GREEN VERSUS CONVENTIONAL HOUSING: TIME-TO-SELL AND WILLINGNESS TO PAY

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ABSTRACT

This research is the first to explore the time-to-sell (TTS) and willingness to pay (WTP) in the context of green real estate. We employ unique data on transactions and household characteristics of owner-occupiers in newly developed green and conventionally built condominiums. We find that, after addressing the potential endogeneity between unit TTS and price, the average TTS of units in green, as compared to conventional, structures is significantly shorter. Considering developers' financing cost, this shorter TTS is equivalent to an indirect price premium of 1.8%–5.3%. We further find that whenever the indirect green premium associated with TTS decreases, the green quality-adjusted price premium increases. Finally, we find an insignificant difference between the green and conventional structures in the correlation between household characteristics and the WTP. Our findings may serve both developers and policymakers in promoting green real estate construction.

Key Words: green housing, green premium, time-to-sell, willingness to pay

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1. INTRODUCTION

The growing body of literature on the economics of green real estate often focuses on estimating the premium associated with green, as compared to conventional, construction. Indeed, studies reveal a green premium in sale prices (in both pre- and post-completion of the construction stage), rent prices, and construction costs. Further, evidence of the price premium is found both in the housing and commercial markets and among both primary and secondary market transactions (see, among others, Eichholtz, Kok, and Quigley, 2010, 2013; Deng, Li, and Quigley, 2012; Deng and Wu, 2014; Kahn and Kahn, 2014; and Bond and Devine, 2016).[1]

Interestingly, however, while the direct economic effects (i.e., cost and pricing) of green construction have been extensively addressed in the literature, much less is known about the indirect economic effect of the time-to-sell (TTS) of green real estate units. This deficit in the literature is particularly surprising given the considerable financing costs potentially associated with the TTS of newly developed real estate.[2] In this study, we thus seek to close this deficit by empirically exploring the TTS of newly developed green condominiums. Moreover, our unique dataset allows us to estimate the willingness to pay (WTP) for green housing units according to household socio-demographic characteristics. It is noteworthy that while the correlation between the WTP and individual characteristics has received much attention in the literature on both green and non-green products (e.g., Roe et al., 2000; Tsen et al., 2006), it has never previously been considered in green-related real estate studies.

Our study includes a random sample of 190 primary market ("first-hand") transactions in six multi-story structures, of which three are green and three are conventionally built, located side by side in a neighborhood of Netanya, Israel.[3] Except for the green aspect, all six structures exhibit similar physical amenities (see additional background and summary statistics in the next sections) and were sold by the developers during the period 2009–2014. In addition to observing transaction price,

[1] Eichholtz, Kok, and Yonder (2012), Deng, Li, and Quigley (2012), and McGrath (2013) also show a positive effect of green real estate investments on capital market-related figures. For more on the positive green price premium, see, for example, Fuerst and McAllister, 2011a, 2011b; Brounen and Kok, 2011; Deng et al., 2012; Zheng et al., 2012; Eichholtz et al., 2013; and Deng and Wu, 2014.

[2] Importantly, while TTS has received much attention in the real estate literature (see, e.g., Smith, Gibler, and Zahirovic-Herbert, 2016; Chen and Rutherford, 2012; and Brastow, Springer, and Waller, 2012), it has never been studied in relation to green products.

[3] Netanya is the eighth-most-populous city in Israel (see Section 2 for more background detail).

TTS, and the assets' physical amenities, we survey households occupying units in these structures, focusing on their socio-economic and demographic characteristics, as well as information regarding personal preferences (such as political views; car use; and dietary, exercise, and smoking habits).

Our investigation includes a controlled estimate of the TTS of green versus conventionally built units, addressing the potential endogeneity between unit price and TTS. We also estimate the correlation between household socio-demographic and other personal characteristics and the WTP. Finally, we examine the robustness of our findings to issues of sampling and test specifications.

Our results indicate that the average projected TTS of units in the green structures is significantly shorter than in conventional structures. Specifically, while the average projected TTS of units in conventionally built structures is equal to about 18–21 months (where unit TTS is computed by the time elapsed from the first transaction in the respective building; see further details below), the average TTS of units in green structures is shorter by about 4–13 months. This TTS difference is equivalent to an indirect green price premium of about 1.8%–5.3%. In addition, examining the quality-adjusted price of units in green, as compared to conventionally built structures, we find a direct green price premium of up to 4.5%. Our results further indicate a tradeoff between the indirect (via TTS) and direct (via price) green premiums: when the indirect green premium decreases, the direct green premium increases. Thus, considering both price and TTS, we estimate a total green price premium of about 5.3%–6.3%. In contrast, however, we find an insignificant difference between green and conventional units in the association between household characteristics and the WTP. Our results are robust to sampling and test design issues.

The main contribution of our study is twofold. First, our results on the shorter TTS associated with green units—an aspect that has never been explored in the context of green real estate—carries, of course, meaningful economic benefits favoring green construction, a considerable outcome by both developers and policymakers in the real estate industry. Further, our evidence that household socio-demographic and other personal characteristics are insignificantly associated with the WTP for green housing effectively suggests the lack of a "clientele effect" in the purchase of green units. The latter finding may, in turn, spare developers' efforts to market green real estate to specific segments of the population.

The remainder of the paper is organized as follows. Section 2 provides background on green construction in Israel and the specific housing projects from which our observations are culled. Section 3 presents descriptive statistics of the sample. In Section 4 we explore the TTS and price of green, as compared to conventional, housing units. In Section 5 we explore the WTP and the likelihood of purchasing green, as compared to conventional, units. Finally, Section 6 provides a summary and concluding remarks.

2. BACKGROUND

Green Housing in Israel

Israel Standard Number 5281, issued by the Standards Institution of Israel and published by the Ministry of Environmental Protection, specifies the criteria for acquiring a green building certificate for new residential structures. Table 1 presents the criteria for rating residential buildings as green according to the 2005 standard that applies to the buildings in our sample. As indicated in the table, the rating criteria include (in order of importance) energy savings (29%), soil (19%), water (17%), estimator's assessment (8%), air quality (7%), management (7%), waste (4%), noise (4%), radiation (3%), transportation (1%), and materials (1%). The green certificate includes two grading options: pass (55–74 points on a scale of 0 to 100) and excellent (75–100 points).[4] All three green structures included in our sample merited a grade of excellent.

Green and Conventionally Built Structures in the Sample

Figure 1 presents a map showing the location of the green and conventional structures in our sample. As indicated by the map, all six structures are located next to each other in the Kiriat Ha'sharon neighborhood in the southeastern part of the city of Netanya (the eighth-most-populous city in Israel). That the structures are located in close proximity to one another poses a great empirical advantage, as it provides a perfect control for the location of the housing units in the sample. Moreover, that the units in these structures are located on different floors and transacted in varying time

[4] The green standard in Israel was revised in 2011. According to the revised standard, the rating required for the minimal formal category (of a one-star green building) is 55 points (on a scale of 0 to 100). The highest possible rating is the five-star category.

periods provides sufficient variation in the price and time-on-market variables that is required for our statistical estimation.

The Kiriat Ha'sharon neighborhood has been characterized by rapid development and commonly attracts a young, educated population. In addition, the neighborhood is relatively close to Netanya Academic College and to shopping centers, malls, and a natural park with bicycle trails and playground facilities. Finally, there is ample bus service to both the central bus and train stations.

The "treatment" group in our study includes housing units in three 19-story green condominiums. The architectural design of the buildings provides for four units per floor, a large lobby, and 2–3 elevators. Of the total number of 222 units in these structures, we sampled 97 units (about 44%)—including at least one unit per floor.[5] Further, the control group includes condominium units in two 20-story and one 15-story conventionally built structures located next to the green structures. Moreover, the amenities of these structures (lobby, number of units per floor, and elevators) resemble those of the green structures. Of the total number of 220 units in these conventional structures, we sampled 93 units (about 42%), including at least one unit per floor.[6]

Table 2 presents the date of construction permit issuance and date of construction completion of the three green and three conventionally built structures. We identify the structures in each of the two groups (green and conventionally built) in order of their completion date (green 1, 4, and 6, and conventionally built 2, 3, and 5). As indicated in the table, the issuance of construction permits for all structures occurred over the 2009–2010 period, and construction was completed over the 2011–2013 period.

3. DESCRIPTION OF THE SAMPLE

Our study is based on two datasets. The first includes information on housing unit transactions in green and conventionally built structures, and the second is a survey of

[5] We exclude penthouse units from our dataset due to their idiosyncratic amenities. Importantly, however, penthouse units are not the first units sold in the examined green structures and, hence, their omission does not affect our computed time-to-sell variable (see further description below). Also, due to a somewhat different lobby design, the first floor of each of the green structures, unlike the conventional structures in the sample, includes only two (rather than four) units.

[6] The authors physically inspected all six structures to confirm that the architectural design and amenities are indeed similar across the green and conventionally built structures.

socio-demographic characteristics and preferences and habits of households occupying those structures. Below we describe the two datasets.

Green and Conventionally Built Housing Transactions

We observe a sample of firsthand transactions of newly developed green and conventionally built condominium units.[7] A main focus of our study is to explore the time-to-sell (TTS) of green, as compared to conventional, units. We compute a unit TTS by the elapsed number of months between the first transaction in the respective building and the current transaction. That we observe at least one transaction per floor in all buildings increases the validity of our TTS measure. Moreover, in the analysis that follows, we test robustness of the results to alternative TTS specifications.

Table 3 presents summary statistics of dwelling unit characteristics in the sample. As indicated in the table, sample observations include 190 condominium units, of which 151 (79%) are occupied either by owners or renters, and where ownership status in the remaining 39 units is unknown.[8] Also, 51% of the units (97 observations) are located in one of the three green-certified structures; the others (93 observations) are in conventionally built structures. The average unit (non-quality-adjusted) price (*PRICE*) is about $346K, and the average TTS is about 16 months (*TTS*), where the typical dwelling unit in the sample is a 4.5-room (*ROOMS*), 1,340-square-foot (*AREA*) condominium apartment. The average floor is about 9.5 (*FLOOR*).[9]

In addition, 9% of the transactions were presales carried out prior to the issuance of the construction permit (*PRESALE*1), and 75% were presales occurring subsequent to permit issuance and prior to construction completion (*PRESALE*2). The remainder (16%) were units sold subsequent to construction completion (*POSTSALE*). The average price of the units in the *PRESALE*1, *PRESALE*2, and *POSTSALE* categories is about $317K, $341K, and $388K, respectively.

[7] Transaction data are based on three sources: the developer (Shikun and Binui, Arison Group), Israel Tax Authority, and Israel Survey.

[8] Of the 151 households whose ownership status is known, 113 are owner-occupiers (about 75%). These figures resemble those of the entire population of Israel: homeownership rate in Israel is equal to about 70% (Israel Central Bureau of Statistics, 2015).

[9] All housing prices are converted from New Israeli shekels (NIS) to U.S. dollars, where the exchange rate is 1 NIS = $0.25.

Table 4 presents summary statistics of the sample stratified by green and conventionally built structures. As indicated in the table, the average (non-quality-adjusted) price of green and conventional units is about $359K and $333K, respectively. The $26K (or 8.33%) difference is statistically significant at the 1%-level.[10] Also, the (uncontrolled) *TTS* of green and conventional units is about the same and equals 16 months, where of the 97 (93) green (conventionally built) units, 11% (6%), 64% (86%), and 25% (8%) are in the *PRESALE*1, *PRESALE*2, and *POSTSALE* categories, respectively. [11] Finally, the percentage of owner-occupiers, as well as unit characteristics (*FLOOR* and *AREA*), is similar across units in the green and conventionally built structures.[12]

Household Socio-Demographic and Other Personal Characteristics

Other than observing transactions in green and conventionally built structures, we further survey households occupying units in those structures in order to explore household personal characteristics that associate with the willingness to pay for green housing. Based on the survey, we thus generate a series of variables describing socio-economic, demographic, and other personal characteristics (including preferences, habits, and political views) of the households. In the survey, we focus only on the population of homeowners—of the 151 owner-occupied units in our transaction dataset, we survey 113 homeowners. Table 5 presents summary statistics of household characteristics of the sub-sample of 113 owner-occupiers.[13] As indicated in the table, 65% and 35% of the households live in green and conventionally built condominiums, respectively; 73% of the households are employees (denoted by *EMPLOYEE*), 19% are self-employed (*SELF_EMPLOYED*), and 8% are either unemployed, students, or

[10] Deng and Wu (2014) find that the "green price premium" of residential developments arises largely during the resale, rather than the presale, phase. However, in line with our findings, they find a small green price premium even at the presale stage.

[11] It further follows from Table 3 that the non-quality-adjusted-price of the green (conventional) units transacted under *PRESALE*1, *PRESALE*2, and *POSTSALE* is about $319K, $357K, and $383K ($312K, $327K, and $405K), respectively.

[12] The only exception is the average number of rooms: 4.58 and 4.37 in green and conventional structures, respectively. This difference, however, is controlled for in the hedonic price estimation that follows (see next section).

[13] For Pearson correlation matrix among household characteristics, see the Appendix.

retirees (*OTHERS*). Among the employed and self-employed, the average annual net income (including wage and non-wage sources) (*INCOME*) is about $44K.[14]

In addition, the typical household includes 3–4 persons (*PERSONS*); the average age of survey participants is 38 (*AGE*), of whom 55% are women (*WOMEN*), 20% immigrated to Israel (*IMMIGRANT*), 60% are sons or daughters of immigrants (*FATHER_IM*), and 31% hold a master's or Ph.D. degree (*MASTERS*).

The weekly car gasoline expense per household on a standardized scale between 0 (no expense) and 1 (maximal expense) (denoted by *STANDARD_GAS*) is 0.29;[15] 77% participate in municipal elections (*VOTE*); 54% hold conservative political views on security and foreign affairs issues (*RIGHTWING*); and the average score of one's attitude regarding the desired degree of governmental market intervention (*INTERVENE*) (on a standardized scale of 0 [minimal intervention] to 1 [maximal intervention]) is 0.40. Also, 16% are smokers (*SMOKE*); the average number of hours devoted weekly to physical exercise is about 3.0 (*EXERCISE*); and the average BMI index (the ratio of weight [in kilograms] to squared height [in meters]) on a standardized scale of 0 (minimum BMI) to 1 (maximum BMI) (denoted by *STANDARD_BMI*) is 0.33 (equivalent to a BMI of 24.5).

Finally, Table 6 presents household characteristics stratified by green versus conventional structures. Interestingly, it follows from the table that for almost all household characteristics, the average difference between the green and conventional structures is statistically insignificant. The only statistically significant difference is found for *INCOME*, *STANDARD_CAR_GAS*, and *RIGHTWING*.

4. TIME-TO-SELL AND PRICE: GREEN VERSUS CONVENTIONAL UNITS

We explore differences in the price and time-to-sell (TTS) between units in green and conventional structures, controlling for unit physical characteristics, changes in the local housing price index, and the phase at which the unit was transacted (presale or post-construction sale). Along the lines of Haurin (1988), Chen and Rutherford

[14] This is compared to the national average net household income of about $47K (see Israel Central Bureau of Statistics, 2015).

[15] The original (non-standardized) figures of weekly car gas consumption include a maximum of $250, with an average of $74.

(2012), and others, we develop a simultaneous equation model allowing for endogeneity between the price and TTS variables.

The Model

Consider the following simultaneous equation model:

(1)

$$TTS = \alpha_0 + \alpha_1 PRICE + \alpha_2 STRUCTURE4\_6 + \alpha_3 PRESALE2 + \alpha_4 POSTSALE + \alpha_5(HPI - 1.18) + \alpha_6 FLOOR + \alpha_7(AREA - 1{,}331) + \alpha_8(ROOMS - 4.5) + u_1$$

and

(2)

$$PRICE = \beta_0 + \beta_1 TTS + \beta_2 GREEN + \beta_3 PRESALE2 + \beta_4 POSTSALE + \beta_5(HPI - 1.18) + \beta_6 FLOOR + \beta_7(AREA - 1{,}331) + \beta_8(ROOMS - 4.5) + u_2$$

where *TTS* and *PRICE* are the endogenous unit time-to-sell and transaction price variables, respectively; $\alpha_0, \alpha_1, \ldots, \alpha_8$ and $\beta_0, \beta_1, \ldots, \beta_8$ are the structural parameters; and u_1 and u_2 are random disturbance terms. Also, the exogenous variables, exactly identifying equations (1) and (2), include a dummy variable that equals 1 for green units and zero otherwise (denoted by *GREEN*) and a dummy variable that equals 1 for structures 4 and 6 and zero otherwise (denoted by *STRUCT*4_6) (recall that structure 1 is the first-built green structure and 4 and 6 are the subsequently built green structures). [16] Other exogenous variables appearing in both equations include: *PRESALE*2 and *POSTSALE* (where *PRESALE*1 is the base category), controlling for the construction phase at which the transaction occurred; *HPI* (the housing price index, where *HPI*=1.18 is the sample mean); and *FLOOR*, *AREA* (*AREA*=1,331 is the sample mean), and *ROOMS* (*ROOMS*=4.5 is the sample mean)—controlling for the unit's physical amenities.[17]

[16] Importantly, as structure type (green and conventionally built) is unaffected by *TTS* and *PRICE*, the *STRUCT*4_6 and *GREEN* variables may properly serve as exogenous variables for identifying equations (1) and (2).

[17] We do not control for location in equations (1) and (2), since a major advantage of our test is that all six structures are located in close proximity to one another (see, once again, the map in Figure 1). In addition, we originally supplemented each of equations (1) and (2) with three dummy variables that

The reduced form solution of the model in equations (1) and (2) is given by:

(3)

$$TTS = \theta_0 + \theta_1 GREEN + \theta_2 STRUCT4\_6 + \theta_3 PRESALE2 + \theta_4 POSTSALE + \theta_5(HPI - 1.18) + \theta_6 FLOOR + \theta_7(AREA - 1{,}331) + \theta_8(ROOMS - 4.5) + u_1'$$

and

(4)

$$PRICE = \delta_0 + \delta_1 GREEN + \delta_2 STRUCT4\_6 + \delta_3 PRESALE2 + \delta_4 POSTSALE + \delta_5(HPI - 1.18) + \delta_6 FLOOR + \delta_7(AREA - 1{,}331) + \delta_8(ROOMS - 4.5) + u_2'$$

Note that under the formulation of the model, the constant terms θ_0 and δ_0 are, respectively, the projected TTS and price of an average (4.5-room, 1,331-square-foot) unit in a conventionally built structure (when the control for *HPI* is equal to 1.18). The coefficient on the variable *GREEN* (θ_1) in equation (3) represents the average difference in the projected TTS between the base category (conventionally built units) and the units in structure 1—the first-built green structure. Similarly, the coefficient on the variable *GREEN* (δ_1) in equation (4) represents the average difference in the projected price between the base category (conventionally built units) and the units in structure 1. Correspondingly, the coefficients of the variable *STRUCT*4_6 [θ_2 and δ_2 in equations (3) and (4), respectively] represent the difference (in the projected TTS and price, respectively) between the first-built green structure (structure 1) and subsequently built green structures (structures 4 and 6).

Finally, in order to compare only the units in the subsequently built green structures (structures 4 and 6) to the units in the conventional structures, we re-estimate equations (3) and (4) after omitting the observations of the first-built green structure

indicated the season (autumn, spring or summer, where winter served as the base category) at which the transaction has occurred. Estimated coefficients on these dummy variables, however, were statistically insignificant (results are not presented and available by request). We thus omitted these variables from the regressions.

from the sample and correspondingly omitting the variable *GREEN* from the right-hand side of the equations.[18]

Results

Table 7 presents the results obtained from the estimation of the model. Specifically, columns 1 and 2 report the estimated structural coefficients obtained via 3SLS methodology [estimating equations (1) and (2)]; columns 3 and 4 report the results from the estimation of the reduced form equations (3) and (4); and columns 5 and 6 report the results from re-estimating equations (3) and (4) while omitting the observations of the first-built green structure—focusing on the difference between units in the subsequently built green structures and those in the conventional structures.

Results demonstrate that, after controlling for unit price and physical amenities, as well as changes in the local price index, units in green structures (as compared to those in conventional structures) sell significantly faster on average. Specifically, it follows from columns (3) and (4) [columns (5) and (6)] that while the average TTS of a unit in the conventionally built structures is about 21 (18) months (significant at the 1%-level), the average TTS of a unit in structure 1 (the first-built green structure) and in structures 4 and 6 (the subsequently built green structures) is about 4.3 and 12.8 months shorter, respectively (both figures significant at the 1%-level). Moreover, green units sell on average at a greater or equal price. Thus, whereas the average projected price of units in a conventional structure is about \$307K–\$313K [columns (4) and (6), respectively], the average projected price of units in the first-built and subsequently built green structures is about \$14K and \$5K higher, respectively (significant at the 1%-level and insignificant, respectively).[19]

It is important to note that while the greater average price of units in green, as compared to conventional, structures represents a direct price premium, the decreased

[18] As shown in the results of the 3SLS estimation of equations (1) and (2) below, we cannot reject the no-endogeneity hypothesis between price (*PRICE*) and time-to-sell (*TTS*) (Chi-Square with 8 d.f. of the Wu Hausman generates *p*-value=0.43–0.51). We thus estimate equations (3) and (4) by OLS.

[19] The outcomes on the association between the first-built green structure (structure 1) and the TTS and price variables are seen via the coefficient on the variable *GREEN* in columns 3 and 4 of Table 7. Similarly, for the results on the association between the subsequently built green structures (structures 4 and 6) and the TTS and price variables, one should sum up the coefficients on *GREEN* and *STRUCT*4_6 in columns 1–4 in Table 7 or refer to the coefficient on *STRUCT*4_6 in columns 5 and 6 in the table. Finally, we should note that the outcomes in Table 7 are robust to the omission of the *PRESALE*2 and *POSTSALE* dummy variables from the estimation (the only change is in the constant term; results are available upon request).

TTS of those units (compared to the conventionally built ones) represents an indirect premium that stems from the savings in developers' financing costs. Table 8 shows the computation of the direct and indirect price premiums that associate with the sale of green units. The computation is based on the estimation outcomes reported in Table 7 and a conservative assumption of a 5% annual development financing cost. As indicated in the table, given the average projected price of units in the green structures, the decreased average TTS associated with those units (4.3–12.8 months) can be translated into about \$6K–\$17K financing cost saving, which is equivalent to an indirect price premium (over conventionally built units) of about 1.8%–5.3% (see section 2 of Table 8). Hence, accounting for both the direct (price) and indirect (TTS) premiums associated with green over conventional structures, the total benefit for the developer accrues to about \$17K–\$19K—which translates into a total green premium of about 5.3%–6.3% (see section 3 of Table 8).[20]

Furthermore, as expected, our results indicate a tradeoff between TTS and price. Specifically, note that when the indirect green price premium (associated with the shorter TTS) is high (about 5.3%), the direct price premium is statistically insignificant—see structures 4 and 6 in sections 1 and 2 of Table 8. In contrast, when the indirect price premium is relatively low (about 1.8% and statistically insignificant), the direct price premium is high (about 4.5%)—see structure 1 in sections 1 and 2 of Table 8.

Finally, referring once again to Table 7, the coefficients on the control variables in price equations (2) and (4) are significant with the expected signs.[21] In particular, the projected price rises by about \$1,014 with every additional month of TTS (significant at the 10%-level), whereas the projected TTS decreases by about 0.3 month for every \$1,000 increase in the price. Moreover, the results on the Wu Hausman test for the 3SLS procedure (see columns 1 and 2) reject the hypothesis of endogeneity between *TTS* and *PRICE* (*p*-value=0.43 and 0.51 for the *TTS* and *PRICE* equations).[22]

[20] Obviously, in order to compute the net benefit from green construction, one should deduct the additional associated construction costs (see, e.g., Miller, Spivey, and Florance, 2008).

[21] The only exception is the drop in the projected price of units sold in the post-sale compared to the presale periods. Note, however, that when stratified by green versus conventional structures, this drop becomes statistically insignificant for conventional structures.

[22] The positive (negative) correlation between *PRICE* and *TTS* in the TTS (price) equation is a common outcome of a 3SLS procedure. Note, however, that when we replace 3SLS with OLS, the coefficient of the price variable in the TTS equation becomes positive (4.39×10^{-6}) and statistically insignificant.

Robustness Tests

We assess the robustness of our findings on the association of units in green structures with a shorter TTS to issues of sampling and test design. Recall that we measure the TTS of each transaction by the elapsed time between its date of occurrence and the date of the first transaction in the respective building. That our sample of transactions includes at least one condominium unit per floor of each of the six examined structures supports the validity of our TTS measurement. However, to further gauge the sensitivity of our findings to the approach by which the variable *TTS* is computed, we re-estimate equations (3) and (4) by (*a*) chronologically ordering the transactions in each building (denoting the first transaction as 1 and the last as *N*); and (*b*) computing TTS_{ij} for each transaction *i* (*i*=*j*,…,*N*) by the elapsed time between its date of occurrence and the date of the *j*-th transaction (for *j*=2,3,4,5) within the respective building (thus generating four alternative TTS measures, one for each *j*, *j*=2,3,4,5). We then re-estimate equations (3) and (4) after substituting *TTS* with TTS_{ij}, *j*=2,3,4,5.[23] Finally, as before, we repeat the estimation of equations (3) and (4) (under these alternative specifications) after omitting the observations of the first-built green structure from the sample and correspondingly omitting the variable *GREEN* from the right-hand side of the equations.

Table 9 presents the results from re-estimating equations (3) and (4). Findings support our outcome on the shorter average TTS associated with green structures. Specifically, it follows that after controlling for unit price, physical amenities, and changes in the housing price index, the average TTS of units in green structures 4 and 6 and green structure 1 is shorter (as compared to units in the conventional structures) by about 8–12 and 2 months, respectively (coefficient on *STRUCTURE*4_6 and the sum of coefficients on *GREEN* and *STRUCTURE*4_6 are significant at the 1%-level under all specifications, and coefficient on *GREEN* is significant at the 10%-level under one specification and insignificant otherwise). This result maintains in Table 10, where we re-estimate equations (3) and (4) after omitting the observations of green structure 1 from the sample (again, coefficient on *STRUCTURE*4_6 is significant at the 1%-level under all specifications). Further, and consistent with previous results on the tradeoff

[23] Note that in the original estimation of equations (1)–(4), *TTS* is in fact equal to TTS_{ij} where *i*=1,...,*N* and *j*=1.

between *TTS* and *PRICE*, it follows from Table 9 that when the TTS difference between green and conventional units is small (i.e., there is a small *indirect* green price premium), the *direct* price premium rises (to about \$12K–\$13K; significant at the 1%-level—see the coefficient on *GREEN* when *PRICE* is the dependent variable under all specifications of Table 9).

The computations at the bottoms of Tables 9 and 10 present the direct and indirect green price premium rates that follow from re-estimating equations (3) and (4) and assuming a 5% annual developer financing cost. It follows that the average indirect premium (associated with a shorter TTS) of green over conventional units is equal to 3.1%–5.1%.[24]

5. GREEN VERSUS CONVENTIONAL HOUSING UNITS: WILLINGNESS TO PAY AND LIKELIHOOD OF PURCHASING

In the following analysis, we explore the correlation between household personal characteristics and the willingness to pay for housing units in green, as compared to conventional, structures.

The Model

Consider the following two models:

(5) $PRICE = \gamma_0' + X_1\phi_1' + X_2\phi_2' + \omega_1'$

and

(6) $GREEN = \gamma_0'' + X_1\phi_1'' + X_2\phi_2'' + \omega_1''$,

where *PRICE* and *GREEN* are the dependent variables; X_1 is a matrix of housing unit and market characteristics, $X_1 = [(HPI - 1.18); FLOOR; (AREA - 1{,}331); (ROOMS - 4.5)]$ (where the figures 1.18, 1,331, and 4.5 represent the green sample mean of *HPI*, *AREA*, and *ROOMS*, respectively—once again, see Table 4); X_2 is a matrix of household characteristics, X_2=[(*TOTAL_INC* − 44,176); (*AGE* − 38); *PERSONS*; *IMMIGRANT*; *FATHER_IM*; *MASTERS*; *STANDARD_CAR_GAS*; *VOTE*; *RIGHTWING*; *STANDARD_INTERVENE*; *SMOKE*; *EXERCISE*; and

[24] In addition, our results are generally robust to substituting *PRICE* in equation (2) with its logarithm term (results are available by request).

STANDARD_BMI] (where the figures 44,176 and 38 are the sample mean of *INCOME* and *AGE*, respectively—see Table 5); γ_0' and γ_0'' are constant terms, ϕ_1' and ϕ_1'' are column vectors of parameters corresponding to the matrix X_1 ($\phi_1'^T = [\gamma_1', \gamma_2', \gamma_3', \gamma_4']$ and $\phi_1''^T = [\gamma_1'', \gamma_2'', \gamma_3'', \gamma_4'']$); ϕ_2' and ϕ_2'' are column vectors of parameters corresponding to the matrix X_2 ($\phi_2'^T = [\gamma_5', \gamma_6', \dots, \gamma_{17}']$ and $\phi_2''^T = [\gamma_5'', \gamma_6'', \dots, \gamma_{17}'']$); and ω_1' and ω_1'' are random disturbance terms.

Equation (5) is a willingness to pay model in which our focus is on the correlation between household personal characteristics (the vector X_2) and transaction price of units in green (vs. conventional) structures. Importantly, as the estimation in Section 4 above shows that the hypothesis of endogeneity between *TTS* and *PRICE* is rejected, we omit *TTS* from the analysis of the willingness to pay in (5).[25] Also, equation (6) is a Probit model estimating of the marginal likelihood of occupying a unit in the green structure, given the conventional structure alternative.

Results

Table 11 presents regression outcomes from the estimation of equation (5) for the sample stratified by green and conventional structures. Column 1 (2) shows the results obtained from the estimation of the full model (step-wise regression) for the green unit subsample; column 3 (4) reports the results obtained from the estimation of the full model (step-wise regression) for the conventional unit subsample; and column 5 (6) computes the coefficient differences between the green and conventional units for the full model (step-wise regression) outcomes.

It follows that while the $12.5K average baseline price difference between green and conventional units is significant at the 10%-level (about $312K for green compared to $299K for conventional units), the difference in the WTP for unit physical characteristics between green and conventional structures is, generally, statistically insignificant. The only exception is the difference in the WTP for a higher floor, which is somewhat lower for green units (average of $4.9K and $6.1K for the green and conventional units, respectively; difference is significant at the 5%-level).

Interestingly, it further follows that, with the exception of the *INCOME* variable, there is an insignificant difference between green and conventional units in

[25] The omission of the TTS variable further allows us to include in this section households in units for which the *TTS* variable is unobservable.

the association between household characteristics and the WTP. Specifically, a $100K increase in household net income associates with an increase in the average WTP for a green unit of about $49K (significant at the 1%-level), compared to an insignificant association with the WTP for a conventional unit—the difference is significant at the 5%-level.[26]

Table 12 presents the outcomes from a Probit estimation of Equation (6). Columns 1 and 2 report on the marginal likelihood of occupying a unit in a green structure (given the alternative of a conventional structure) of the full and the step-wise regression, respectively. Consistent with the outcomes from the WTP approach of equation (5), the results of the Probit procedure show evidence that, with the exception of the *IMMIGRANT* and *PERSONS* variables, all personal characteristics insignificantly associate with the likelihood of purchasing green over conventional housing units. Specifically, an additional member in the household associates with a 23%–26% increase in the probability of occupying a green unit (significant at the 5%-level), while immigrant status associates with about a 21%–28% increase in the probability of occupying a green housing unit (significant at the 5%-level).

6. SUMMARY AND CONCLUSIONS

In this study, we explore the time-to-sell (TTS) of, and willingness to pay (WTP) for, newly developed green—as compared to conventional—condominiums. We find that after addressing the potential TTS-price endogeneity and controlling for physical characteristics, as well as changes in the local housing price index, average TTS of units in green structures is significantly shorter than that in conventional structures. The difference in TTS is equivalent to an average indirect green price premium of about 1.8%–5.3%. Moreover, we find a tradeoff between the green premiums associating with TTS and price: in cases where the indirect green price premium (associated with a shorter TTS) reaches about 5.3%, the direct price premium is statistically insignificant. However, when the indirect price premium is relatively low, the direct price premium reaches up to about 4.5%. Thus, considering both price and TTS, we estimate a total direct and indirect green price premium equal to roughly

[26] It further follows from Table 11 that one additional year in owner age associates with an increase in the average WTP for a conventional unit of about $720 (significant at the 5%-level) and that immigrants associate with a decrease in the WTP for a conventional unit by about $16K. However, the difference between green and conventional units in these correlations is statistically insignificant.

5.3%–6.3%. In contrast, however, we generally find an insignificant difference between green and conventionally built units in the correlation between household personal characteristics and the WTP. The results are robust to sampling and test design issues.

To the best of our knowledge, our research is the first to explore the TTS and WTP in the context of green real estate. Our outcomes on the shorter average TTS associated with green units and on the insignificant correlation between the WTP and household characteristics in green housing units may serve both entrepreneurs who consider the development of green structures and policymakers who wish to promote the sustainable development of green real estate.

REFERENCES

Bank of Israel. March 2013. Average Rate of Interest on Unindexed Mortgages.

Bank of Israel, Spokesman Press Announcement. August 2013. Questions and Answers of Instructions Draft about Limitations on Mortgage Loans. [in Hebrew]

Bank of Israel, Office of the Spokesperson and Economic Information. June 10, 2015. Press Release: Housing Loans Issued between 2010 and 2013—Analysis by Income Deciles and Geographic Regions: 1–9.

Bond, Shaun A., and Avis Devine. 2016. Certification Matters: Is Green Talk Cheap Talk? *The Journal of Real Estate Finance and Economics*, 52 (2): 117–140.

Brastow, Raymond T.; Springer, Thomas M.; and Waller, Bennie D. 2012. Efficiency and Incentives in Residential Brokerage. *Journal of Real Estate Finance and Economics*, 45: 1041–1061.

Brounen, Dirk, and Kok, Nils. 2011. On the Economics of Energy Labels in the Housing Market. *Journal of Environmental Economics and Management*, 62 (2): 166–179.

Chen, Jun, and Rutherford, Ronald C. 2012. Quality and Time-on-the-Market in Residential Markets. *Journal of Real Estate Finance and Economics*, 44: 414–428.

Deng, Yongheng; Li, Zhiliang; and Quigley, John. 2012. Economic Returns to Energy-Efficient Investments in the Housing Market: Evidence from Singapore. *Regional Science and Urban Economics*, 42 (3): 506–515.

Deng, Yongheng, and Wu, Jing. 2014. Economic Returns to Residential Green Building Investment: The Developers' Perspective. *Regional Science and Urban Economics*, 47: 35-44.

Eichholtz, Piet; Kok, Nils; and Quigley, John. 2010. Doing Well by Doing Good? Green Office Buildings. *American Economic Review*, 100: 2494–2511.

Eichholtz, Piet; Kok, Nils; and Quigley, John. 2013. The Economics of Green Building. *Review of Economics and Statistics*, 95 (1): 50–63.

Eichholtz P., Kok N., Yonder E. 2012. Portfolio Greenness and the Financial Performance of REITs. *Journal of International Money and Finance*, 31:1911–1929.

Fuerst, Franz, and McAllister, Patrick. 2011a. Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values. *Real Estate Economics*, 39 (1): 45–69.

Fuerst, Franz, and McAllister, Patrick. 2011b. An Investigation of the Effect of Eco-labeling on Office Occupancy Rates. *Journal of Sustainable Real Estate*, 1 (1): 49–64.

Haurin, Donald. 1988. The Duration of Marketing Time of Residential Housing. *AREUEA Journal*, 16 (4): 396–410.

Israel Central Bureau of Statistics. October 2015. Households Income and Expenses: Data from Households Expenditure Survey 2013: General Summaries, publication number 1613: Table 4, p. 83; Table 6, p. 93.

Israel Central Bureau of Statistics. 2015. Statistical Abstract of Israel, Table 12.36: Employee Jobs, Wages, and Average Wages per Employee Job, at: http://www.cbs.gov.il/shnaton66/st12_36.pdf

Israeli Council for Green Construction. July 2011. Israeli Standard 5281, Part 2: Sustainable Building ("Green Building") Requirements for Residence Structures, General Guide: 1–48. [in Hebrew]

Kahn, Matthew, and Kok, Nils, 2014. The Capitalization of Green Labels in the California Residential Housing Market. *Regional Science and Urban Economics*, 47: 24-34.

McGrath, Karen M. 2013. The Effects of Eco-Certification on Office Properties: A Cap Rates-Based Analysis. *Journal of Property Research*, 30 (4): 345–365.

Miller, Norm; Spivey, Jay; and Florance, Andrew. 2008. Does Green Pay Off? *Journal of Real Estate Portfolio Management*, 14 (4): 385–399.

Ministry of Construction, Announcement of the Spokesman. 2012. at: http://www.moch.gov.il/spokesman/pages/doverlistitem.aspx?listid=5b390c93-15b2-4841-87e3-abf31c1af63d&webid=fe384cf7-21cd-49eb-8bbb-71ed64f47de0&itemid=393 [in Hebrew]

Roe B.; Teisl, M.F.; Levy, A.; and Russell, M. 2000. U.S. Consumers' Willingness to Pay for Green Electricity. *Energy Policy*, 29: 917–925.

Smith, Patrick S.; Gibler, Karen M; and Zahirovic-Herbert, Velma, 2016. The Effect of Relisting on House Selling Price. *Journal of Real Estate Finance and Economics*, 52: 176–195.

Tsen, C.H.; Phang, G.; Hasan, H.; and Buncha, M.R. 2006. Going Green: A Study of Consumers' Willingness to Pay for Green Products in Kota Kinabalu. *International Journal of Business and Society*, 7 (2): 40–54.

Zheng, Siqi; Jing, Wu; Kahn, Matthew; and Deng, Yongheng. 2012. The Nascent Market for "Green" Real Estate in Beijing. *European Economic Review*, 56 (5): 974–984.

Table 1: Criteria for Rating the Building as Green by the Israeli Standard

Subject	Typical Characteristics	Maximal Points
Energy	Energetic performance of building: bio-climatic design; natural cooling and heating; energy ranking of the building; natural lighting. Systems: Lighting; Renewed energy; Water heating; Air conditioning; Elevators; Consumption control	29
Soil	Site choice; Polluted soils and sites; Density and development of structures; Reducing the urban-heating phenomena; Site ecology	19
Water	Saving clean running water consumed at the building; Saving water consumed for gardening; Consumption control; Sustainable drainage system	17
Estimator's Assessment		8
Air quality	Winds around the buildings; Visual comfort; Fresh air; Thermal comfort; Volatile organic compounds; Acoustics	7
Management	Management of building site; Management of building	7
Waste	Domestic garbage management and separation of garbage	4
Noise	Prevention of noise penetration between walls. Standing in a low specific noise rate in the living rooms	4
Radiation	Building Materials exhibit the Israeli 5098 standard and the building is checked for radiation, where the latter is lower than the standard	3
Transportation	Alternative transportation; Parking and Bicycle facilities	1
Materials	Standardized green materials; Recycled materials; Local materials; Responsible outsourcing (suppliers with green, safe, and social certificates)	1
Total		100

Notes: Source: The Israeli Council for Green Construction, Israeli Standard 5281, Part 2: Sustainable Building ("Green Building"), November 2005 (in Hebrew). The scale of grading is 0–100 points, where the green certificate includes two categories: pass (55–74 points) and excellent (75–100 points).

Figure 1: Map of the Geographical Area where the Green and Conventional Structures Are Located

Notes: Source: Google Map. Structures 1, 2, and 3 (4, 5, and 6) are green (conventionally built). All structures are located on Alonim Street.

Table 2: Date of Construction Permit Issuance and Completion by Structures

Structure	Type	Date of Issuance of Construction Permit	Date of Completion	obs.
1	Green	October 2009	December 2011	39
2	Conventional	March 2009	January 2012	24
3	Conventional	March 2009	January 2012	39
4	Green	February 2010	March 2012	27
5	Conventional	August 2010	August 2012	30
6	Green	February 2010	April 2013	31
			Total	190

Table 3: Summary Statistics

Variable	Definition	Obs.	Mean	STD.	Min	Max
PRICE	The non-deflated price of the dwelling unit converted to U.S. dollars	190	346,289	48,552	258,000	524,250
TTS	Number of months from the first purchase in the building to the exercise of the current purchase	190	16.69	12.52	0	50
*STRUCTURE*1	1=Green Construction 0=Standard Construction	190	0.51	0.50	0	1
*PRESALE*1	1=presale transaction prior to the issue of the housing permit 0=otherwise	17	0.09	0.29	0	1
*PRESALE*2	1= transaction after issuance of the housing permit, but prior to full completion of the structure; 0=otherwise	142	0.75	0.44	0	1
POSTSALE	1= transaction after full completion of the structure; 0=otherwise	31	0.16	0.37	0	1
*PRESALE*1 × *PRICE (PRICE>0)*	Prices of units sold in presale transaction	17	316,820	36,821	267,750	425,500
*PRESALE*2 × *PRICE (PRICE>0)*	Prices of units sold during construction but prior to full completion of the structure	142	340,739	45,946	258,000	524,250
POSTSALE × *PRICE (PRICE>0)*	Prices of units sold after full completion of the structure	31	387,874	42,208	323,620	471,249
HPI	Housing price index reflecting 1+the rate of increase in current new dwelling units in Netanya	190	1.14	0.11	0.97	1.41
ROOMS	Number of rooms	190	4.47	0.46	4	5
FLOOR	The floor on which the unit is located	190	9.59	5.37	1	22.00
AREA	The area of the dwelling unit measured in square feet	190	1340	104	1076	1669
OWNER	1=owner-occupiers 0=renters	151	74.8%	43.5%	0	1

Notes: Summary statistics refer to the (first) purchase of 190 newly developed condominiums. Construction of green structures completed in 2009–2010. Time-to-sell (*TTS*) is computed from the first date of purchase in the second quartile of 2009 (*TTS*=0). Last purchase completed in the third quartile of 2014 (*TTS*=60).97 (93) units are located in the green (conventional) structures. All nominal figures are converted from New Israeli Shekels to U.S. dollars (1 NIS ≈ $0.25).

Table 4: Summary Statistics—Stratified by Green and Conventional Structures

Variable	Definition	Obs.	GREEN	CONVENTIONAL
PRICE	The nominal price of the dwelling unit converted to U.S. dollars	190	359,418	332,596
TTS	Number of months from the first sale transaction in the building to the exercise of the current transaction	190	16.94	16.43
GREEN	1=Green Construction 0=Standard Construction	190	1.00	0.00
*PRESALE*1	1=presale transactions prior to the issuance of the housing permit 0=otherwise	190	0.11	0.06
*PRESALE*2	1= transactions after issuing the housing permit, but prior to full completion of the structure; 0=otherwise	190	0.64	0.86
POSTSALE	1= transaction after full completion of the structure; 0=otherwise	190	0.25	0.08
*PRESALE*1 × *PRICE (PRICE>0)*	Prices of units sold in presale transactions	17	319,239	312,384
*PRESALE*2 × *PRICE (PRICE>0)*	Prices of units sold during construction but prior to full completion of the structure	142	357,418	327,813
POSTSALE × *PRICE (PRICE>0)*	Prices of units sold after full completion of the structure	31	383,001	404,584
HPI	Housing price index reflecting 1+the rate of increase in current new dwelling units in the city of Netanya	190	1.18	1.09
ROOMS	Number of rooms	190	4.58	4.37
FLOOR	The floor on which the unit is located	190	9.57	9.61
AREA	The area of the dwelling unit measured in square feet	190	1,331	1,351
OWNER	1=owner-occupiers 0=renters	151	76.3%	72.2%
Observations			97	93

Notes: Summary statistics refer to the 190 newly developed condominiums—of which 97 (93) units are located in green (conventional) structures. Construction of green structures completed in 2009–2010. Time-to-sell (*TTS*) of green units computed from the date of the first transaction in the second quartile of 2009 (*TTS*=0). Last purchase completed in the third quartile of 2014 (*TTS*=60). All nominal figures are converted from New Israeli shekels (NIS) to U.S. dollars (1 NIS ≈ $0.25).

Table 5: Summary Statistics—Owner-Occupied Households

A. Dwelling Unit and Structure Characteristics

Variable	Definition	Obs.	Mean	STD.	Min	Max
PRICE	The non-deflated price of the dwelling unit converted to U.S. dollars	113	360,751	42,182	291,037	471,249
TTS	Number of months from the first purchase in the building to the exercise of the current purchase	113	20.5	13.2	0	50
HPI	Housing price index reflecting 1+the average rate of increase in current new dwelling units in Netanya	113	1.2	0.1	1	1.4
ROOMS	Number of rooms	113	4.5	0.5	4	5
FLOOR	The floor on which the unit is located	113	10.3	5.6	1	19
AREA	The area of the dwelling unit measured in square feet	113	1,333	105	1,076	1,528
GREEN	1=Green Construction 0=Standard Construction	113	0.65	0.48	0	1

Table 5: Summary Statistics of Owner-Occupied Households (continued)

B. Socio-Demographic and Other Personal Owner-Occupier Characteristics

Variable	Definition	Obs.	Mean	STD.	Min	Max
EMPLOYEE	1=employee; 0=otherwise	113	73.5%	44.4%	0	1
SELF_EMPLOYED	1=self-employed; 0=otherwise	113	18.6%	39.1%	0	1
OTHER	1=either unemployed, a student without a job, or a retiree; 0=otherwise	113	8.0%	27.2%	0	1
INCOME	Net income from all sources	113	44,176	16,393	6,000	84,000
PERSONS	Number of persons living in the housing unit	113	3.7	1.0	1	5
AGE	The age of the tenant	113	38.2	10.4	25	75
WOMEN	1=women; 0=men	113	54.9%	50.0%	0	1
IMMIGRANT	1= place of birth outside Israel; 0=otherwise (place of birth in Israel)	113	20.4%	40.4%	0	1
FATHER_IM	1= father's place of birth outside Israel; 0=otherwise	113	60.2%	49.2%	0	1
MASTERS	1= holds either MA or Ph.D. degrees; 0=otherwise	113	31.0%	46.4%	0	1
CAR_GAS	Weekly expenses of car gasoline (in U.S. dollars)	113	74.3	47.7	0	250
STANDARD_CAR_GAS	$\frac{CAR\_GAS - Min(CAR\_GAS)}{Max(CAR\_GAS) - Min(CAR\_GAS)}$	113	29.7%	19.1%	0	1
VOTE	1=Participates in municipal elections; 0=otherwise	113	77.9%	41.7%	0	1
RIGHTWING	1=holds conservative views on security and foreign policy issues; 0=otherwise	113	54.0%	50.1%	0	1
INTERVENE	A measure for the desired degree of government intervention on a scale of 0 (maximal intervention level) to 1 (free market with minimal intervention level)	113	40.2%	29.4%	0	1
SMOKE	1=smoker; 0=otherwise	113	15.9%	36.8%	0	1
EXERCISE	Number of hours devoted to physical exercise per week	113	3.0	3.9	0	30
BMI	The ratio between weight (kg.) and squared height (meters)	113	24.5	3.5	18.0	35.7
STANDARD_BMI	$\frac{BMI - Min(BMI)}{Max(BMI) - Min(BMI)}$	113	32.9%	15.8%	0.04	0.83

Note: Summary statistics refer to the 113 newly developed owner-occupied condominiums, of which 74 (39) units are located in green (conventional) structures.

Table 6: Summary Statistics of Owner-Occupied Households—Stratified by Green and Conventional Structures

A. Dwelling Unit and Structure Characteristics

Variable	Definition	Obs.	GREEN	CONVENTIONAL
PRICE	The non-deflated price of the dwelling unit converted to U.S. dollars	113	360,541	361,148
TTS	Number of months from the first purchase in the building to the exercise of the current purchase	113	18.4	24.3
HPI	Housing price index reflecting 1+the average rate of increase in current new dwelling units in Netanya	113	1.19	1.16
ROOMS	Number of rooms	113	4.55	4.53
FLOOR	The floor on which the unit is located	113	9.72	11.26
AREA	The area of the dwelling unit measured in sq. feet	113	1,328	1,343
GREEN	1=Green Construction 0=Standard Construction	113	1.00	0.00

Table 6: Summary Statistics of Owner-Occupied Households—Stratified by Green and Conventional Structures (continue)

B. Socio-Demographic and Preferences of Owner-Occupiers

Variable	Definition	Obs.	GREEN	CONVENTIONAL
EMPLOYEE	1=employee; 0=otherwise	113	74.32%	71.79%
SELF_EMPLOYED	1=self-employed; 0=otherwise	113	17.57%	20.51%
OTHER	1=either unemployed, a student without a job, or a retiree; 0=otherwise	113	8.11%	7.69%
INCOME	Net income from all sources	113	41,432	49,384
PERSONS	Number of persons living in the housing unit	113	3.64	3.72
AGE	The age of the tenant	113	38.46	37.74
WOMEN	1=women; 0=men	113	60.81%	43.59%
IMMIGRANT	1= place of birth outside Israel; 0=otherwise (place of birth in Israel)	113	22.97%	15.38%
FATHER_IM	1= father's place of birth outside Israel; 0=otherwise	113	59.46%	61.54%
MASTERS	1= holds either MA or Ph.D. degrees; 0=otherwise	113	35.14%	23.08%
CAR_GAS	Weekly expenses of car gasoline (in U.S. dollars)	113	67.57	87.18
STANDARD_CAR_GAS	$\frac{CAR\_GAS - Min(CAR\_GAS)}{Max(CAR\_GAS) - Min(CAR\_GAS)}$	113	27.03%	34.87%
VOTE	1=Participates in municipal elections; 0=otherwise	113	78.38%	76.92%
RIGHTWING	1= holds conservative views on security and foreign issues; 0=otherwise	113	63.52%	35.90%
STANDARD_INTERVENE	A measure for the desired degree of government market intervention on a scale of 0 (maximal intervention) to 1 (minimal intervention)	113	40.54%	39.74%
SMOKE	1=smoker; 0=otherwise	113	13.51%	20.51%
EXERCISE	Number of hours devoted to physical exercise per week	113	2.81	3.26
BMI	The ratio between weight (kg.) and squared height (meters)	113	24.63	24.27
STANDARD_BMI	$\frac{BMI - Min(BMI)}{Max(BMI) - Min(BMI)}$	113	33.44%	31.81%
Observations			74	39

Note: Summary statistics refer to the 113 newly developed owner-occupied condominiums, of which 74 (39) units are located in green (conventional) structures.

Table 7: Simultaneous Equation Model with Time-to-Sell and Price

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TTS*	*PRICE*	*TTS*	*PRICE*	*TTS*	*PRICE*
Constant	116.93***	286,077***	20.62***	307,389.95***	17.62***	313,456.78***
	(38.55)	(13,037.77)	(1.79)	(6,599.38)	(2.50)	(9,255.70)
GREEN	–	18,232***	-4.34***	13,830.56***	–	–
	–	(5,683.67)	(1.08)	(3,985.86)	–	–
*STRUCT*4_6	-10.90***	–	-8.27***	-8,393.56*	-12.79***	4,526.10
	(1.61)	–	(1.26)	(4,658.74)	(1.18)	(4,363.98)
*PRESALE*2	3.82	-5,407.04	4.19***	-1,157.08	7.11***	-5,320.29
	(2.41)	(5,383.98)	(1.52)	(5,601.46)	(2.31)	(8,561.43)
POSTSALE	6.81	-31,176.5***	12.58***	-18,408.35**	13.14***	-23,446.14**
	(4.22)	(9,627.54)	(2.11)	(7,792.61)	(2.87)	(10,614.12)
(*HPI*–1.18)	156.14***	88,731.61*	97.34***	187,526.39***	101.84***	201,184.97***
	(24.48)	(49,707.91)	(5.36)	(19,807.88)	(6.21)	(22,993.53)
FLOOR	1.51**	4,890.05***	-0.02	4,869.70***	0.06	4,739.86***
	(0.62)	(373.42)	(0.10)	(380.94)	(0.12)	(429.16)
(*AREA*–1,331)	0.01	64.88***	-0.01	58.48***	-0.01	69.25***
	(0.01)	(20.59)	(0.01)	(20.11)	(0.01)	(25.11)
(*ROOMS*–4.5)	10.67**	27,722.8***	1.50	29,244.40***	0.59	28,213.39***
	(4.31)	(4,117.96)	(1.10)	(4,074.33)	(1.48)	(5,474.29)
Proj(*PRICE*)	-3.14×10^{-4}**	–	–	–	–	–
	(0.00)	–	–	–	–	–
Proj(*TTS*)	–	1,014.94*	–	–	–	–
	–	(556.30)	–	–	–	–
Method	3SLS	3SLS	ILS	ILS	OLS	OLS
Wu Hausman Test: Calculated Chi-Square with 8 d.f.	6.96 (p-value = 0.43)	7.21 (p-value = 0.51)	–	–	–	–
coef(*GREEN*)+ coef(*STRUCT*4_6)	–	–	–12.61*** (p-value = 0.00%)	5,437.00 (p-value = 17.70%)	–	–
Excluded Group	None	None	None	None	STRUCT1	STRUCT1
Observations	190	190	190	190	151	151
R-squared	0.58	0.85	0.84	0.85	0.82	0.84

Notes: The structural model includes two equations and consists of two endogenous variables [*TTS* (in months), and *PRICE*] and 6 exogenous variables [*GREEN*, *STRUCTURE*4_6, (*HPI*–1.18), *FLOOR*, (*AREA*–1,331), (*ROOMS*–4.5)]. The model is estimated by 3SLS and ILS methodologies. Columns 1 and 2 report the estimated structural coefficients obtained via the 3SLS methodology. Columns 3 and 4 report the estimated coefficients of the solution equations (reduced form). Columns 5 and 6 report the estimated coefficients after excluding the units in structure 1—the first-built green structure—from the sample. Numbers in parentheses are standard errors. * significant at the 10%-level. ** significant at the 5%-level. *** significant at the 1%-level.

Table 8: Computing the Direct and Indirect Green Price Premiums Based on the Estimation Outcomes in Table 7 and a 5% Developer Annual Financing Cost.

(1) Direct Green Price Premium

Based on Estimation in columns:	(3)-(4)	(3)-(4)	(5)-(6)
Green Structure	Structure 1	Structures 4 and 6	Structures 4 and 6
Direct Green Price Premium ($) ÷ Projected Price of Conventional Units (Constant term)	13,831 ÷ 307,389.95	0 ÷ 307,389.95	0 ÷ 313,456.78
Direct Green Price Premium (%)	4.50%	0.00%	0.00%

(2) Indirect Green Price Premium

Based on Estimation in columns:	(3)-(4)	(3)-(4)	(5)-(6)
Green Structure	Structure 1	Structures 4 and 6	Structures 4 and 6
Projected Price of Conventional Units (constant term) × 5% Financing Cost × TTS (years)	307,390 × 0.05 × (4.34/12) = 5,559	307,390 × 0.05 × (12.61/12) =16,151	313,457 × 0.05 × (12.79/12) =16,704
Indirect Green Price Premium ($) ÷ Projected Price of Conventional Units (constant term)	5,559 ÷ 307,389.95	16,151 ÷ 307,389.95	16,704 ÷ 313,456.78
Indirect Green Price Premium (%)	1.81%	5.25%	5.33%

(3) Total Green Price Premium

Based on Estimation in columns:	(3)-(4)	(3)-(4)	(5)-(6)
VARIABLES	*STRUCT*1	*STRUCT*4_6	*STRUCT*4_6
Direct Green Price Premium ($) Indirect Green Price Premium ($)	13,831 5,559	0 16,151	0 16,705
Total Green Price Premium ($) ÷ Projected Price of Conventional Units (constant term)	(13,831+5,559) ÷ 307,390	16,151 ÷ 307,390	16,705 ÷ 313,457
Total Green Price Premium (%)	6.31%	5.25%	5.33%

Table 9: Robustness Test—Various Computations of the TTS Variable (All Observations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	*TTS*	*PRICE*	*TTS*	*PRICE*	*TTS*	*PRICE*	*TTS*	*PRICE*
Constant	15.74***	306,988***	8.68***	307,798***	5.50*	304,106***	24.03***	298,039.30***
	(1.94)	(7,211)	(2.34)	(8,557)	(2.92)	(10,575)	(2.37)	(7,152.94)
GREEN	-2.00*	13,201***	0.41	11,842***	0.39	11,186**	-0.98	12,333.73***
	(1.11)	(4,122)	(1.15)	(4,207)	(1.20)	(4,334)	(1.33)	(4,015.75)
*STRUCT*4_6	-9.94***	-8,631*	-9.06***	-8,995*	-7.86***	-8,732*	-10.00***	-11,290.60**
	(1.30)	(4,849)	(1.36)	(4,991)	(1.42)	(5,151)	(1.56)	(4,706.16)
*PRESALE*2	4.25**	-1,144	7.55***	-2,925	9.26***	1,728	-11.05***	11,728.19**
	(1.69)	(6,294)	(2.12)	(7,783)	(2.76)	(9,993)	(1.56)	(4,701.17)
POSTSALE	12.78***	-18,466**	17.33***	-19,686**	19.19***	-12,999	–	–
	(2.24)	(8,339)	(2.56)	(9,389)	(3.10)	(11,216)	–	–
(*HPI*–1.18)	90.54***	189,851***	75.71***	183,303***	70.07***	167,436***	55.06***	165,925.12***
	(5.47)	(20,341)	(5.73)	(21,007)	(6.22)	(22,482)	(7.04)	(21,227.11)
FLOOR	0.08	4,904***	0.04	5,059***	0.05	4,984***	0.06	4,565.42***
	(0.11)	(400)	(0.11)	(412)	(0.12)	(426)	(0.13)	(406.41)
(AREA–1,331)	-0.01*	56.33***	-0.00	56.57***	-0.00	64.03***	-0.00	53.88***
	(0.01)	(20.56)	(0.01)	(20.73)	(0.01)	(21.51)	(0.01)	(19.72)
(ROOMS–4.5)	1.76	29,131***	0.49	28,606***	0.07	27,352***	0.53	28,466.38***
	(1.14)	(4,253.88)	(1.20)	(4,404)	(1.27)	(4,576)	(1.40)	(4,228.56)
Method	ILS	ILS	ILS	ILS	ILS	ILS	ILS	ILS
Excluded Group	None	None	None	None	None	None	None	None
Excluded Trans.	1st	1st	1st-2nd	1st-2nd	1st-3rd	1st-3rd	1st-4th	1st-4th
coef(*GREEN*)+ coef(*STRUCT*4_6)	–11.95***	4,569.17	–8.65***	2,846.20	–7.46***	2,454.17	–10.98***	1,043.13
Observations	183	183	166	166	151	151	135	135
R-squared	0.82	0.85	0.79	0.85	0.77	0.84	0.69	0.86

Green Structure 1	(2)	(4)	(6)	(8)
Direct Green Price Premium:				
Price Premium ($)	13,201	11,842	11,186	12,334
÷ Projected Price of Conventional Units	÷ 306,988	÷ 307,798	÷ 304,106	÷ 298,039
= Direct Green Price Premium Rate (%)	=4.12%	=3.85%	=3.68%	=4.14%

Green Structures 4 and 6	(2)	(4)	(6)	(8)
Indirect Green Price Premium:				
Projected Price of Conventional Units (constant term)	306,988	307,798	304,106	298,039.30
× 5% Financing Cost × TTS (years)	× 0.05 × (11.95/12)	× 0.05 × (8.65/12)	× 0.05 × (7.46/12)	× 0.05 × (10.98/12)
=Indirect Green Price Premium ($)	=15,285	=11,094	=9,453	=13,635
Indirect Green Price Premium ($)	15,285	11,094	9,453	13,635
÷ Projected Price of Conventional Units ($)	÷ 306,988	÷ 307,798	÷ 304,106	÷ 298,039
=Indirect Green Price Premium (%)	=4.98%	=3.60%	=3.11%	=4.58%

Notes: Standard errors are given in parentheses. * significant at the 10%-level. ** significant at the 5%-level. *** significant at the 1%-level.

Table 10: Robustness Test: Varying the Computation of TTS (Omitting Observations of Structure 1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	*TTS*	*PRICE*	*TTS*	*PRICE*	*TTS*	*PRICE*	*TTS*	*PRICE*
Constant	11.69***	317,189***	3.37	322,068***	0.18	317,554***	22.07***	301,110***
	(2.91)	(10,875)	(3.30)	(12,163)	(4.10)	(14,983)	(2.79)	(8,317)
*STRUCT*4_6	-12.13***	3,804	-8.59***	2,181	-7.10***	1,516	-10.16***	-441
	(1.22)	(4,545)	(1.27)	(4,685)	(1.32)	(4,844)	(1.47)	(4,363)
*PRESALE*2	8.17***	-9,367	12.64***	-15,206	14.10***	-9,239	-9.36***	11,352**
	(2.81)	(10,475)	(3.20)	(11,799)	(3.97)	(14,512)	(1.93)	(5,750)
POSTSALE	14.26***	-27,022**	19.90***	-31,814**	21.48***	-23,650	–	–
	(3.25)	(12,128)	(3.55)	(13,096)	(4.21)	(15,413)	–	–
(*HPI*–1.18)	94.74***	201,576***	79.17***	194,487***	71.33***	181,188***	50.82***	180,333***
	(6.39)	(23,826)	(6.61)	(24,371)	(7.12)	(26,037)	(8.12)	(24,187)
FLOOR	0.17	4,732***	0.13	4,861***	0.15	4,744***	0.09	4,347***
	(0.12)	(450)	(0.12)	(454)	(0.13)	(473)	(0.15)	(446)
(*AREA*–1,331)	-0.01*	66.66***	-0.01	69.03***	-0.01	79.31***	-0.01	63.33***
	(0.01)	(25.69)	(0.01)	(25.44)	(0.01)	(26.45)	(0.01)	(24.05)
(*ROOMS*–4.5)	1.08	28,569***	-0.66	28,037***	-0.92	26,135***	0.31	27,483***
	(1.54)	(5,757)	(1.60)	(5,889)	(1.67)	(6,126)	(1.88)	(5,604)
Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Omitted Group	STRUCT1	STRUCT1	STRUCT1	STRUCT1	STRUCT1	STRUCT1	STRUCT1	STRUCT1
Excluded Transaction	1st	1st	1st-2nd	1st-2nd	1st-3rd	1st-3rd	1st-4th	1st-4th
Observations	146	146	134	134	121	121	107	107
R-squared	0.80	0.84	0.77	0.85	0.74	0.84	0.62	0.85

Green Structures 4 and 6	(2)	(4)	(6)	(8)
Indirect Green Price Premium:				
Projected Price of Conventional Units (constant term)	317,189	322,068	317,554	301,110
× 5% Financing Cost × TTS (years)	× 0.05 × (12.13/12)	× 0.05 × (8.59/12)	× 0.05 × (7.10/12)	× 0.05 × (10.16/12)
=Indirect Green Price Premium ($)	=16,031	=11,527	=9,394	12,747
Indirect Green Price Premium ($)	16,031	11,527	9,394	12,747
÷ Projected Price of Conventional Units ($)	÷ 317,189	÷ 322,068	÷ 317,554	÷ 301,110
=Indirect Green Price Premium (%)	5.05%	3.58%	2.96%	4.23%

Notes: Standard errors are given in parentheses * significant at the 10%-level. ** significant at the 5%-level. *** significant at the 1%-level.

Table 11: Estimation Results of the Willingness to Pay for Green vs. Conventional Housing Unit

TYPE	GREEN		CONVENTIONAL		GREEN – CONV	
Model:	full	Step-wise	full	Step-wise	full	Step-wise
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	PRICE	PRICE	PRICE	PRICE	Diff	Diff
Constant	309,785***	311,676***	329,554***	299,088***	-19,769	12,588*
	(13,177)	(4,086)	(25,519)	(5,917)	(27,046)	(7,048)
(*HPI*–1.18)	84,369***	93,644***	141,315***	125,062***	-56,945	-31,418
	(24,765)	(20,531)	(42,990)	(28,405)	(46,969)	(34,400)
FLOOR	4,963***	4,944***	4,278***	6,129***	684	-1,184**
	(457)	(386)	(1,303)	(466)	(1,283)	(596)
(*AREA*–1,331)	92***	79***	92	–	0	–
	(30)	(26)	(73)	–	(73)	–
(*ROOMS*–4.5)	23,131***	25,949***	12,584	–	10,547	–
	(6,854)	(5,254)	(15,520)	–	(15,872)	–
(*INCOME*–44,176)	0.49***	0.49***	-0.23	–	0.72**	–
	(0.12)	(0.11)	(0.27)	–	(0.28)	–
PERSONS	-1,700	–	-5,730	–	4,030	–
	(4,008)	–	(7,198)	–	(7,786)	–
(*AGE*–38)	57	–	599	719**	-542	–
	(241)	–	(469)	(321)	(497)	–
IMMIGRANT	-1,840	–	-5,760	-16,382**	3,920	–
	(4,743)	–	(9,569)	(6,231)	(10,039)	–
FATHER_IM	7,876	–	5,214	–	2,661	–
	(6,298)	–	(12,704)	–	(13,328)	–
MASTERS	-930	–	-175	–	-755	–
	(5,072)	–	(9,039)	–	(9,800)	–
STANDARD_CAR_GAS	-293	–	723	–	-1,016	–
	(2,310)	–	(3,231)	–	(3,805)	–
VOTE	-1,296	–	-9,925	–	8,629	–
	(12,888)	–	(17,484)	–	(20,849)	–
RIGHTWING	4,374	–	636	–	3,738	–
	(6,871)	–	(12,519)	–	(13,487)	–
INTERVENE	7,308	–	-5,126	–	12,435	–
	(4,902)	–	(8,675)	–	(9,424)	–
SMOKE	6,408	–	-5,533	–	11,941	–
	(5,785)	–	(8,457)	–	(9,792)	–
EXERCISE	-170	–	-1,932	–	1,762	–
	(458)	–	(1,449)	–	(1,407)	–
STANDARD_BMI	-11,900	–	4,664	–	-16,565	–
	(14,589)	–	(28,066)	–	(29,797)	–
Observations	74	74	39	39	–	–
R-squared	0.89	0.88	0.92	0.89	–	–
F-Statistic	27.19***	98.50***	13.84***	70.43***	–	–
Average VIF	1.86	1.76	2.87	1.12	–	–

Notes: Low collinearity is implied by Average VIF below 10. Robust standard errors are given in parentheses. * significant at the 10%-level. ** significant at the 5%-level. *** significant at the 1%-level.

Table 12: Likelihood of Purchasing Green and Conventional Housing Units

	Full	Step-wise
	(1)	(2)
VARIABLES	GREEN	GREEN
Constant	0.85***	0.70***
	(0.21)	(0.11)
100×(*HPI*–1.18)	0.02**	0.01***
	(0.01)	(0.01)
FLOOR	-0.02**	-0.02**
	(0.01)	(0.01)
(*AREA*–1,331)	-0.00	–
	(0.00)	–
(*ROOMS*–4.5)	0.20	–
	(0.18)	–
(*INCOME*–44,176)	-0.00	–
	(0.00)	–
PERSONS	0.23**	0.26***
	(0.10)	(0.09)
(*AGE*–38)	0.00	–
	(0.01)	–
IMMIGRANT	0.28***	0.21**
	(0.10)	(0.09)
FATHER_IM	0.14	–
	(0.12)	–
MASTERS	-0.15	–
	(0.12)	–
STANDARD_CAR_GAS	0.02	–
	(0.05)	–
INTERVENE	-0.46	–
	(0.30)	–
VOTE	0.01	–
	(0.19)	–
CONSERVATIVE	-0.11	–
	(0.11)	–
SMOKE	-0.24	–
	(0.15)	–
EXERCISE	-0.01	–
	(0.01)	–
STANDARD_BMI	0.37	–
	(0.37)	–
Observations	113	113
Pseudo R-Squared	0.23	0.14
Wald Chi-Squared	33.96***	20.53***

Notes: The table displays the outcomes obtained from the Probit model in terms of marginal probabilities. Standard errors are given in parentheses. * significantly different from zero at the 10% significance level. ** significantly different from zero at the 5% significance level. *** significantly different from zero at the 1% significance level.

Appendix: Pearson Correlation Matrix between Household Characteristics

	TOTAL_INC	*RIGHTWING*	*AGE*	*MASTERS*	*IMMIGRANT*	*FATHER_IM*	*PERSONS*	*CAR_GAS*	*INTERVENE*	*VOTE*	*SMOKE*	*EXERCISE*	*STANDARD_BMI*
TOTAL_INC	1												
RIGHTWING	-0.0139	1											
	(0.8836)												
AGE	-0.0795	-0.0392	1										
	(0.4028)	(0.6799)											
MASTERS	0.0514	-0.0343	-0.1556*	1									
	(0.5890)	(0.7182)	(0.0999)										
IMMIGRANT	-0.027	-0.0624	0.3896***	0.0416	1								
	(0.7763)	(0.5112)	(0.0000)	(0.6614)									
FATHER_IM	0.0487	-0.0619	0.3247***	0.2322**	0.4112***	1							
	(0.6085)	(0.5145)	(0.0005)	(0.0133)	(0.0000)								
PERSONS	0.147	0.0602	-0.1801*	-0.1336	-0.1754*	-0.1419	1						
	(0.1203)	(0.5263)	(0.0563)	(0.1583)	(0.0631)	(0.1337)							
CAR_GAS	0.1835*	-0.1485	0.0846	-0.1469	0.0013	-0.1161	0.09	1					
	(0.0517)	(0.1165)	(0.3727)	(0.1206)	(0.9893)	(0.2207)	(0.3434)						
INTERVENE	-0.0918	0.0266	-0.1941**	-0.0388	-0.0947	-0.0698	0.0453	-0.0425	1				
	(0.3335)	(0.7799)	(0.0394)	(0.6835)	(0.3184)	(0.4624)	(0.6339)	(0.6551)					
VOTE	-0.0151	0.064	0.1197	0.0804	0.0576	0.0455	-0.1113	-0.0355	0.0595	1			
	(0.8737)	(0.5008)	(0.2067)	(0.3973)	(0.5443)	(0.6324)	(0.2405)	(0.7088)	(0.5315)				
SMOKE	-0.0847	-0.0348	-0.123	-0.0824	-0.0399	-0.0411	-0.0455	-0.0385	0.0208	-0.1758*	1		
	(0.3722)	(0.7146)	(0.1944)	(0.3857)	(0.6751)	(0.6656)	(0.6326)	(0.6857)	(0.8266)	(0.0625)			
EXERCISE	-0.0847	-0.0348	-0.123	0.101	0.062	0.0632	-0.0565	-0.053	0.0797	0.1897*	0.004	1	
	(0.3722)	(0.7146)	(0.1944)	(0.2871)	(0.5143)	(0.5060)	(0.5525)	(0.5772)	(0.4013)	(0.0442)	(0.9663)		
STANDARD_BMI	-0.0895	-0.0734	0.3724***	-0.0621	0.1519	0.3490***	-0.1006	0.185**	-0.0719	0.14	-0.017	-0.165*	1
	(0.346)	(0.4398)	(0.0000)	(0.5136)	(0.1082)	(0.0002)	(0.2889)	(0.0498)	(0.4491)	(0.1391)	(0.854)	(0.080)	

Notes: The table displays the Pearson correlation matrix between individual socio-demographic characteristics and preferences. For each row variable, the first row is the Pearson correlation with the column variable, and the second row (in parentheses) is the calculated p-value for the rejection of the null hypothesis of zero correlation. * significant at the 10%-level. ** significant at the 5% level. *** significant at the 1%-level.