

Spatial Econometric Analysis of Regional Housing Markets

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1. Introduction

Research on regional housing markets has tended to lag behind research on national housing markets for two main reasons. First, the data demands of the former are naturally greater. Indeed, government statistical bureaus typically pay more attention to national data than they do to regional data. Second, the econometric analysis of regional housing markets is more methodologically demanding because it involves accounting for the dependence between regional housing markets. Econometric models of national housing markets have been constructed for many countries including Israel (Bar Nathan et al 1998). By contrast, there are no econometric models of regional housing markets. Our purpose here is, therefore, to fill this void.

In two previous papers we investigated the determinants of regional house prices in Israel (Beenstock and Felsenstein 2010) and the determinants of regional housing construction (Beenstock and Felsenstein 2013). We used spatial econometric methods for nonstationary spatial panel data to take account of the dependence between regional housing markets. We showed that there are spatial as well as temporal spillovers in regional house prices and housing construction. In the present paper we investigate the joint determination of regional house prices and housing construction. Specifically, we use updated results obtained from our previous work to construct a spatial econometric model of regional housing markets in Israel. The model is used to simulate regional as well as national supply and demand shocks to housing markets in terms of their spatial as well as their temporal propagation. Due to spatial dependence in housing construction and the demand for housing, region specific shocks propagate within regions over time, but they also propagate between regions, inducing "domino effects". Because regions are mutually dependent, region specific shocks eventually reverberate back onto the region in which the shock originated, inducing "boomerang effects".

These spatial phenomena are obviously concealed in national models of housing markets. However, there are additional methodological and theoretical advantages to regional models over national models. There may be aggregation bias in national models, since by assumption regional housing markets are taken to be homogeneous. If they are heterogeneous, it might be impossible to estimate national models. Hypotheses about the supply and demand for housing might be rejected nationally, even though they are corroborated regionally. Or if they are not rejected nationally, the parameter estimates may be biased.

After reviewing the literature, we proceed to present an overview of the model's structure under the simplifying assumption that there are only two regions. This "toy model" presented in section 3 makes transparent the spatial and temporal dynamics that take place in the econometric model in which there are nine dependent regions. It also makes transparent the identifying restrictions which enable the estimation of the model's structural parameters. The non stationary panel data for Israel (1987-2010) that serves the analysis is described in Section 4. Section 5 presents the econometric model. The spatial and temporal dynamics of the model are illustrated in section 6 in which the effects of regional and national shocks are simulated.

2. Literature Review

Cameron et al (2006) have correctly pointed that regional house price models are not simply miniature versions of national models. The same can be said for regional housing market models. Regional models offer many more observations than national models. This makes them more informative when coming to explain the joint determination of house prices and construction and more likely to yield accurate parameter estimates than national models. Greater possibilities for substitution also exist between regions than between national units where borders and language can act as barriers. This can potentially induce spatial dependence. Regional models also are more likely to address inherently spatial issues such as spillovers between regions, spatial autocorrelation and spatial patterns of coefficient heterogeneity. However, Cameron et al (2006) note that many of the ostensibly 'regional' models that exist for house prices, in fact fall short of being truly regional in practice. It may be too much to expect that a structural model of regional housing markets also incorporates spatial effects, the treatment of time series (non-stationary) data and dynamic simulation.

Consequently, very few explicitly regional models of the housing market exist. Regional house price models exist in abundance and have been comprehensively reviewed elsewhere (Muellbauer and Murphy 1994, Meen and Andrews 1998). They have been criticized for either over-focusing on statistical issues such as series cointegration or for using non-structural models that are difficult to interpret. Regional housing construction models are less prevalent in the literature. Despite the fact that supply side factors such as land availability, zoning regulations and topography are inherently regional issues, the literature has been largely concerned

with national housing construction (Ball et al 2010). Similar to regional housing demand, regional construction is likely to be inter-dependent. House builders are likely to operate in more than one region in order to reach scale economies. In this way regions complement each other. On the other hand, housing contractors may have regional preferences in which case construction in one region may substitute for another.

It might have been thought that the New Economic Geography (NEG) paradigm lends itself to the development of structural regional models of the housing market incorporating dynamics and spatial effects. As Andrew (2012) notes, relaxing some of the standard (Helpman-Hanson) NEG model restrictions, such as a fixed housing stock and the assumption that income and price elasticities of demand are equivalent, can lead to the development of insightful regional housing models. In addition, the NEG framework offers explicit spatial insights into the connection between the housing market and the tradable sector thereby addressing the role of regional housing markets in regional growth.

In practice however, the application of the NEG approach has been very limited. Empirical extensions of the NEG to regional housing markets are hard to operationalize due to the non-linearities of many causal relations and have led to some surprising outcomes. Akin to the argument that increasing the provision of roads increases congestion, Fingleton (2008) has illustrated that increasing housing supply raises house prices (in South East England at least). His model shows that lowering house prices is only likely to happen if accompanied by greater housing density and a decrease in the quality of the supply. In this model, while house prices are not considered as a purely endogenous result of income (as in many NEG models), they are derived outside the main NEG model. In a further elaboration involving a model derived from both calibration and iteration (Fingleton 2009), house prices are again determined outside the model and additional covariates to income are used. The model simulates the regional outcomes of exogenous employment contraction and shows strong negative impact on house prices and the regional spillovers accompanying this shock. In both these NEG-type models, the approach is cross sectional with spatial dynamics.

Perhaps the most comprehensive NEG- inspired regional housing market model is presented by Andrew (2012). This extends the Helpman-Hanson model in a general equilibrium framework that addresses house prices, housing construction,

wages and migration. While housing construction in his model is determined exogenously in the model, the housing stock is not fixed and does respond to regional population growth. His main concern is with relative house prices (affordability) and the conditions under which responses from the construction sector impact on affordability and regional population growth. Migration is addressed explicitly and tracing regional spillovers suggests important insights with respect to policy interventions. For example, Andrew (2012) concludes that unilateral housing intervention (via construction policy) in one region can lead to slower long run regional convergence. Additionally, when multiple equilibria exist, eliminating barriers to migration can result in unbalanced regional growth and differences in house prices rather than regional convergence.

Outside the NEG framework, very few explicitly regional models of the housing market can be found. Even fewer exist that combine a structural model with spatial effects, treatment of time series (non-stationary) data and dynamic simulation. Bhattacharjee and Jensen Butler (2006) is probably the closest in spirit. They estimate a model that has supply, demand and price schedules and a micro model relating to behavior (matching and searching) in order to inform the demand-supply mismatch. Their system comprises four structural equations relating to vacancies, demand, overpricing and time to market for each region and six exogenous or lagged endogenous variables relating to supply, neighborhood characteristics and market conditions. Spatial interaction between regions is generated by a spatial lag (SAR) model.

Other housing market models address part of the housing market but not the system in its entirety. For example, in the Murphy, Meullbauer and Cameron (2006) model, house prices, housing stock and house price expectations are right hand side variables in a migration model. Spillover effects relate to migration and not to the housing market. Vermeulen and van Ommeren (2012) present a VAR estimation incorporating housing stock, migration and employment but with no underlying structural model.

3. Toy Model

The population (N) is fixed and lives in two regions A and B, hence $N = N_A + N_B$. There is no mobility between these regions, hence N_A and N_B are exogenous¹. Since

¹ We are currently endogenizing these variables.

the model is symmetric, the specification of the model refers to region A. The housing stocks (H) are quasi-fixed at the beginning of period t and are measured in square meters:

$$H_{At} = \delta H_{At-1} + S_{At-1} \quad (1)$$

where S denotes housing construction and δ denotes the rate of depreciation. Housing construction during period t-1 is completed by the beginning of period t, i.e. the gestation lag is one period.

Housing construction is hypothesized to vary directly with profitability as measured by house prices minus construction costs. Building contractors decide where to build according to relative profitability in A and B. Construction during period t is determined according to:

$$S_{At} = \alpha + \beta(P_{At} - C_t) - \gamma(P_{Bt} - C_t) + \psi S_{Bt} \quad (2)$$

where P denotes house prices per square meter, C denotes unit construction costs assumed to be the same in A and B, and $\gamma < \beta$ allows for imperfect substitution between construction in A and B. The coefficient $\psi < 1$ captures spillover effects in construction from B to A induced by complementarities in construction. In terms of spatial econometrics, equation (2) is a SARMA model in which the spatial AR coefficient is ψ and the spatial MA coefficient is γ . In the “standard” specification in which each housing market is an island unto itself, ψ and γ are zero. Since the model is symmetric equation (2) also applies to B.

The demand for housing space varies directly with population and inversely with house prices per square meter. Although formally there is no migration in the model, we assume that if housing is more expensive in B, residents in A are prepared to pay more for their housing. Since the housing stock is quasi fixed at the beginning of period t, house prices in A vary directly with the population and inversely with the housing stock. They also vary directly with house prices in B:

$$P_{At} = \mu + \pi N_{At} - \theta H_{At} + \phi P_{Bt} \quad (3)$$

where $\phi < 1$. Equation (3) also applies to P_B through symmetry.

The model has six state variables (P, S and H in A and B) which are dynamically related because it takes one period to build. Given house prices, construction in A is:

$$S_{A_t} = a + bP_{A_t} - cP_{B_t} - dC_t \quad (4)$$

$$a = \frac{\alpha(1+\psi)}{1-\psi^2}, \quad b = \frac{\beta-\gamma\psi}{1-\psi^2} > 0, \quad c = \frac{\beta\psi-\gamma}{1-\psi^2}, \quad d = \frac{(\beta-\gamma)(1+\psi)}{1-\psi^2} > 0$$

Since c may be positive or negative, the effect of house prices in B on construction in A is indeterminate. This reflects the fact that construction in A and B are complementary through ψ but are substitutes through γ .

House prices in A, given housing stocks, are equal to:

$$P_{A_t} = e + fN_{A_t} + \phi fN_{B_t} - gH_{A_t} - \phi gH_{B_t} \quad (5)$$

$$e = \frac{\mu(1+\phi)}{1-\phi^2}, \quad f = \frac{\pi}{1-\phi^2}, \quad g = \frac{\theta}{1-\phi^2}$$

House prices in A vary directly with the populations in A and B and inversely with their housing stocks. If $\phi = 0$ house prices are autarkic; they do not depend on the supply and demand for housing elsewhere².

Whereas equations (4) and (5) are static, the solution for the housing stock has second order dynamics, induced by equation (1), and has an ARMA(2,2) structure:

$$H_{A_t} = 2hH_{A_{t-1}} + iH_{A_{t-2}} + Z_{A_{t-1}} + hZ_{A_{t-2}} - \phi gbZ_{B_{t-2}} \quad (6)$$

$$h = (gb - \delta), \quad i = h^2 - (\phi gb)^2$$

$$Z_{A_t} = \alpha + be - dC_t + bfN_{A_t} + b\phi fN_{B_t}$$

For plausible rates of depreciation h and i are positive. The two roots of equation (6) are real and less than 1:

$$\rho_1 = \delta - gb(1+\phi) \quad (7a)$$

$$\rho_2 = \delta + gb(\phi-1) \quad (7b)$$

in which case convergence to equilibrium is monotonic. This equilibrium is obtained by collapsing the lag structure in equation (6) to obtain the long-run solution for the housing stock:

$$H_A^* = \frac{[1 + gb(1-\phi) - \delta](\alpha + be - dC) + bf(1+h)(1 - gb\phi^2)N}{1 - 2h - i} \quad (8)$$

Since the roots are less than 1 the denominator of equation (8) is positive. The equilibrium housing stock varies inversely with the cost of construction (C) and directly with the total population (N).

The model is conveniently recursive. Since Z_A and Z_B are exogenous the solutions for housing stocks are first obtained from equation (6). These solutions are substituted into equation (5) to obtain the solutions for house prices. Finally, the latter

² Matters would be different if migration occurred between A and B.

are substituted into equation (4) to obtain solutions for housing construction. The second order dynamics in equation (6) are transmitted to house prices and housing construction:

$$P_{At} = 2hP_{At-1} + iP_{At-2} + (1 + 2h + i)e + fN_{At} + 2hfN_{At-1} + ifN_{At-2} + \phi fN_{Bt} + 2h\phi fN_{Bt-1} + i\phi fN_{Bt-1} - gZ_{At-1} - ghZ_{At-2} - b\phi g^2 Z_{Bt-2} \quad (9)$$

$$S_{At} = 2hS_{At-1} + iS_{At-2} + (1 + 2h + i)[\alpha + (b - c)e] - d(C_t + 2hC_{t-1} + iC_{t-2}) + (b - c)(1 + \phi)f(N_{At} + 2hN_{At-1} + iN_{At-2}) + (b\phi - c)f(N_{Bt} + 2hN_{Bt-1} + iN_{Bt-2}) - g(c\phi + b)(Z_{At-1} + Z_{Bt-1}) - g[h(c\phi + b) + (b + c)b\phi g](Z_{At-2} + Z_{Bt-2}) \quad (10)$$

The impact effect of an increase in the population in B on house prices in A is ϕf from equation (9) and on construction in A it is $f(b\phi - c) = \pi \frac{\beta(\phi - \psi) + \gamma(1 - \phi\psi)}{(1 - \psi^2)(1 - \phi^2)}$

from equation (10). These effects are zero, as expected, if the spatial spillover parameters (ϕ, γ, ψ) are zero.

4 . The Data

Since the early 1970s Israel's Central Bureau of Statistics (CBS) has published house price indices for nine regions (see map). These indices are based on transactions prices, which are collected when stamp duty is paid on house purchases. These data are presented in Figure 2 and have been discussed by Beenstock and Felsenstein (2010). We have constructed data on building starts (Figure 2) completions for these nine regions using data published by CBS. These data have been described in detail by Beenstock and Felsenstein (2013) where we also explain the central role of the Israel Land Authority (ILA) in the housing market of Israel.

There are no published data on the stock of housing either at the national or regional levels. For the present paper we have constructed housing stock data for the nine regions, where the change in the housing stock is equal to lagged completions (for which data are available) minus demolitions and housing reassigned for commercial use. We have followed the methodology described in Bar Nathan et al (1998) for constructing these data, using census data for 1995 and 2008 as well as floor-space data obtained from aerial photography in 2008 to set the levels of these housing stocks. We also used data on floor-space obtained from local authorities in 2002. The main problem concerns the lack of systematic data on demolitions and reassignments, which we interpolate to match these floor-space data. The results of

this exercise are plotted in Figure 3, and the implications for housing density (housing space per head) are plotted in Figure 4. Housing space per head has grown at an annual rate of 1.1 percent, which is less than the rate of growth of consumption per head. In the wake of mass immigration from the former USSR, which caused a doubling of house prices during the 1990s, housing density increased nationwide. Housing density has been systematically greatest in Jerusalem where its large ultra orthodox population lives in cramped conditions, and has been lowest in Sharon, where incomes are relatively high. Figure 4 presents a “spaghetti” effect for the other seven regions.

5. Econometric Model

The model has been estimated by seemingly unrelated regression (SUR) using spatial panel data during 1987 – 2010. Since the data are difference stationary we used the group augmented Dickey Fuller statistic (GADF, Pedroni 2004) to test for panel cointegration. The econometric model is presented in Table 1. Since the parameter estimates do not have standard distributions, we do not report standard errors. Instead, hypothesis tests are carried out using GADF.

The estimation of equations 1 and 2 are discussed in detail in Beenstock and Felsenstein (2013). They constitute a multiple cointegration system in starts and completions because housing-under-construction is difference stationary like starts and completions. In equation 1 housing starts vary directly with local profitability in construction and national profitability, but they vary inversely with profitability in neighboring regions, i.e. there is spatial substitution but national complementarity in housing starts. The general price elasticity of supply is 0.208 (0.318 + 0.487 – 0.597) and its counterpart after allowing for spatial dynamics is 0.492 (0.208/(1 - 0.577)). The variable Z (the share of MOH starts) proxies MOH incentives to engage in housing construction. It may be shown that the coefficient of crowding-out of private starts by MOH starts is:

$$\frac{dS_p}{dS_g} = \frac{0.166 - 1.166Z}{1 + 1.166Z} \quad (11)$$

which implies that crowding out occurs if the share of MOH starts exceeds 14.2 percent, and crowding-in occurs otherwise. Equation 1 also includes a spatial lag on

Z, implying that when there are more MOH starts in neighboring regions, this reduces local starts as a whole.

Equation 2 relates completions to starts. It assumes that contactors use housing-under-construction as a buffer between starts and completions, and that they complete more when business is good. There is no intercept term to ensure that starts are eventually completed. Given everything else contractors complete 17.5 percent of housing-under-construction. However, the instantaneous response of completions to starts is 0.136, i.e. for every 100 m² of starts contractors complete 13.6 m² of building under construction. By one year later a further 22.5 m² are completed. The average lag is 2.5 years, it takes 5 years for starts to be completed, and there is mild overshooting induced by the lagged dependent variable in equation 2. Eventually completions increase 1 for 1 with starts.

Table 1 The Model

$$1. \ln S_{it} = fe_i + 0.318 \ln \left(\frac{P_{it}}{C_t} \right) + 0.487 \ln \left(\frac{P_t}{C_t} \right) - 0.597 \ln \left(\frac{\tilde{P}_{it}}{C_t} \right) + 1.166 Z_t - 0.439 \tilde{Z}_t + 0.577 \ln \tilde{S}_t$$

$$2. F_{it} = 0.175 U_{it} + 0.544 F_{it-1} + 0.136 S_{it}$$

$$3. \ln P_{it} = fe_i + 0.734 \ln N_{it} - 0.639 \ln H_{it} + 0.271 \ln Y_{it} + 1.140 \ln \tilde{N}_{it} + 0.520 \ln \tilde{P}_{it}$$

$$4. Z_{it} = \frac{S_{Git}}{S_{it}}$$

$$5. U_{it} = U_{it-1} + S_{it-1} - F_{it-1}$$

$$6. H_{it} = H_{it-1} + F_{it-1} - D_{it-1}$$

GADF_z: equation 1 -3.46, equation 2 -3.4, equation 3 -3.37

Legend: S starts, S_G starts initiated by MOH (exogenous), F completions, D demolitions (exogenous), P house price index, C construction cost index (exogeneous), N population (exogenous), Y income (exogenous), U housing under construction, GADF_z The z statistic for GADF, Spatial lagged variables are over-scripted with ~.

Equation 3 is an inverted demand curve for housing. The price elasticity of demand for housing space is -1.565 (1/0.639), the elasticity of demand with respect to the population is 1.15 (0.724/0.939) and the income elasticity of demand is 0.42 (0.271/0.639). In addition, local house prices vary directly with neighboring house prices and with neighboring populations.

6. Model Properties

To explore the properties of the model we carry out a full dynamic simulation (FDS) during 1994-2010 in which the state variables (house prices, starts, completions and housing stocks) in the nine regions are solved conditional on the exogenous variables (population, income, building costs, MOH starts). The FDS serves as a base-run which is perturbed by changing the exogenous variables to obtain their impulse responses. Since there are four key state variables and nine regions there are 36 state variables altogether. Since the model is nonlinear (because equations 1 and 3 are loglinear and the other equations are linear) the impulse responses are in principle state-dependent; the effect of the exogenous variables on the state variables depends upon when they occur. However, it turns out that this state dependence is of minor importance. Of greater importance is the geographical location of the perturbations. A shock of a given scale in a large region is proportionately smaller than in a small region. Also, because geography matters in the model, a proportionate shock in a region that is more spatially connected generates greater impulse responses than the same shock in a less spatially connected region. This means that impulse responses are asymmetric since a shock in one region propagates differently to the same shock in its neighbor, or elsewhere.

Shocks may be temporary or permanent. In the former case the impulse responses are expected to die out over time and space. If this were not the case the model could not have been cointegrated. Permanent shocks are expected to change the long-run levels of the state variables, and the impulse responses are not expected to die out. However, they are expected to be convergent since the model cannot be explosive if it is cointegrated. However, because the model is state-dependent shocks may create the misleading impression that they don't die out or converge. Shocks may also be local or global. In the former case the shock occurs in one region, and in the latter case it occurs in all regions. Because of the spatial interactions in the model the impulses that propagate from a global shock is more than the sum of its parts. This results from the domino and boomerang effects mentioned above.

In the first scenario the population in North is increased permanently by 50,000 in 1994. Percentage impulse response are reported in Figure 5 for house prices (panel A) and housing starts (panel B). The impulse responses in Figure 5 are induced by spatial and temporal dynamics in the model. Shocks propagate over space and time in both house prices and construction. House prices initially increase by 4.3 percent in North, which spills-over onto other regions via the spatial lag structure in equation 3.

House prices in Sharon are affected most (3.1 percent) whereas house prices in Dan and Center are affected least (1.1 percent). The increase in house prices affects starts. The greatest initial increase is in North (1.6 percent) as might be expected but the smallest increase is not in Dan and Center; it is in South. This happens because of spatial spillover effects in equation 1 of the moving average variety and the autoregressive variety. Therefore the rankings in panels A and B are not the same.

The increase in housing starts eventually increases housing stocks, which result in lower house prices. This explains why house prices and housing starts overshoot in panels A and B respectively. Theory predicts that in the long-run house prices and starts should converge upon a higher equilibrium level. Figure 5 indicates clear signs of convergence, but by the end of the simulation convergence is not yet achieved. Convergence failure results from the fact that building gestation (equation 3) is protracted and the rate of depreciation on the housing stock is naturally low.

In the next simulation the population shock is assumed to be temporary rather than permanent, i.e. the population in North is increased by 50,000 in 1994 but reverts to its erstwhile level in 1995. House prices are expected to increase temporarily in North, and spillover onto house prices elsewhere. In the long run house prices are expected to remain unchanged. Figure 6A shows that house prices in North increase by 4.3 percent in 1994 in response to the increase in housing demand. Figure 6A also shows that house prices in North spillover onto other regions as in Figure 5A. The increase in house prices induce an increase in housing starts, which causes housing stocks to increase (Figure 6B). Furthermore housing starts increase due to spatial dynamics in equation 1 in the model. The largest increase is naturally in North, which peaks at 0.075 percent 5 years after the shock but the smallest increase is now in Krayot. Because the increases in housing stocks are persistent but the demand for housing is unchanged from 1995, house prices are lower from 1995 (although this is difficult to discern in Figure 6A).

This simulation shows that temporary shocks have persistent effects, which take a long time to die out. Indeed, because the lag between housing starts and completions is spread out over 5 years, and because the rate of depreciation on the housing stock is naturally small, housing stocks in Figure 6B considerably exceed their equilibrium levels even 12 years after the shock occurred. If there was no gestation lag, the rate of depreciation was 100% and each region was an island unto itself there would be no persistence.

We have mentioned that these impulse responses are state dependent both because they depend upon when the shock is assumed to occur and where it occurs. For example, if the population is increased by 50,000 in Jerusalem instead of North, house prices in Jerusalem increase by more than they do in Figure 5A. This partly results from the fact that because the Jerusalem population is smaller than in North, the shock in Jerusalem is larger in percentage terms. In addition to this, because of the spatial dynamics of the model there is no reason why a given percentage shock should have the same effect everywhere.

In Figure 7 we simulate internal migration from Tel Aviv to North. It might have been expected that house prices should initially increase in North and decrease in Tel Aviv. However, Figure 7A shows that house prices initially decrease in North by 2 percent and decrease in Tel Aviv by 13 percent. The decrease in house prices in North results from the spatial lag effect in equation 1. Since the population in Tel Aviv is smaller than the population in North, house prices in North increase by less than they decrease in Tel Aviv. The latter reduces house prices in North through the spatial lag effect so that the net impact effect on house prices is negative. House prices increase in North relative to Tel Aviv by 11 percent, and increase relative to house prices elsewhere. However, absolute house prices decrease. Figure 7A shows that this decrease in house prices spills-over onto North's neighbors (Haifa and Krayot).

The decrease in house prices induces a contraction in housing starts in all regions. As expected the greatest reduction occurs in Tel Aviv (4.5 percent) and the smallest in North (1 percent). However, the intermediate rankings in Figures 7B and 7A differ because of spatial spillover effects.

Next, we simulate an increase of 300,000 m² of MOH housing starts in South which naturally increases the housing stock in that region (Figure 8A) which lowers house prices (Figure 8B). Because of gestation lags it takes 6 years for the housing stock to peak and for house prices there to bottom-out. The shock-waves spread to other regions through several channels. First, because MOH operates in South, contractors build less in other regions (the coefficient of \check{Z} is negative in equation 1). Second the increase in starts in South increases starts elsewhere through the spatial lagged dependent variable in equation 1. Third, house prices change elsewhere via equation 3, which in turn affect starts via equation 1. The net effect is plotted in Figure 8A.

The housing stock overshoots its long run equilibrium for two reasons. First, equation 2 involves a complex root, as noted. Second, the spatio-temporal dynamics of the model induce the state variables to exceed their equilibrium values. If South was an island unto itself only the first reason would apply.

Finally, building costs are increased nationally by 20 percent from 1994 (Figure 9). Results for housing starts are plotted in Figure 9A, which decrease by between 5 – 7 percent. The largest decrease is in Tel Aviv and Dan and the smallest in Jerusalem and the South. This heterogeneity stems from the autoregressive and moving average spatial lag structures in equation 1. After 1994 housing starts begin to recover because house prices begin to increase. However, the recovery is not uniform due to spatial dynamics. Figure 9A shows that 10 years after the increase in building costs, housing starts are about 3 percent lower. By 2004 the housing stock in Krayot is about 0.7 percent lower whereas in Sharon and the North it is 1.5 percent lower. Notice that the rank of the decrease in the percentage change of the housing stocks is not the same as the rank of the percentage change in housing starts.

The implications of Figure 9A for house prices are plotted in Figure 9B. Because housing stocks fall over time, house prices increase over time. By 2004 house prices have increased by 1.3 – 2.0 percent. Note that because of spatial spillovers in house prices (equation 3) the regional rankings for house prices in Figure 9B are not necessarily the same as their counterparts in Figure 9A. Nevertheless, the effect of building costs on housing stocks and house prices is greatest in Sharon and smallest in Krayot.

Theory predicts that in the short-run housing starts overshoot their long-run decrease. This is clearly discernable in Figure 9A. Theory also predicts that in the very long run the increase in construction costs raises the price of housing and lowers the housing stock. Figures 5 are expected to converge on their equilibrium asymptotes. However, by year 14 into the simulation this convergence has not occurred. Nevertheless, Figures 9A and 9B are clearly convergent, even if convergence has not occurred

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Figure 1 House Prices

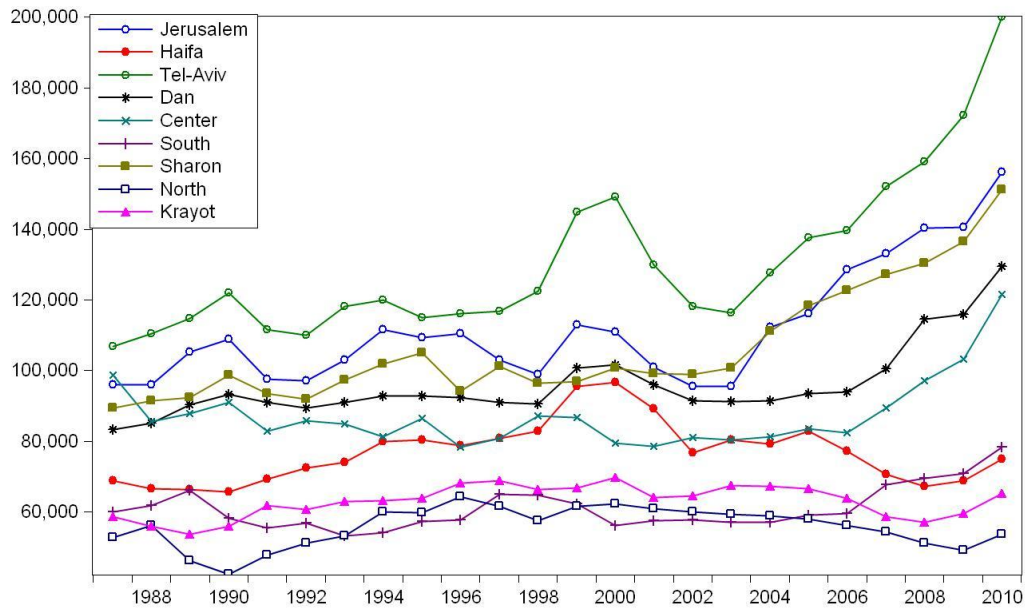


Figure 2 Housing Starts (1000s m²)

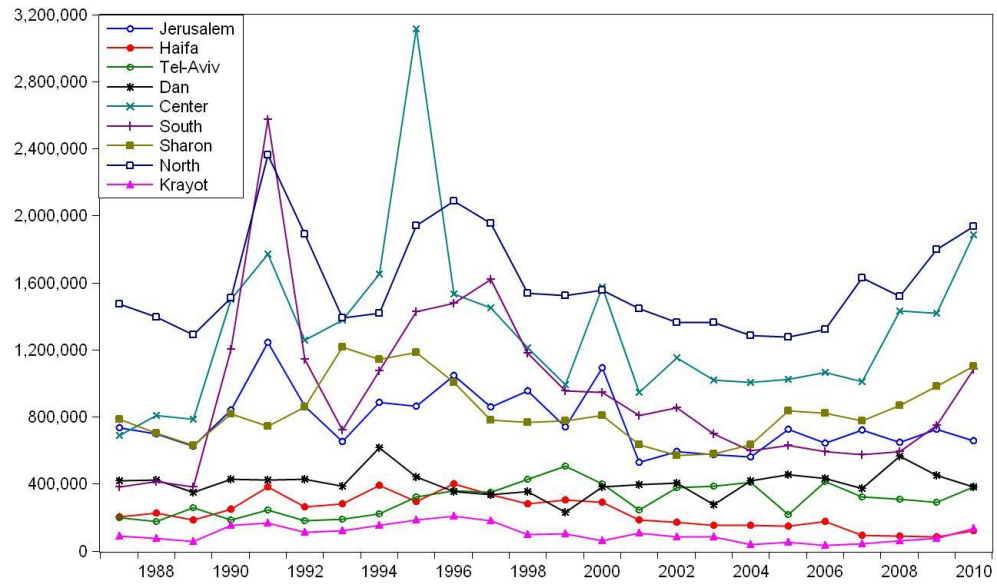


Figure 3 Housing Stocks

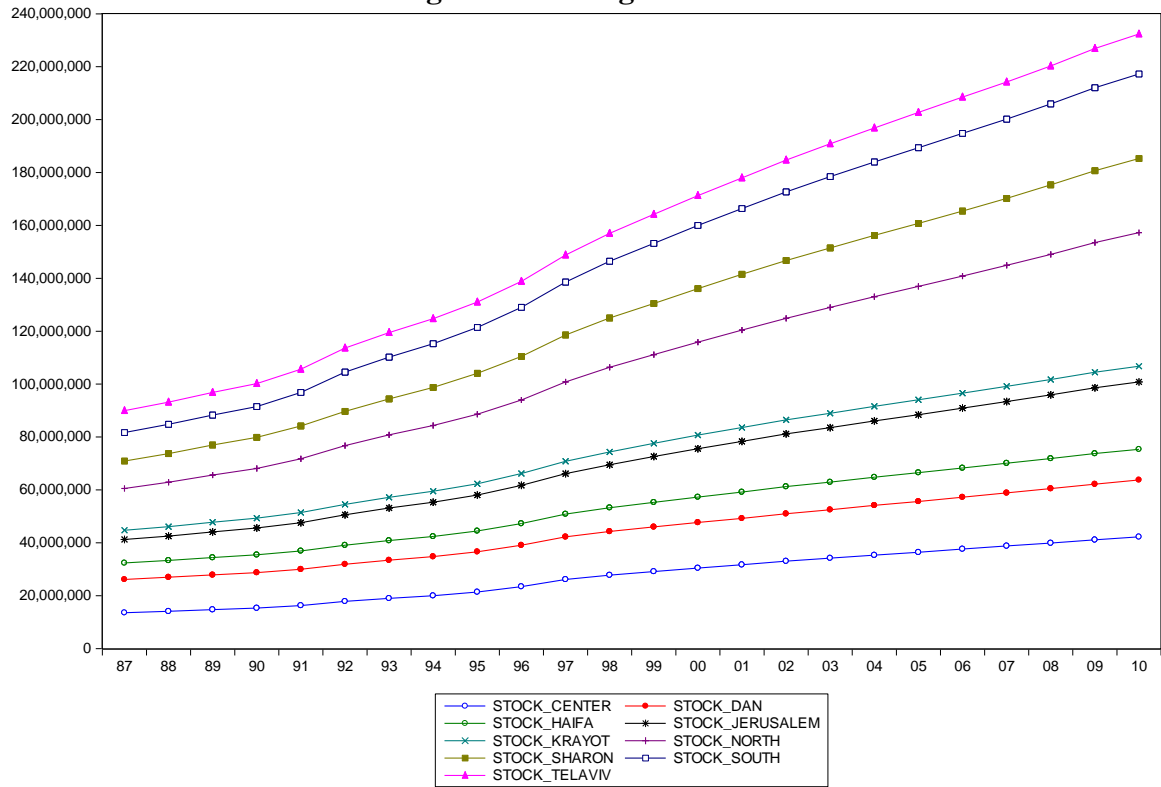


Table 4 Housing Space per Capita (square meters)

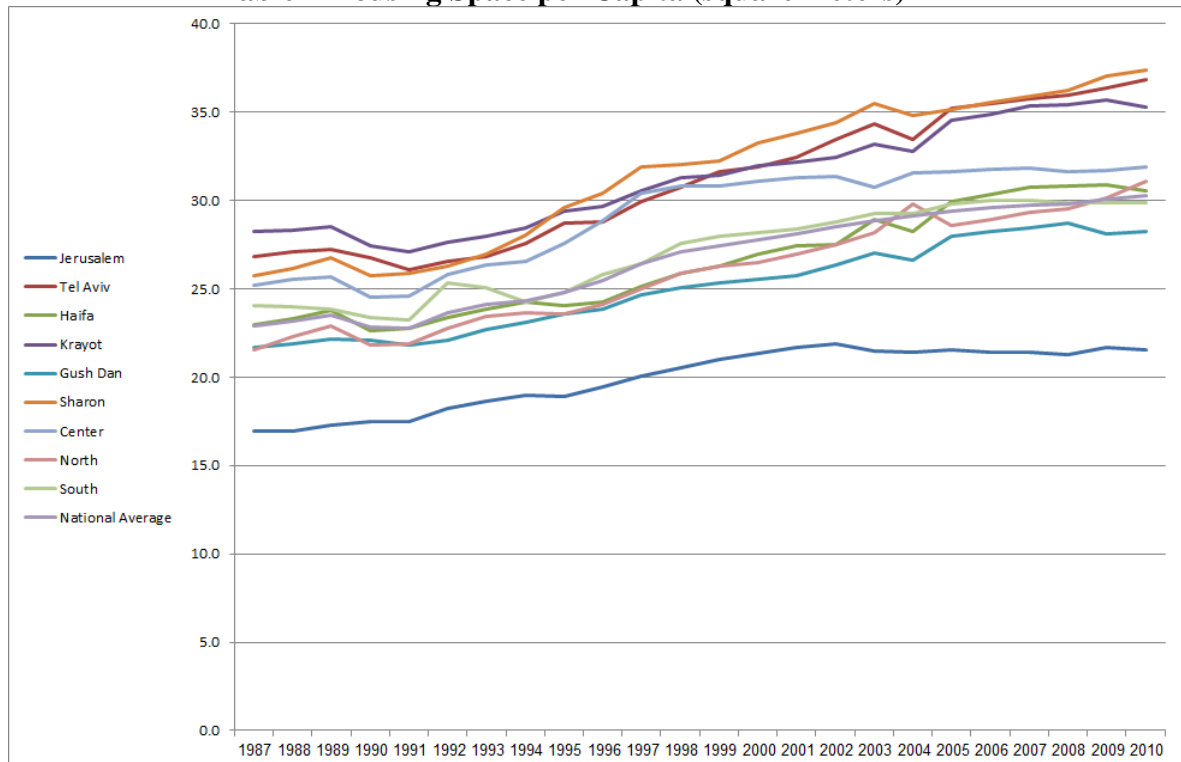
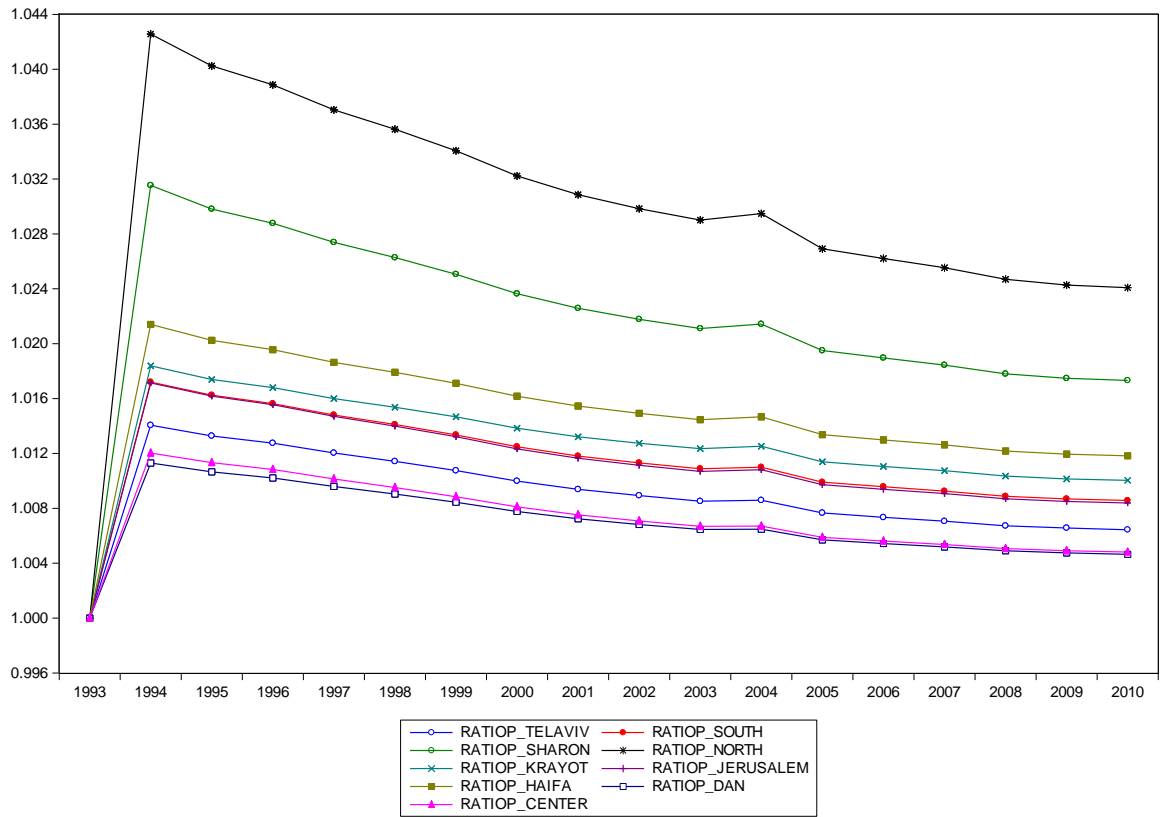


Figure 5 Scenario: Permanent Population Increases in North of 50,000

A. House Prices



B. Housing Starts

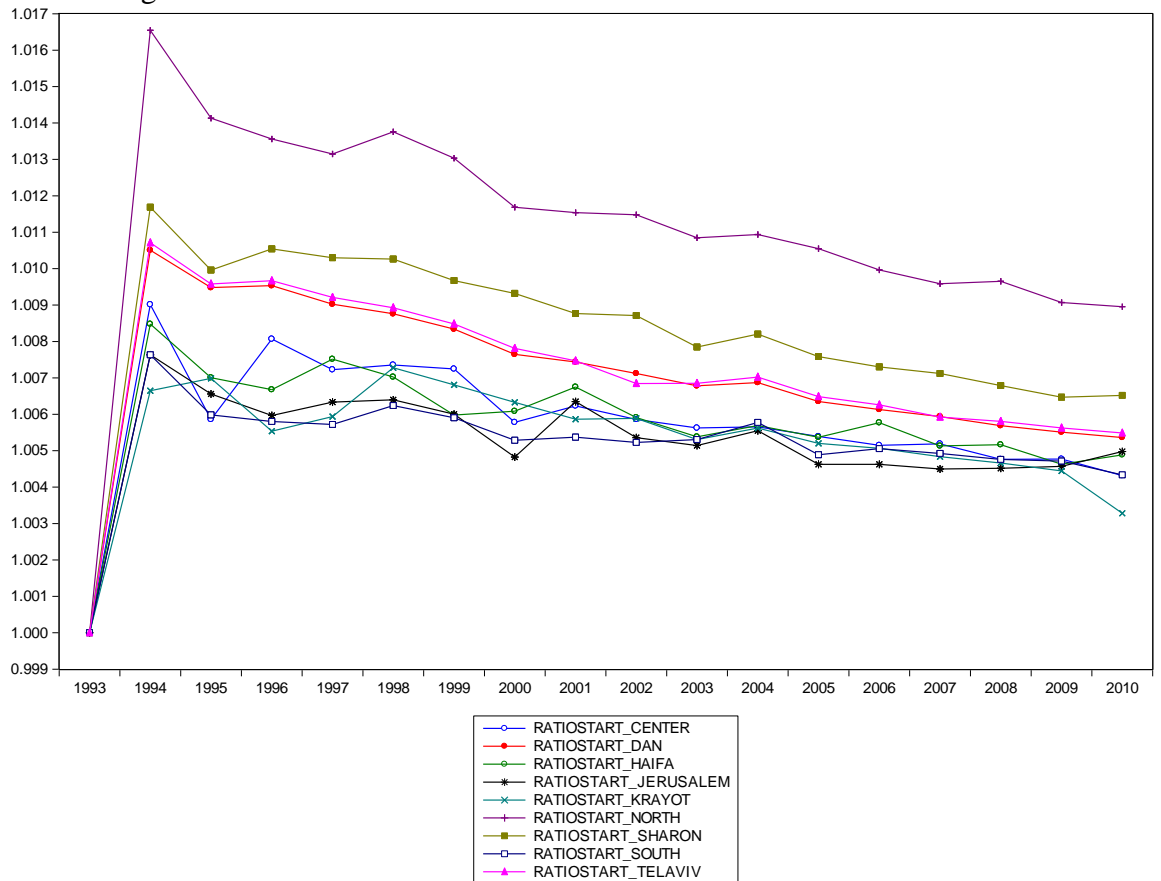
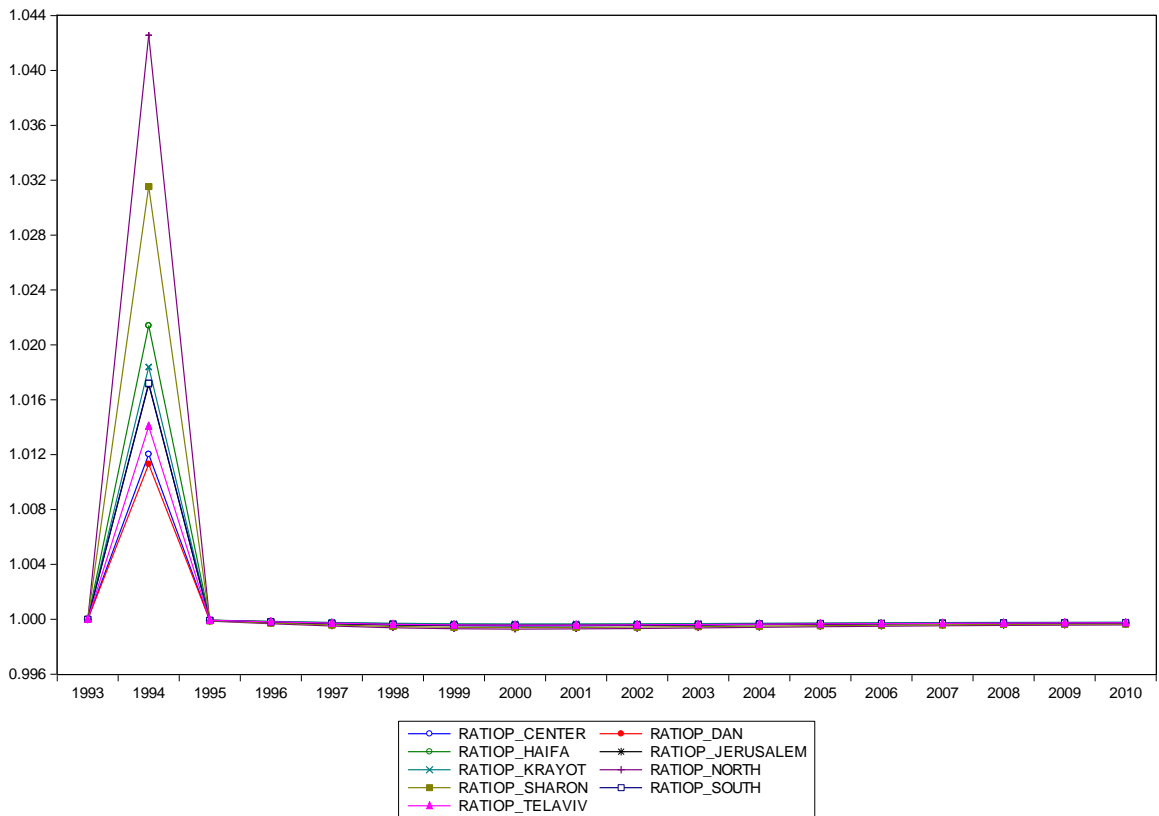


Figure 6 Scenario: Temporary Population Increase in North by 50,000

A. House Prices



B. Housing Stock

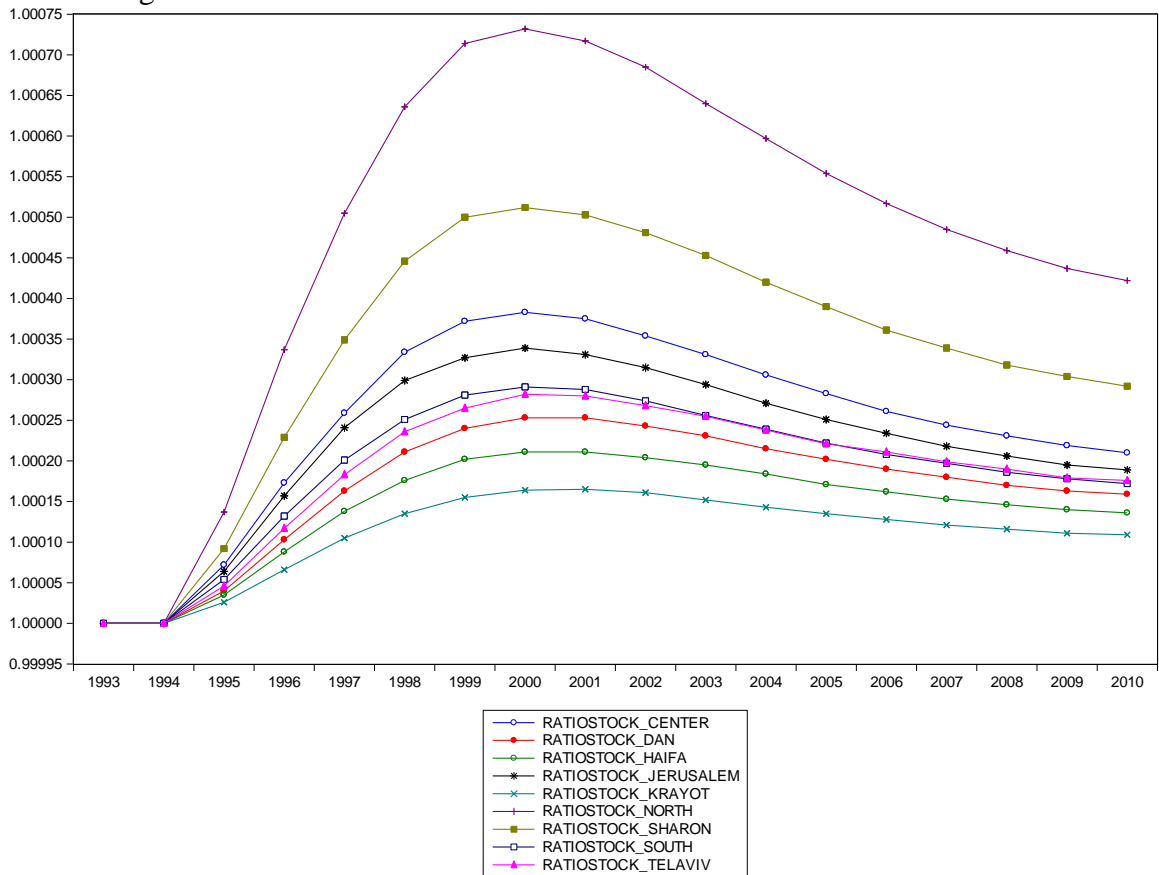
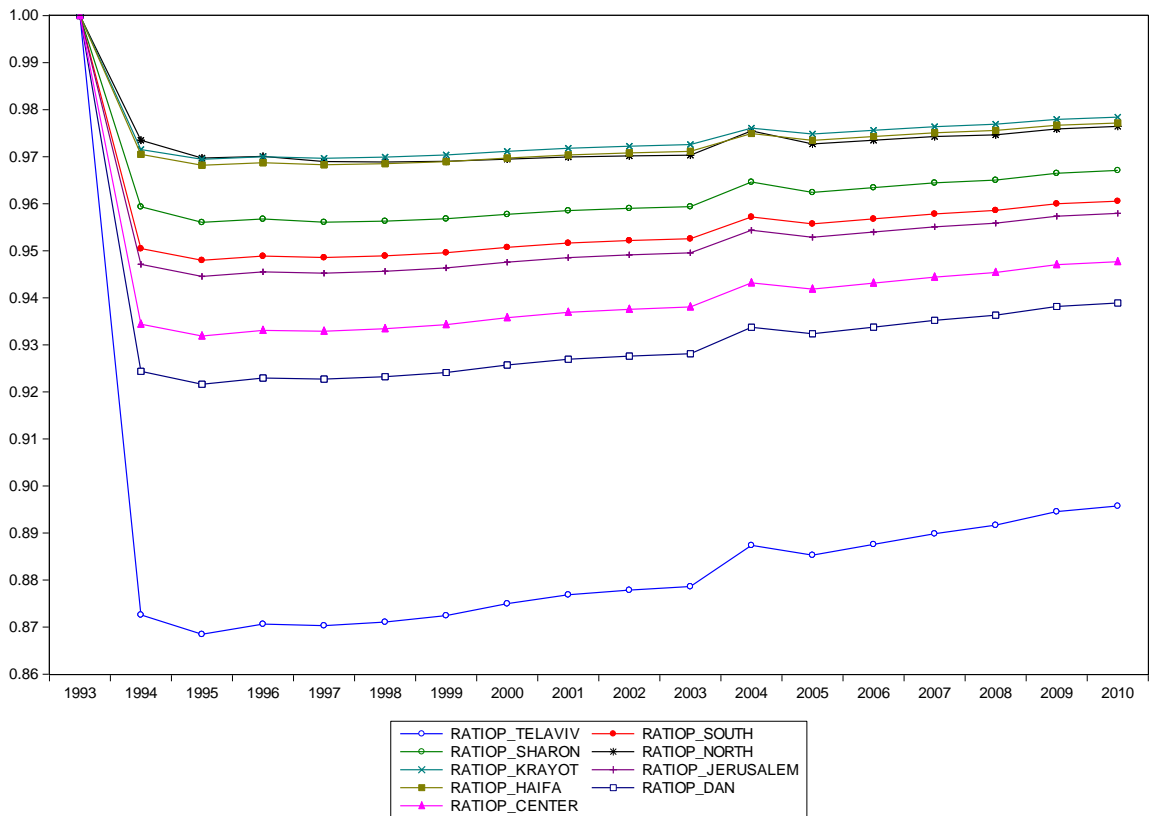


Figure 7 Scenario: Permanent Migration of 50,000 from Tel Aviv to North

A. House Prices



B. Housing Stocks

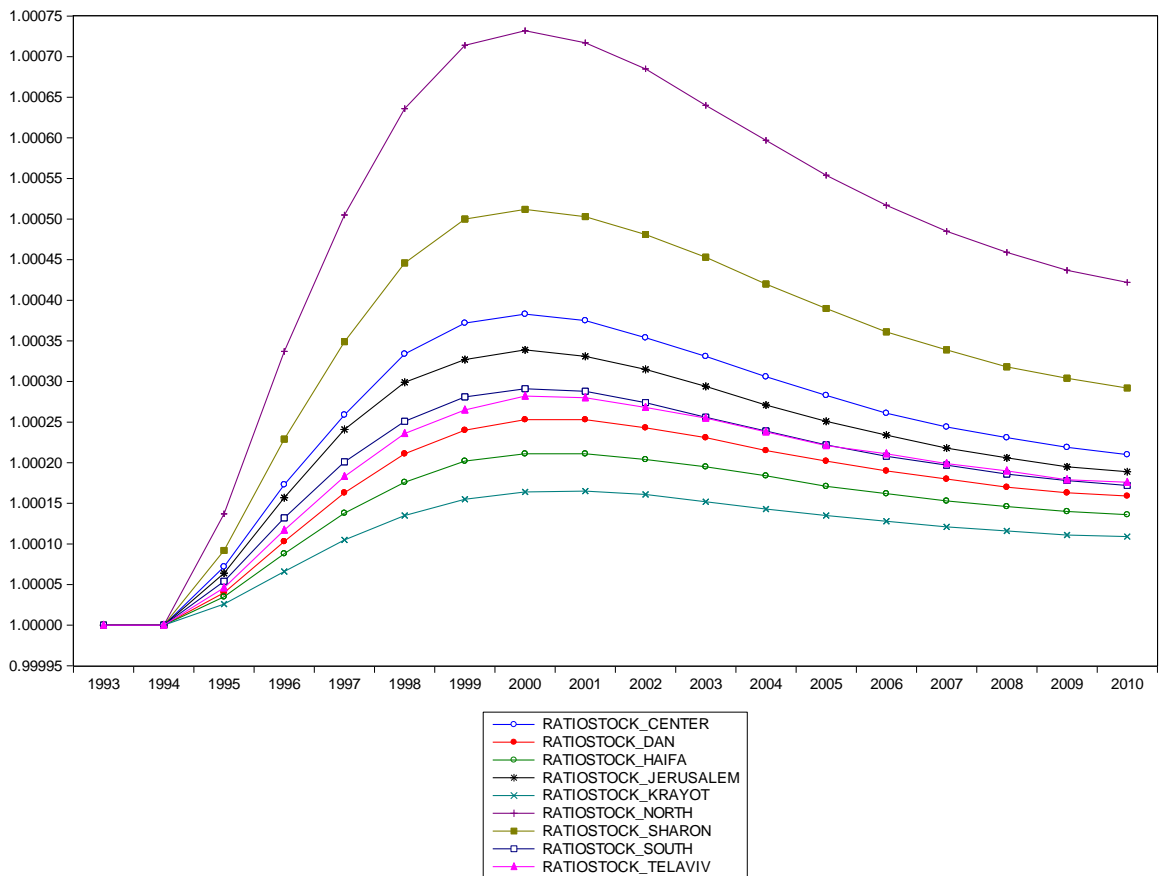
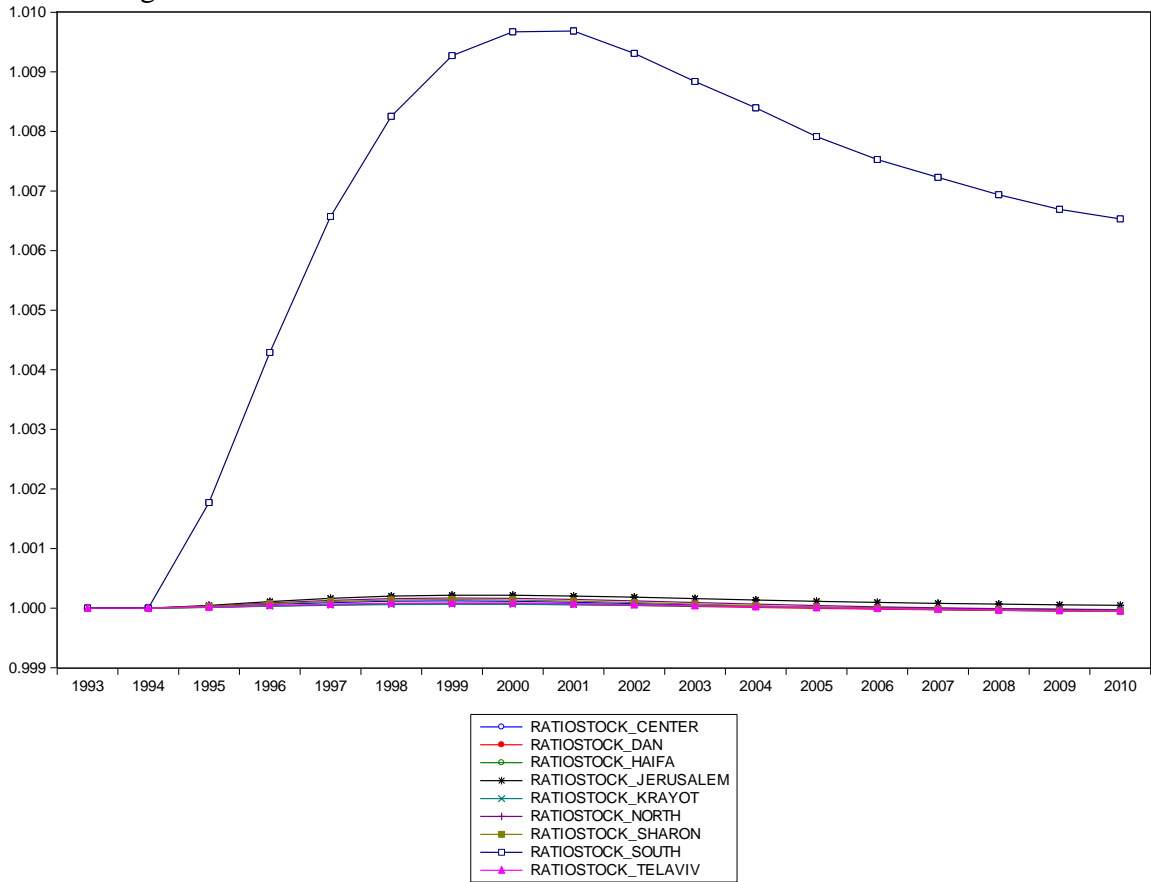


Figure 8 Simulation: MOH Starts Increase by 300,000 m² in South

A. Housing Stocks



B. House Prices

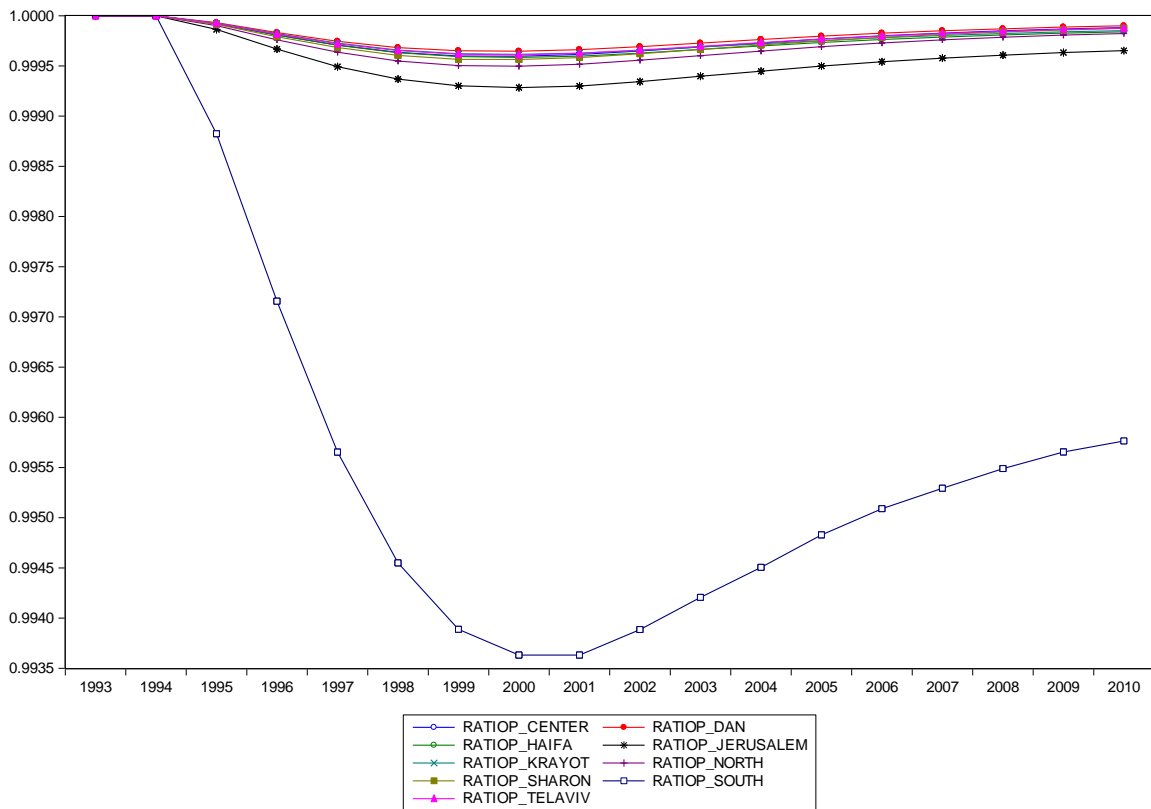
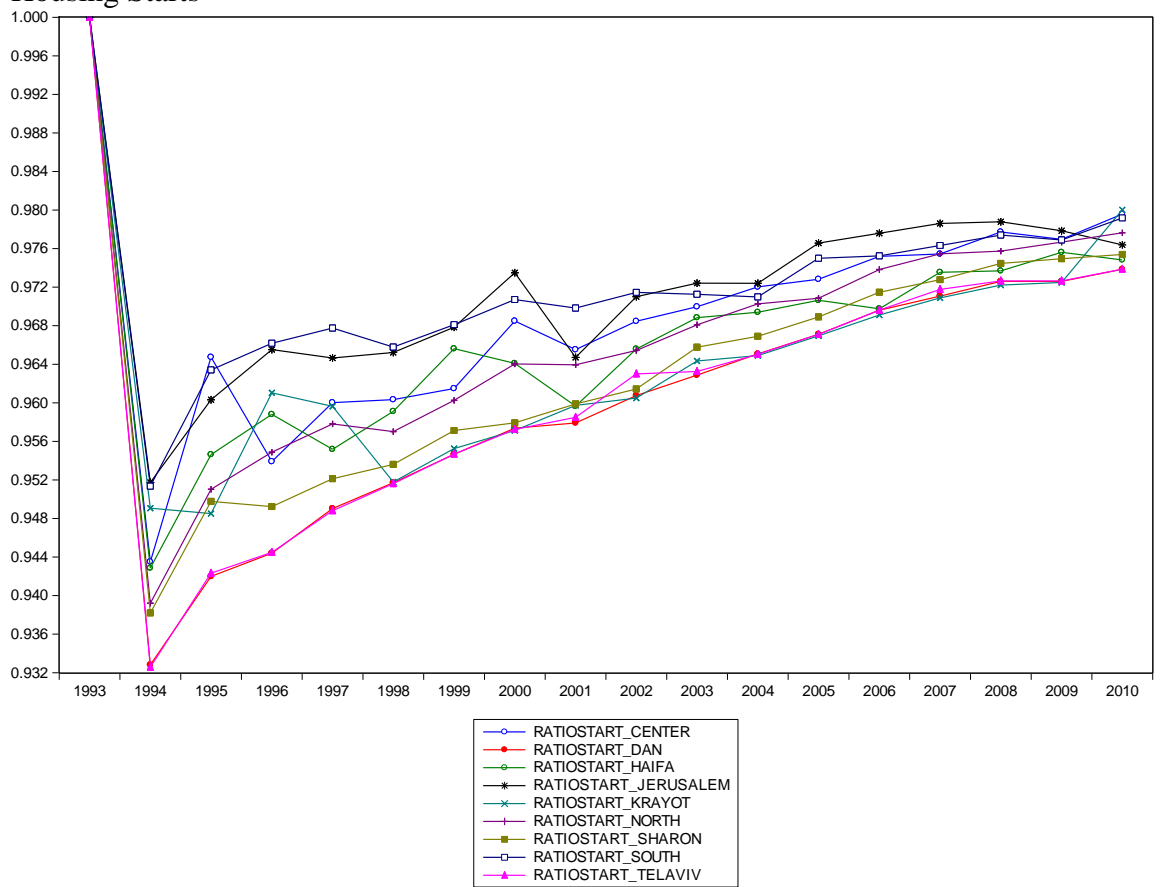
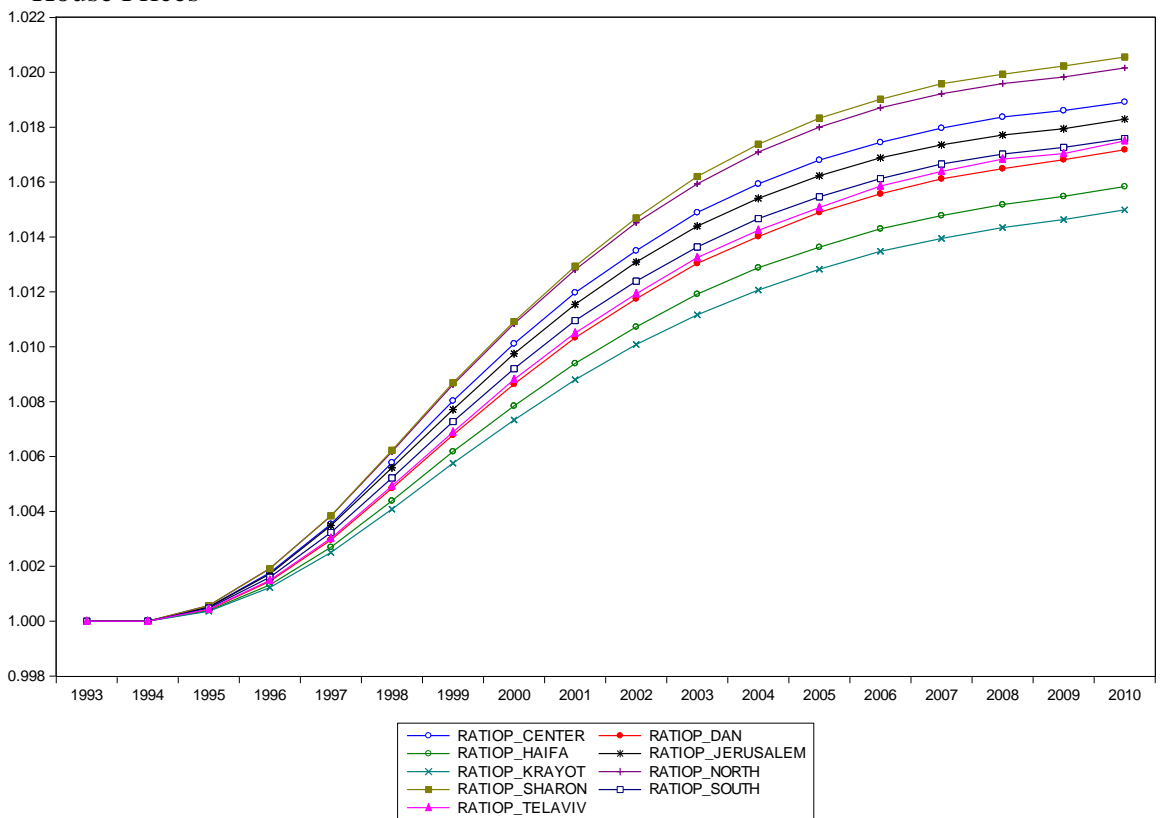


Figure 9 Simulation: Permanent Increase in Building Costs of 20 Percent

A. Housing Starts



B. House Prices



Map

