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Changes in homeowner preferences for housing density following 11 September 2001

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This study analyses data gathered from surveys conducted immediately before and after 11 September, 2001, that elicit respondents' preferences for neighbourhood attributes using a conjoint analysis instrument administered via mail to two randomly selected, mutually exclusive samples of homeowners in Franklin County, Ohio. Sample demographics and income variables were similar. It is found that, prior to 11 September 2001, respondents react to an array of neighbourhood characteristics; the estimated utility model fits the data well. For the data collected after 11 September 2001, only housing density and park availability attributes are significant explanatory variables in the estimated utility model.

I. Introduction

The events of 11 September 2001, had a deep and lasting impact on many Americans. Besides the direct devastation of the attacks, the change in consumption patterns following the attacks left a broad economic footprint on the USA as preferences for items from air travel to entertainment were immediately and, in some cases, permanently affected.

The purpose of this study is to investigate how 9/11 affected preferences for housing density. Given the importance of housing decisions in family budgets and of aggregate housing preferences in shaping the course of urban development, any substantial, widespread change in housing preferences could hold large implications for many urban areas.

II. Methods and Data

The study analyses data gathered from mail surveys conducted before and after 11 September 2001, that elicit preferences for neighbourhood attributes using a conjoint analysis instrument (Louviere, 1988) administered to two randomly selected, mutually exclusive samples of homeowners in Franklin County, Ohio. Conjoint analysis (CA) refers to stated preference elicitation methods where the researcher identifies key product attributes; chooses different levels for each attribute; formulates numerous profiles of the product featuring permutations of attribute levels; prompts respondents to evaluate various product profiles; and analyses respondents' evaluations to draw inferences concerning attribute preferences (Hensher *et al.*, 1999). CA has been used to analyse housing and

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Table 1. Sample statistics: pre- and post-9/11 income and demographics

	Pre-9/11 ($N = 1183$)		Post-9/11 ($N = 769$)	
	Mean	Std. Dev.	Mean	Std. Dev.
Urbanicity scale (0–100)	55.20	16.23	55.05	17.29
Years formal education	14.91	2.61	14.92	2.43
Satisfaction w/local school (1-7)	*4.99	1.46	*5.12	1.38
Age	49.23	14.43	49.58	14.09
Dummy if respondent white	**0.80	0.40	**0.84	0.37
Dummy if respondent male	0.40	0.49	0.42	0.49
Household income	73.65	44.76	76.69	46.64
Number of children in household	0.63	0.82	0.61	0.82
Years in current house	13.12	12.33	13.07	12.18

**, * – Pre- and post-9/11 means are significantly different at the 5% and 10% level as determined by a two-tailed *T*-test.

neighbourhood decisions before (Earnhart 2001; Rouwendal and Meijer 2001; Molin *et al*., 1999).

Respondents choose between two experimentally generated neighbourhood profiles. Because the profiles describe housing density, inferences are drawn about how 9/11 may have affected preferences for neighbourhood attributes that shape urban development.

III. Sample

Data are drawn from responses to two survey instruments. The first survey was mailed to a random sample of 2600 homeowners during August 2001; 1257 completed surveys were received before 7 September 2001. The second survey, which included several new questions about the terrorist attacks (asked at the end of the instrument), was collected from 803 homeowners between 30 November 2001 and 2 January 2002, or about three months after the attacks. The response rate for deliverable surveys to the conjoint questions was 30.3 (32.3)% for the first (second) instrument. Respondent characteristics are similar for both samples (Table 1).

Columbus, Ohio, situated in Franklin County, has a population of 711 470. It is the 15th largest city and the 33rd largest metropolitan area in the USA. Columbus offers an interesting example of a mid-sized city, within a two-hour flight of the attacks, with a distinct downtown 'skyline' area. However, local road networks allow downtown workers to commute to an array of suburban and rural areas within 40 minutes. This gives workers considerable latitude with respect to the housing density of their chosen residence.

IV. Survey and Question Design

Following introductory questions, respondents see two sets of two conjoint profiles. The preface to the conjoint question (Fig. 1) asks the respondent to suppose they were moving and had narrowed their choice to two physically identical houses. Each profile describes: neighbourhood housing density/configuration (a less dense, cul de sac [$density = 0$] or a more dense, grid organization [$Density = 1$]);[1] availability of a park ($Park = 1$, relayed graphically in the neighbourhood configuration picture); surrounding land uses (percentage in agricultural [*AgLand*] and if land is permanently dedicated to cropland [$PermCrop = 1$]); one-way commute time to work (*Commute*, ranging from 5 to 60 minutes); neighbourhood school quality (*School*, four categories ranging from fair to excellent); neighbourhood safety (*Safety*, four categories ranging from somewhat unsafe to very safe); average income of neighbourhood households (*NeighInc*, ranging from \$35 000 to \$70 000); and purchase price of house (ranging from \$129 000 to \$219 000 and used in formulating *AnnPrice*).

A variation of a full-factorial design is used (detailed in Roe *et al*., 2004) to generate the combination of attributes displayed in each profile. Before the choice question, respondents are reminded that the two houses are identical in all other aspects (age, design, size) and are reminded of their budget constraint. Respondents are then asked if they: prefer

[1] Less dense neighbourhoods always appear with cul de sac neighbourhood designs while more dense neighbourhoods always appear with grid designs in the experimental design.

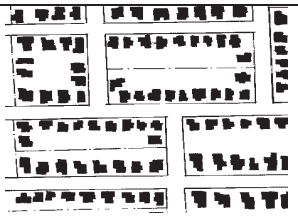
House Choice	**House A**	**House B**	**Averages for Franklin County**
Neighbourhood layout (bird's eye view)			
Housing density	Less dense	More dense	
Surrounding land	Half of the land within one mile in agricultural uses	Most of the land within one mile in permanent cropland	
Commute time to work (by car)	20 minutes	40 minutes	
School quality	Average	Excellent	**Average school quality:** fair
Neighbourhood safety	Safe	Somewhat safe	**Average neighbourhood safety:** somewhat safe
Average household income in neighbourhood ($)	$55 000	$65 000	**Average household income:** $37 221
Price ($)	$165 000	$171 000	**Average house price:** $150 537

Fig. 1. Example conjoint analysis question

neighbourhood A, prefer neighbourhood B or cannot afford either house.

V. Model

It is assumed that respondent preferences are captured by

$$V_j^i(M^i - P_j, \mathbf{A_j}, \mathbf{S}_j^i) = \alpha' L + \beta' Q + e_j^i \qquad (1)$$

where V_j^i denotes individual i's indirect utility from choosing neighbourhood j; M^i is respondent i's annual household income; P_j is the annualized price[2] of house j; $\mathbf{A}_\mathrm{j}$ is a vector of neighbourhood j's other attributes; $\mathbf{S_j}^\mathrm{i}$ is a vector of interaction terms between household i's characteristics and neighbourhood j's attributes;[3] $\boldsymbol{L} = [M^i - P_j\ \mathbf{A_j}\ \mathbf{S}_\mathrm{j}{}^\mathrm{i}]'$ is a vector of linear regressors; $\boldsymbol{Q} = [(M^i - P_j)^2]'$ is a vector of quadratic regressors; $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are conformable coefficient vectors to be estimated; and e_j^i is a

[2] The annualized purchase price of the house was calculated by dividing the list price of the house by 13. The resulting dollar figure is approximately the annual sum of monthly mortgage payments if the home were purchased with a 10% down payment on a 30-year mortgage with a 7.5% fixed interest rate.
[3] Included in these interaction terms are attribute-attribute interactions as well as attribute-characteristic interaction terms.

disturbance term. Denote $\boldsymbol{\alpha}_M$ and $\boldsymbol{\beta}_M$ as the coefficients for the linear and quadratic income terms (i.e., $M^i - P_j$).

Because respondents choose between two profiles, the choice decision is modelled on relative differences in utility between neighbourhoods x and y:

$$dV^i_{xy} = -\alpha_M \Delta(P) + \beta_M \{\Delta(P^2) - 2M^i \Delta(P)\} + \boldsymbol{\alpha}_A \Delta(\mathbf{A}) + \boldsymbol{\alpha}_S \Delta(\mathbf{S}^i) + \varepsilon^i_{xy} \quad (2)$$

where $\Delta(k) = k_x - k_y$, $\Delta(k^2) = (k_x)^2 - (k_y)^2$ for $k \in [P, \mathbf{A}, \mathbf{S}^i]$ and $\varepsilon^i_{xy} = (e^i_x - e^i_y)$ and ε^i_{xy} is assumed to be normally distributed. Following Roe *et al.* (1996), interaction terms are included to gauge differences in preferences for neighbourhood attributes across individuals.

VI. Results

Maximum likelihood estimates of the utility function parameters from pre- and post-9/11 respondents are presented in Table 2. Analysis of data collected prior to 9/11 yields an estimated preference function in which a broad range of neighbourhood characteristics as well as housing price provide significant explanatory power (see columns 1-3 of Table 2 and Roe *et al.*, 2004, for more discussion and interpretation of pre-9/11 results).

When the same model is estimated using post-9/11 data, only two neighbourhood characteristics and one interaction term are significant. The first is neighbourhood density. As in the pre-9/11 data, respondents prefer less dense housing arranged in a cul de sac arrangement, to denser, grid-patterned neighbourhoods. However, the intensity of this preference for less dense housing is even stronger in the post-9/11 data, though this difference is not statistically significant ($\chi^2(1) = 0.97$, $p = 0.33$).

Second, the presence of a neighbourhood park helps explain post-9/11 housing preferences; a park positively affects how respondents view housing scenarios. The pre- and post-9/11 estimates agree in direction, however the post-9/11 coefficient is larger, though not significantly different ($\chi^2(1) = 0.18$, $p = 0.67$).

Finally the interaction of density and education is positive and significant in the post-9/11 data, suggesting that respondents with more formal education held less negative views concerning density than did those with less formal education. Again, the post- and pre-9/11 estimates agree in sign, but the post-9/11 coefficient is larger (though not significantly) in magnitude.

In contrast to the pre-9/11 results, no other characteristics or interactions held significant explanatory power. The pre-9/11 model appears to fit the data better; for example, in sample prediction of neighbourhood choice was much higher than the post-9/11 model (64.7% versus 54.0%). A formal test of the equivalence of the preference model parameters taken from pre- and post-9/11 samples is rejected at the one percent level using a likelihood ratio test ($\chi^2(17) = 75.7$, $p < 0.001$).

Furthermore, using responses to terrorism awareness and attitude questions answered by post-9/11 respondents, we try to identify whether certain types of individuals are driving the significant difference in estimated utility parameters (these analyses are available from the authors upon request). Several models are estimated where respondents to the second survey who stated that they had undergone large changes in satisfaction with regard to their neighbourhood due to the events of 9/11 were omitted or given less weight during estimation. A similar omission and re-weighting is estimated for respondents who believe Columbus is likely to be attacked or who felt that public officials are unable to protect them from future attacks. All variants yield significantly different parameter estimates for the pre- and post-9/11 samples, suggesting that the difference in estimated parameters is driven by a broad segment of the population sample rather than by an easily identified minority of individuals who held particular views concerning terrorism.

VII. Discussion and Summary

It is found that utility parameters from a neighbourhood choice model estimated from stated preference data changed after the events of 9/11 such that respondents continue to prefer less densely populated neighbourhoods with parks. Other attributes that predict neighbourhood choice prior to 9/11 such as housing price, school quality, commute time, neighbourhood safety, and average income of neighbours, are not significant in the post-9/11 model, indicating respondent focus on density and parks only.

While such results might not be surprising for an eastern seaboard city or other likely target of terrorism, they are somewhat surprising for a mid-sized, Midwestern city. Several interesting questions arise from this analysis. First, was this a change in fundamental preference parameters (i.e., the preference for safety) or merely an updating of the probabilities used in respondents' expected utility (or generalized expected utility) calculation. If the latter, a relevant

Table 2. Estimated utility model of pre- and post-11 September conjoint data

	Pre-11 September data			Post-11 September data			Pooled		
Model variable	Coefficient	Std. Error	*P*-value	Coefficient	Std. error	*P*-value	Coefficient	Std. error	*P*-value
Intercept	0.19	0.03	< 0.0001	0.04	0.04	0.24	0.12	0.02	< 0.0001
HH Inc – AnnPrice (α_M)	0.18	0.06	0.00	0.02	0.06	0.77	0.06	0.04	0.10
(HH Inc – AnnPrice)^2(β_M)	−1.12E-03	2.81E-04	< 0.0001	1.36E-04	2.81E-04	0.63	−5.30E-04	1.94E-04	0.01
Δ(Commute)	−8.72E-03	2.00E-03	< 0.0001	1.17E-03	2.36E-03	0.62	−3.85E-03	1.50E-03	0.01
Δ(NeighInc)	1.90E-05	8.89E-06	0.03	3.93E-06	1.10E-05	0.71	1.80E-05	6.50E-06	0.01
Δ(Density)	−0.52	0.23	0.02	−0.86	0.25	0.00	−0.80	0.16	< 0.0001
Δ(AgLand)	0.45	0.14	0.00	−0.02	0.10	0.83	0.09	0.06	0.13
Δ(PermCrop)	0.28	0.10	0.01	0.08	0.10	0.38	0.19	0.07	0.00
Δ(Park)	0.14	0.08	0.08	0.19	0.08	0.02	0.11	0.05	0.04
Δ(School)	0.10	0.05	0.03	0.00	0.05	0.95	0.05	0.03	0.11
Δ(Safety)	0.12	0.03	0.00	0.01	0.04	0.79	0.07	0.02	0.00
Δ(School)*Anychild	0.10	0.05	0.05	−0.02	0.06	0.73	0.06	0.04	0.09
Δ(NeighInc)*Age	−3.61E-07	1.66E-07	0.03	−4.67E-08	2.02E-07	0.82	−2.91E-07	1.23E-07	0.02
Δ(Density)*Education	0.03	0.01	0.04	0.05	0.02	0.00	0.04	0.01	< 0.0001
Δ(Density)*Nonwhite	0.21	0.11	0.05	0.08	0.12	0.53	0.17	0.08	0.03
Δ(AgLand)* Δ(PermCrop)	−0.24	0.12	0.06	−0.04	0.13	0.75	−0.13	0.08	0.11
Δ(PermCrop)* Δ(Park)	−0.13	0.10	0.23	−0.08	0.10	0.44	−0.10	0.07	0.14
Likelihood value	−964.51			−758.18			−1760.54		
% Correct predictions	64.7%			54.0%			58.6		
N	1551			1113			2664		

question becomes how individuals formulate or update subjective probability estimates, particularly for low-probability, high-impact events such as terrorist attacks. The result may provide some support for Sunstein's (2003) conjecture that post-9/11 consumers fell prey to probability neglect, where, for events that arouse strong emotions, consumers focus upon the potential loss associated with the event rather than on its probability.

Alternatively, is the change merely cognitive fallout from the events of 9/11, with respondents only able to focus on the features that were most salient in the post-9/11 media frenzy, i.e., housing density and park space which, perhaps not coincidentally, were the only neighbourhood characteristics relayed graphically. In the pre-9/11 sample, respondents may have differed with regard to which housing attribute was most salient and, hence, became the focal point of decisions; on aggregate this may have led to the statistical significance of a broad range of neighbourhood characteristics and neighbourhood–household interactions terms. The data are somewhat consistent with this, but it does contain one exception: the lack of significance of the farmland variable in the post-9/11 estimates. That is, it is believed that consumers concerned with a terrorist attack would prefer to be in a highly isolated area, such as one surrounded by farmland. However, the variable capturing this neighbourhood feature was not significant in the post-9/11 sample, perhaps because respondents viewed farmland proximity as a generic neighbourhood amenity rather than immunity from terrorist attacks.

Perhaps the more important, and yet unanswered question, is to what degree this alteration in preference parameters was permanent. If housing density preferences were permanently changed for a broad swath of metropolitan homeowners, it could have large implications for the path of development of the metropolitan areas with lower success rates for high-density, urban renewal type projects. Mills (2002) hypothesizes that support for anti-sprawl legislation may also be undercut by the events of 9/11 and the data suggest that homeowner preferences have changed in such a way as to support his conjecture. Also, if these events could so strongly alter the preferences of residents of a mid-sized, Midwestern city like Columbus, which is far from the most likely terrorist attack point, what will be the impact on metropolitan areas more likely to be the targets of such attacks?

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