrangements in the housing sector. Such arrangements create a detachment between the saver (the mortgage funder) and the lender (the mortgage recipient) and result in a mismatch between the offered quantity and the requested quantity in the mortgage market.

A free mortgage market - together with the sensitive mechanism of the interest system as a meeting point between savings and investment in housing - is almost completely destroyed, this being due to the government's "taking over" the supply of financial savings by offering the highest return (CPI linkage + nominal interest) without risk on the part of the investor, this balancing mechanism has been replaced by an administrative mechanism that is not necessarily more efficient.

Over the past twenty years, the Israeli economy was freed from the “taking over” by the government of the various markets, and the author would like to believe that his writing also played a part in this.

**Sources:**

**Uri Baharal** (1976) “Estimates of the Demand for Housing”, Iyunim Bekalkala 1976.

**Eliyahu Borochoy** (1976) “Quantitative Assessment of the Factors for the Rise in the Prices of Apartments”, Iyunim Bekalkala 1976.

**Liora Meridor** (1979) “Econometric Projection Model for the Construction and Housing Sector in Israel”, Iyunim Bekalkala 1979.

**Ephraim Tamari** (1979) “Financial Saving and Linkage of the Private Sector”, Economics Quarterly [Rivon Lekalkala] 101/2, September 1979.

**Chiang** (1974) “Fundamental Methods of Mathematical Economics”, McGraw-Hill.

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