Endogenous Crime Victimization, Taxes, and Property Values*

Andrew J. BUCK, *Temple University*

Simon HAKIM, *Temple University*

Uriel SPIEGEL, *Bar Ilan University*

This paper explores the twofold effect which results from raising taxes in order to finance more policing. Better security, which lowers the probability of loss due to crime, raises housing demand, and thereby increases housing values. At the same time, increases in real estate taxes induce households to search for housing elsewhere, *ceteris paribus*, and thus yields an adverse effect on property values. The net impact of these two opposing forces is measured in an empirical model of the Atlantic City, New Jersey, region.

The adverse effects of crime and taxation upon property values have intrigued economists for more than a decade. This paper endogenizes crime and explores the direct and indirect effects of increased taxation on property values. In order to reduce the probability and losses of crime victimization, residents spend more on police; *ceteris paribus*, property values will rise. The increase in spending is financed through greater taxes, which depress property values. Past studies have typically addressed one or the other problem, but not both.

In a model of hedonic price estimation for single-family homes, Thaler (1978) found that property crimes depress the prices of residences. He reported the psychic and monetary cost of an "average" property crime was roughly $500. In a similar study Gray and Joelson (1979) used census tracts and concluded that of eight different crime rates only vandalism and residential burglary actually affected the mean values of owner-occupied and rented housing.

Hellman and Naroff (1979) and Naroff and Hellman (1980) have

*Direct all correspondence to Dr. Andrew J. Buck, Department of Economics, Temple University, Philadelphia, PA 19122. The authors wish to thank the anonymous referees for their helpful comments; their efforts improved the work. We remain culpable for any remaining errors or omissions. Editor's note: Reviewers were James D. Burnell, William Curington, Stephen A. Hoenack, and Mark Warr.

calculated the impacts of crime on the cost of municipal services and tax revenues. In a follow-up study Hellman and Fox (1984) found that property values are adversely affected by crime and are positively affected by police outlays and household income. In their study the effective property tax rate had an unexpected positive sign.[1]

Little (1988), in a study of a small number of individual properties, is the only one to have analyzed residential properties where violent crimes have occurred. The study concluded that a discount factor of 15 percent can be considered when the victimized property is compared to similar dwelling units.

Thaler (1978), Gray and Joelson (1979), and Hellman and Naroff (1979) based their analysis on Muth's (1969: chaps. 2–3) model, in which the price of a property is assumed to be that of a flow of services rather than the price of an asset. The services include such amenities as shelter, privacy, safety, and convenience. Possible disamenities are air pollution and crime. Thaler (1978) and Burnell (1988) have shown that characteristics like crime and racial composition not only affect their own neighborhood housing values but affect those of surrounding neighborhoods as well.

In this paper we derive the link between real estate taxes and the level of public services needed to maximize real estate values in an environment in which criminal victimization and the associated loss are uncertain. It is a well-established proposition that higher taxes, either rates or levels, are associated with lower property values (Yinger et al., 1988; Polinsky and Shavell, 1976). It is also a stylized fact that increased output by the municipal police department will reduce the losses in real estate value which result from crime (Hellman and Fox, 1984). The model in this paper accommodates both of those widely reported findings. It also is the first to introduce the elements of risk and uncertainty in the determination of real estate values.

The Model

The resident is assumed to be risk averse with a concave utility function. He or she faces two "states of nature": With a probability of P there will be no criminal assault on the property. With a probability of $(1 - P)$ the resident will be a victim and incur some loss, L. There are assumed to be many residents in the community who are identical in their tastes and income levels so the model is stated in the form of a representative consumer.[2]

[1] Their six-equation model was fitted to data on 88 cities of more than 10,000 population. The equations were the supply of crime, a law enforcement production function, a police employment function, a police services demand function, a city revenue function, and a city property value function.

[2] We are describing a generic form of urban model. A review of this characterization can be found in Mills and MacKinnon (1973). More specifically, Inman (1979: 130–64) discussed modeling the local government behavior as if it were a maximization problem for an individual. Presumably the individual would be the median voter.

Both P and $(1 - P)$ are endogenous to the model; this is a distinguishing feature of the model. Although some of the early studies of the economics of crime found the deterrent effect of police problematic (Zipin et al., 1974; McPheters and Stronge, 1974), the great bulk of recent studies show that communities with more effective policing have reduced crime rates, at least in the short run (Friedman, Hakim, and Spiegel, 1989). Thus, police activities affect both the likelihood of being a victim of crime and the extent of the loss when it occurs.

An index of the initial attributes and qualities of the residence and surrounding community is assumed to be W. This index is understood to reflect the constellation of amenities that flow from the physical characteristics of the residence and the other properties in the community, absent any disamenities. The only disamenity is crime, which is modeled explicitly in its impact on W. The resident faces a reduction of the index W due to crime in the amount L with a probability of $(1 - P)$.

The community raises funds to purchase public goods. Suppose T dollars are collected in the form of a property tax.[3] These funds are then used to support the provision of security by the municipal police department. Losses due to crime, L, are reduced as a result of the police expenditure. The evidence is that policing also reduces the probability of victimization, $(1 - P)$. Local budgets are assumed to be balanced, and police outlays are assumed to be efficiently used.

In a state where nothing has been spent on policing then a crime results in a loss of L. If T dollars have been spent on policing, then the loss in the event of crime becomes $[L - f(T)]$. This event occurs with probability $[1 - P(T)]$. The function $f(T)$ reflects the reduced time available to the criminal inside the residence and the fact that the police can recover some of the lost property if the crime is solved. The function $[1 - P(T)]$ reflects the deterrent effect of more security in the community.

The expected utility of the resident depends on the probabilities of the various states of nature. We assume that more taxes (T), used to finance policing, reduce the likelihood of victimization, $[1 - P(T)]$, and the losses associated with crime, $[L - F(T)]$. Therefore more policing raises the expected value of the resident's attributes index. However, more policing requires levying taxes, which in turn lowers the resident's attributes index.

The result of more police outlays and a lower victimization probability narrows the difference between the individual's net attributes in the two states of the world in comparison with the case in which government intervention, in the form of policing, is absent.

To formalize the arguments, let V be the expected market value of the attributes index associated with one unit of residential property. The attributes index reflects the stream of amenities resulting from the physical

[3] The tax can be raised as a lump sum tax or as a proportion of the value of the property. The relative merits of lump sum and proportional taxes have been explored in Wilson (1991). Hence, distributional questions are ignored.

characteristics of the representative property. The problem of the resident is to choose that level of taxes which maximizes the expected market value of the property, *ceteris paribus*.

$$V = \mathrm{Max}[V_0, V_1] \tag{1}$$

$$\begin{aligned} V_0 = {} & [1 - P(T = 0)] \times U(W - L) \\ & + P(T = 0) \times U(W) \end{aligned} \tag{2}$$

$$\begin{aligned} V_1 = {} & [1 - P(T > 0)] \times U[W - T - L + f(T)] \\ & + P(T > 0) \times U(W - T) \end{aligned} \tag{3}$$

The "utility" function U is a mapping from the attributes index, net of any losses and taxes, to the market value of a unit of property.[4]

If $V_1 > V_0$, then the resident chooses to pay a tax,[5] T, in order to finance police activities which yield a reduction in losses from crime, $f(T)$. If, however, $V_0 < V_1$, then a corner solution results, where no police activity is required.

The optimum level of T is derived assuming the "normal" condition of $V_1 > V_0$. It is also assumed that $f(T)$ is positive, while the first derivative $f'(T) > 0$ and the second derivative $f''(T) < 0$. That is, the marginal benefit of loss reduction emanating from the taxes used to finance police activities is positive but diminishing.

In the general case the level of taxes affects the marginal productivity of police, $f(T)$, and the probability of successful crime, $[1 - P(T)]$. In the usual case, in which the residents have decided to fund security, the representative consumer must choose taxes to maximize market value, reflected in the expected utility of different wealth values associated with probabilities $P(T)$ and $[1 - P(T)]$, respectively.

$$\begin{aligned} \underset{T}{\mathrm{Max}}\ V_1 = {} & [1 - P(T)]\, \mathrm{U}\, [W - T - L + f(T)] \\ & + P(T)U(W - T) \end{aligned} \tag{4}$$

The first-order condition for the problem is given by

$$\begin{aligned} \frac{dV_1}{dT} = {} & - P'(T)U[W - T - L + f(T)] \\ & + [1 - P(T)]U_W[W - T - L + f(T)] \\ & \times [f'(T) - 1] + P'(T)U(W - T) \\ & - P(T)U_W(W - T) = 0. \end{aligned} \tag{5}$$

[4] One can think of U as a rule for valuing a hedonic index of a property's attributes. For a brief history of the estimation of hedonic price indexes see Berndt (1991 : 102–49). An essential part of our argument is that the quality of a residence is reduced by victimization. This reduction may be due to expected pecuniary loss as well as the feelings of violation that result from being a victim of crime.

[5] We assume away all free rider effects, and we are assuming a strong form of the Tiebout hypothesis. We also assume that there is no opportunity to buy private security. Without these assumptions the consumer would not truthfully reveal his/her preference for the public good.

By solving for $f'(T)$, which is the marginal benefit of loss reduction resulting from the imposition of a higher tax, we obtain

$$f'(T) = \frac{P(T)U_W(W - T) - P'(T)\{U(W - T) - U[W - T - L + f(T)]\}}{[1 - P(T)]U_W[W - T - L + f(T)]} + 1 > 1. \quad (6)$$

The conclusion derived from equation (6) is that in a world in which victimization is certain the decision about the optimal tax collected for prevention purposes leads to the equilibrium in which $f'(T) = 1$. In conditions of uncertain victimization the optimal value of taxation results in $f'(T) > 1$. That is, if victimization and recovery of one's loss are uncertain, then less is spent on policing than would be spent on policing under conditions of certain victimization.

The Statistical Model

The theoretical model above hypothesized that there are contradictory effects on property values of higher taxes and better security. Higher tax levies lower real estate values. If the resources are used to finance efficient police services, then the probability of victimization and associated losses decrease, leading to rising property values.

To test these hypotheses, one would estimate a model of property values which incorporates the provision of public security, the crime rate, and the tax rate. Ideally, the communities in the sample would all be concentric cities with a central business district, and would all be remote from other areas which produce externalities. Market values in the sample communities would not vary systematically except with respect to the hypothesized relationships. With such an experimental design one could abstract from the considerations of the opportunity cost of travel time and community demographics found in modern von Thünen type models (Fujita, 1989; Solow, 1972, 1973; Oron, Pines, and Sheshinski, 1973; Beckman, 1972).

To approach this ideal begin by specifying a cross-sectional time-series model, equation (7), of 64 communities in Atlantic, Cape May, and Ocean counties in New Jersey for the period 1972–86. The central business district for the study is taken to be Atlantic City, the seat of casino gambling in the eastern United States since 1978.

$$\begin{aligned} \text{Value}_{i,t} = \alpha_0 \ \alpha_1 \text{Tax Rate}_{i,t} + \alpha_2 \text{Police}_{i,t} \\ + \alpha_3(\text{Tax Rate} \times \text{Police}) + \mathbf{Z}_{i,t}\beta \end{aligned} \quad (7)$$

The results of the estimation of this model are presented in Table 1. $\text{Value}_{i,t}$ is the market value of property in the ith community in the tth period computed from assessed value, the state equalization ratio, the number of square miles of residential property in the community, and the implicit housing price deflator. The state equalization ratio corrects for different assessing practices and recent sales price experience across communities. Deflating by the implicit housing price index eliminates the confounding effects of inflation. Standardizing by the area of the community corrects for size effects. *Tax rate* is the average rate at which real estate is taxed in the community (residential tax revenue divided by residential assessed value). *Ceteris paribus*, a result of the model in the previous section is that an increase in the tax rate will lower the expected value of property.[6] *Police* is the ratio of police department expenditures to total budgetary spending in the community. The presumption is that greater spending reflects larger purchases of inputs, which lead to greater security in the community and reduced probability of victimization and losses.[7] The interaction term between Police and Tax Rate is included to permit, e.g., the possibility that the marginal effect of a tax increase differs across communities with different levels of police expenditure.

$\mathbf{Z}_{i,t}$ is a vector of other conditioning variables which affect property values. It includes a dummy variable (*Accessible*) for the accessibility of the community to Atlantic City,[8] the assessed value of hotel properties in Atlantic City (*Hotel*) in order to capture the advent and value of casino gambling in 1978,[9] the travel time from the community to Atlantic City in minutes (*Minutes*), the product of Minutes and Accessible, the product of a casino dummy (*Casinos;* 0 before 1978, 1 otherwise) and Minutes, the unemployment rate (*Unemp*), the population density (*Density*), and rates of three types of property crime: *Larceny, Auto Theft,* and *Burglary.*[10]

An issue that arises at this point is the use of purchased inputs, Police, and socioeconomic variables (**Z**) to model the outputs resulting from public expenditure. Many studies have found that socioeconomic variables have significant impacts on the efficiency of public expenditure. The impacts of purchased inputs tend to be small and insignificant. The issue is whether at the margin purchased inputs contribute at all to the market value of real estate (Oates, 1977; Summers and Wolfe, 1977). A contrary view can be found in studies of property tax capitalization (Rosen and Fullerton, 1977).

[6] Stull and Stull (1991) is representative of current work on the capitalization of taxes in property values. While Stull and Stull focused on income tax, they reviewed the literature on property taxes.

[7] Ideally we would use the victimization rate, corrected by the clearance rate, and average pecuniary losses due to crime in the community. Unfortunately, clearance rates are available for our sample of communities for only a short time period, and average pecuniary losses are not available at all.

[8] The communities in the accessible group are listed in the notes to Table 1. Generally speaking, they lie along major thoroughfares connecting Atlantic City to Philadelphia and New York, or are adjacent to Atlantic City.

[9] From 1972 to 1978 the assessed value of hotel property did not change. After 1978 the figure grew at a near exponential rate. This data is available from the New Jersey State Gaming Commission.

[10] In effect, we are constructing a hedonic model of real estate value. Other papers in this genre include Asabere and Harvey (1985), Asabere (1990), and Goldberg and Scott (1988).

TABLE 1

Market Value, Taxes, and Crime

Variable	Pooled	Before Casinos	After Casinos	Inaccessible Locations	Accessible Locations	Inaccessible, Pre-Casino	Accessible, Pre-Casino	Inaccessible, Post-Casino	Accessible, Post-Casino
Constant	8.8723	−0.1009	16.5233	3.8895	12.3896	−3.0665	−5.4289	11.3080	34.0909
	(1.44)	(−0.01)	(1.90)	(0.58)	(1.65)	(−0.38)	(−0.90)	(1.21)	(2.19)
Accessible[a]	−23.9204	−13.8393	−31.5534						
	(−5.62)	(−2.67)	(−5.51)						
Hotel[b]	0.0014		0.0011	0.0015	0.0010			0.0012	0.0007
	(3.62)		(2.57)	(3.41)	(2.83)			(2.37)	(1.64)
Minutes[c]	−0.2321	−0.0763	−0.4190	−0.2267	−0.1281	−0.0973	−0.0782	−0.4279	−0.2014
	(−4.64)	(−1.34)	(−6.93)	(−4.23)	(−2.82)	(−1.63)	(−2.18)	(−6.49)	(−3.85)
Accessible × Minutes	0.459	−0.1132	0.1981						
	(0.483)	(−0.96)	(1.55)						
Casinos × Minutes	−0.0912			−0.0917	−0.0591				
	(−2.62)			(−2.33)	(−1.36)				
Unemp[d]	0.0428	0.0428	0.0229	0.0179	0.0121	0.0177	0.0507	0.0015	−0.0377
	(2.20)	(1.88)	(0.86)	(0.82)	(0.45)	(0.70)	(2.13)	(0.05)	(−0.83)
Density	1.6576	1.3473	1.7992	1.7974	0.9450	1.4416	0.8046	1.9945	1.0011
	(32.31)	(20.03)	(26.69)	(28.22)	(19.62)	(17.90)	(16.98)	(23.37)	(15.51)
Larceny[e]	0.0006	−0.0072	0.0016	−0.0008	0.0043	−0.0215	0.0029	0.0061	0.0041
	(0.43)	(−1.07)	(0.80)	(−0.18)	(6.08)	(−2.05)	(0.62)	(1.16)	(3.00)

Auto Theft[e]	0.0501	0.0432	0.0529	−0.0442	−0.0017	0.1516	0.0172	−0.1071	−0.0013
	(2.63)	(1.36)	(2.19)	(−0.69)	(−0.18)	(1.68)	(1.07)	(−5.46)	(−0.11)
Burglary[e]	−0.0148	−0.0039	−0.0185	−0.0013	−0.0039	0.0027	−0.0096	−0.0043	−0.0025
	(−2.57)	(−0.27)	(2.48)	(−0.12)	(−0.81)	(0.14)	(−1.33)	(−0.28)	(−0.28)
Tax Rate[f]	−79.5447	−25.8922	−140.2751	9.4291	−253.9266	50.8031	148.4708	−27.7507	−608.9634
	(−0.82)	(−0.22)	(−0.97)	(0.08)	(−2.00)	(0.39)	(1.34)	(−0.18)	(−2.11)
Police[f]	400.9731	351.4464	429.1761	494.8452	17.9509	470.2934	79.9901	507.1940	−127.2256
	(7.31)	(5.79)	(5.18)	(7.84)	(0.28)	(6.52)	(1.75)	(5.43)	(−0.86)
Tax Rate × Police	−6,734.6503	−5,017.4871	−7,286.7752	−8,576.4376	−384.3179	−7,344.3624	−2,909.2119	−9,164.2524	2,473.3205
	(−6.43)	(−3.85)	(−4.76)	(−7.12)	(−0.32)	(−4.82)	(−2.55)	(−5.46)	(0.88)
F statistic	140.56	71.87	105.54	146.00	70.95	79.53	37.86	112.39	57.22

NOTE: Cell entries are least squares regression coefficients, with *t* statistics given in parentheses.

[a] The accessible communities are Ventnor, Northfield, Egg Harbor, Pleasantville, Brigantine, Absecon, Galloway, Stafford, Ocean, South Toms River, and Ocean Gate.

[b] Hotel assessed value is prepared by the Atlantic City Board of Assessors and the Atlantic County Board of Taxation.

[c] Minutes of travel time from the community to Atlantic City is prepared by the New Jersey Department of Transportation.

[d] The unemployment rate is available from the New Jersey Department of Labor, Municipality Labor Force Estimates, Division of Planning and Research, Office of Demographic and Economic Analysis (Annual Reports).

[e] The crime statistics are available from the New Jersey Attorney General Uniform Crime Reports.

[f] Tax Rate, Police, and the State Equalization Ratio are all available from the New Jersey Division of Local Government Services, Annual Statements of Financial Conditions of Counties and Municipalities, New Jersey Department of Community Affairs. The (market) value of real estate is calculated by dividing the assessed valuation by the state equalization ratio. The housing deflator and services industry deflator are available from the Economic Report of the President.

Since there are no reliable, consistently available measures of security output available for the sample,[11] we cannot resolve the issue here.

The appropriate estimator is determined by both the sample size and behavior of the error term. With only 15 annual observations (1972–86) any attempt to test for autocorrelation was eschewed. The presence of 64 communities in the cross section permitted a test for heteroscedasticity (White, 1980). As a result of that test all observations were weighted by the inverse of the square root of the population.

The equations reported in Table 1 are two-stage least squares results. The various crime, Police, and Tax Rate variables, which may be considered endogenous, were fitted to a complete set of lagged variables as well as distance, density, and unemployment. Tests for exogeneity confirmed our suspicion that crime, Police, and Tax Rate were endogenous (Greene, 1990: 638–41). Testing for overidentifying restrictions indicated that omitting the lagged variables results in an overidentified equation. Greene (1990: 638–41) pointed out that this is common in models which use lagged endogenous variables as instruments. Furthermore, the test for overidentifying restrictions is not constructive in that it does not recommend a subsequent course of action.

Given that there may be distinct casino era and accessibility effects, there are several ways in which the data may be pooled. The data may be pooled on all years and all localities. The data may be divided into pre- and post-casino samples. It may be divided into accessible and inaccessible samples. Finally, it may be divided into the four groups formed by the intersection of accessibility and the presence of casino gambling. F statistics can be used to determine the best pooling scheme. The top half of Table 2 shows the residual sum of squares, sample size (n), and number of estimated coefficients (k) under the maintained (most general) model and the three alternatives. The Chow test statistics of stability of coefficients between groupings are presented at the bottom of Table 2. The results of the tests suggest that the separation of the sample into four groups is the most appropriate. Nevertheless, all estimation results for the competing degrees of pooling are reported in Table 1.

Before addressing the central issues raised in the theoretical section, we

[11] Among the reasons cited for the lack of correspondence between expenditures on inputs and outputs are differences in factor prices, differences in production functions, and endowments of nonmarket inputs across communities. Geographic proximity and homogeneity of the communities minimize all three of these considerations.

In any case, regression of the number of crimes cleared by arrest, ARREST, on the logarithm of the size of the municipal police department, POLICE, yields the following:

$$\text{ARREST} = \underset{(3.92)}{0.6186} + \underset{(6.25)}{236.3571} \times \text{POLICE}.$$

The simple correlation between ARREST and POLICE is .29.

We did not use the ARREST variable in the study because it is available for only the last seven years of the study.

TABLE 2

Residual Sums of Squares and *F* Statistics for Maintained and Restricted Models

Model	Residual Sum of Squares	n	k
Ω			
Pre-casino and inaccessible	102,570.72	312	10
Pre-casino and accessible	1,822.54	72	10
Post-casinoandinaccessible	280,009.78	468	11
Post-casino and accessible	9,247.96	108	11
ω_1			
Inaccessible	387,555.24	728	12
Accessible	12,654.71	232	12
ω_2			
Pre-casino	117,814.18	384	12
Post-casino	322,492.54	576	13
ω_3			
Pooled	441,682.33	960	14

F Statistics for Restrictions[a] (Column versus Row Model)

	ω_1	ω_2	ω_3
Ω	0.85	6.52	4.00
ω_3	9.69	0.26	

[a]The Ω model is the maintained model; all slopes and intercepts are allowed to differ. The ω_i models (i = 1, 2, 3) are the restricted models.

review the expected and realized signs on the coefficients of the variables included in $Z_{i,\ t}$. The crime variables are expected to have negative coefficients (Gray and Joelson, 1979). This is almost always the case for the burglary rate. Larceny has a negative coefficient in a third of the samples. Auto Theft has a negative coefficient in nearly half the cases. There are a variety of reasons for the remaining perverse signs on the crime variables. Among these is specification error bias. A lack of alternative exogenous variables which differ across both time and community prevents correcting this problem in a rigorous fashion.

The coefficient on the unemployment rate, expected to be negative (Hellman and Fox, 1984), is statistically different from zero in only three of the nine cases. Two cases are models that would be rejected as being too restrictive under the Chow test discussed above.

The density variable measures the continuum of community types in this area from rural to urban. The density coefficient is always positive and significant (Gray and Joelson, 1979; Burnell, 1988).

In the classic models of location theory, the marginal effect of minutes of travel time is negative (Fujita, 1989). The sign of this effect can be determined from Table 1 by adding the relevant dummy × Minutes coefficient

TABLE 3

Marginal Effect of Travel Time on Market Value

Sample	Inaccessible, Pre-Casino	Accessible, Pre-Casino	Inaccessible, Post-Casino	Accessible, Post-Casino
Pooled	−0.2321	−0.1861	−0.3233	−0.2773
	(−4.63)	(−2.19)	(−6.82)	(−3.37)
Pre-casino	−0.0763	−0.1894		
	(−1.24)	(−1.88)		
Post-casino			−0.4190	−0.2209
			(−6.94)	(−2.02)
Inaccessible	−0.2267		−0.3185	
	(−4.23)		(−6.13)	
Accessible		−0.1281		−0.1872
		(−2.81)		(−4.88)
No pooling	−0.0973	−0.0782	−0.4279	−0.2013
	(−1.63)	(−2.18)	(−6.49)	(−3.85)

NOTE: Numbers in parentheses are *t* statistics.

to the Minutes coefficient. The results of these calculations are shown in Table 3. The marginal effect of travel time is always negative and statistically significant. This implies that the value of amenities emanating from casinos as an economic and entertainment center diminish with the distance from Atlantic City (Solow, 1972, 1973; Oron, Pines, and Sheshinski, 1973).

Obviously the effect of casino gaming, like any new development, has been to raise the market value of properties in Atlantic City. Gambling, as measured by hotel assessed value in Atlantic City, has also had a positive impact on the market value of properties in the surrounding communities. This is in accordance with von Thünen models in which a section of a city emerges as a center of business and economic development (Capozza and Schwann, 1990; Dixit, 1973).

The most important results of the empirical model are presented in Table 4. The model in the theoretical section of the paper argued that, *ceteris paribus,* an increase in property taxes should lower market value. The partial derivative of market value with respect to Tax Rate is given by

$$\frac{\partial \text{Value}}{\partial \text{Tax Rate}} = \alpha_1 + \alpha_3 \text{Police}. \qquad (8)$$

The middle column of Table 4 reports this partial derivative evaluated at the mean value of Police for the appropriate sample.[12] In every instance the sign of the derivative is negative and statistically significant.[13] As Tax Rate rises,

[12] The choice of mean is somewhat arbitrary. However, the sign pattern does not change even when the highest value for Police is used.

[13] The partial derivative in equation (8) expressed in terms of the least squares estimator of α_1 and α_2 is a linear combination of random variables. The variance of this new random variable is given by Var (α_1) + Var (α_2) + 2 × Police × Cov(α_1, α_2). The *t* statistic is then calculated in the usual fashion.

TABLE 4

Marginal Effects of Taxes and Police on Market Value

Sample	Tax Rate	Police
Pooled	−625.051	104.648
	(−13.77)	(6.06)
All places		
Pre-casino	−412.238	110.607
	(−7.53)	(4.56)
Post-casino	−745.077	123.131
	(−11.60)	(4.79)
All years		
Inaccessible	−659.532	126.058
	(−12.49)	(5.05)
Accessible	−290.436	−1.649
	(−6.11)	(−0.17)
No pooling		
Inaccessible and pre-casino	−512.509	132.452
	(−7.86)	(4.83)
Accessible and pre-casino	−86.884	−80.889
	(−1.96)	(−2.68)
Inaccessible and post-casino	−750.810	136.958
	(−10.25)	(3.48)
Accessible and post-casino	−355.942	−7.764
	(−4.61)	(−0.46)

NOTE: Numbers in parentheses are *t* statistics.

property values fall. The sign pattern on the Tax Rate and Tax Rate × Police coefficients, α_1 and α_3, suggests that an increase in taxes will reduce property values and that a rise in the propensity to spend on police cannot ameliorate this effect. The explanation is that people tend to be shortsighted in their evaluation of the efficacy of allocating an additional percent of the municipal budget to police.

It was also argued that an increase in the propensity for the municipality to spend on police should increase property values. The partial derivative of market value with respect to Police is

$$\frac{\partial \text{Value}}{\partial \text{Police}} = \alpha_2 + \alpha_3 \text{Tax Rate}. \tag{9}$$

The final column of Table 4 reports this partial derivative evaluated at the appropriate sample mean for Tax Rate.[14] For two-thirds of the models the derivative is positive and significant as hypothesized. As Police increases, property values rise. Furthermore, the sign pattern on α_2 and α_3 is such that an extra dollar of the total budget spent on police will raise property values, but the accompanying increase in the tax rate needed to fund the spending

[14] The same sign pattern emerges when the greatest value for Tax Rate is used in the place of the mean.

serves to mitigate the positive effect of more spending on police. At low tax rates an increase in the police share of the municipal budget can be construed as increasing the marginal product of police. However, beyond some high tax rate, a low marginal product of police is overwhelmed by the rise in taxes necessary to increase the output of security.

Conclusions

The model presented endogenizes both the probability of falling victim to crime and the associated losses. This feature distinguishes the paper from earlier work on either the effects of crime on property values or the capitalization of taxes in property values. The model is used to demonstrate that increased police services yield an increase in property values due to a reduction of uncertainty about victimization and the losses resulting from crime. In the absence of government intervention by levying taxes and supporting police services, crime has a depressing effect on property values. By themselves higher taxes will depress property values. Therefore the net effect of increased tax rates to fund additional security in the community has an ambiguous impact on property values. An additional reason for the ambiguity is that as the level of taxes and corresponding outlays rise, the marginal productivity of police diminishes while the disutility of additional taxes increases.

The empirical results for Atlantic City, spanning pre- and post-casino eras, are consistent with the theoretical model. They are also consistent with the other papers on property tax capitalization, community amenities, and public spending. In the majority of specifications an increase in crime reduced market value. The effect of unemployment was ambiguous. The effect of density on property values was positive. Travel time from the community to the central business distract always had a negative and significant impact on market value. The introduction of casinos also had a positive impact on market value in the region.

The central thrust of the theoretical model was to deal with taxes and a public good, security, on which those taxes could be spent. The provision of security in the community will, in and of itself, increase property values. The empirical model shows that an increase in taxes will reduce market values and that an increase in the propensity to spend on police will not offset that reduction. Reciprocally, an increase in the propensity to spend on police increases market value, but the effect is mitigated by the tax increase necessary to fund the additional spending on the public good. **SSQ**

REFERENCES

Asabere, Paul K. 1990. "The Value of a Neighborhood Street with Reference to a Cul-de-Sac." *Journal of Real Estate Finance and Economics* 3:185–93.

Asabere, Paul K., and B. Harvey. 1985. "Factors Influencing the Values of Urban Land: Evidence from Halifax-Dartmouth, Canada." *Journal of the American Real Estate and Urban Economics Association* 13:361–77.

Beckman, Martin. 1972. "von Thünen Revisited: A Neoclassical Land Use Model." *Swedish Journal of Economics* 74:1–7.

Berndt, Ernst. 1991. *The Practice of Econometrics: Classic and Contemporary.* Reading, Mass.: Addison-Wesley.

Burnell, James D. 1988. "Crime and Racial Composition in Contiguous Communities as Negative Externalities: Prejudiced Households' Evaluation of Crime Rate and Segregation Nearby Reduces Housing Values and Tax Revenues." *American Journal of Economics and Sociology* 47:177–93.

Capozza, D. R., and G. M. Schwann. 1990. "The Value of Risk in Real Estate Markets." *Journal of Real Estate Finance and Economics* 3:117–40.

Dixit, Avinash. 1973. "The Optimum Factory Town." *Bell Journal of Economics* 4:637–51.

Friedman, Joseph, Simon Hakim, and Uriel Spiegel. 1989. "Short and Long Run Effects of Police Outlay on Crime." *American Journal of Economics and Sociology* 48:177–91.

Fujita, Masahisa. 1989. *Urban Economic Theory.* Chap. 3. New York: Cambridge University Press.

Goldberg, K., and R. C. Scott. 1988. "The Effect of Property Taxes, Public Benefits, and Amenities on Neighborhood Housing Prices." *Illinois Business Review* 45 (April): 10–13.

Gray, Charles M., and Mitchell R. Joelson. 1979. "Neighborhood Crime and the Demand for Central City Housing." Pp. 47–59 in Charles M. Gray, ed., *The Cost of Crime.* Beverly Hills: Sage.

Greene, William H. 1990. *Econometric Analysis.* New York: Macmillan.

Hakim, Simon, J. Weinblatt, and Uriel Speigel. 1984. "Substitution, Size Effects, and the Composition of Property Crime." *Social Science Quarterly* 65:719–34.

Hellman, Daryl A., and James A. Fox. 1984. *Urban Crime Control and Property Values: Estimating Systematic Interactions.* Northeastern University, Center for Urban and Regional Economic Studies, Boston. Final report to the National Institute of Justice, U.S. Department of Justice grant no. 81IJ-CX-0063.

Hellman, Daryl A., and Joel L. Naroff. 1979. "The Impact of Crime on Urban Residential Property Values." *Urban Studies* 16:105–12.

Inman, Robert P. 1979. "The Fiscal Performance of Local Governments: An Interpretive Review." Pp. 270–321 in P. Mieszkowski and M. Straszheim, eds., *Current Issues in Urban Economics.* Baltimore: Johns Hopkins University Press.

Little, Sheila A. 1988. "Effects of Violent Crimes on Residential Property Values." *Appraisal Journal* 56 (July): 341–43.

McPheters, L. R., and W. B. Stronge. 1974. "Law Enforcement Expenditures and Urban Crime." *National Tax Journal* 27:633–44.

Mills, Edwin S., and James MacKinnon. 1973. "Notes on the New Urban Economics." *Bell Journal of Economics* 4:593–601.

Muth, Richard F. 1969. *Cities and Housing.* Chicago: University of Chicago Press.

Naroff, Joel L., and Daryl Hellman. 1980. "Estimates of the Impact of Crime on Property Values." *Growth and Change* 22 (October): 24–30.

Oates, Wallace. 1977. "On the Use of Local Zoning Ordinances to Regulate Population Flows and the Quality of Public Services." Pp. 201–19 in O. Ashenfelter and W. Oates, eds., *Essays in Labor Market Analysis*. New York: Wiley.

Oron, Yoram, David Pines, and Eitan Sheshinski. 1973. "Optimum vs. Equilibrium Land Use Pattern and Congestion Toll." *Bell Journal of Economics* 4:619–36.

Polinsky, Mitchell, and Steven Shavell. 1976. "Amenities and Property Values in a Model of an Urban Area." *Journal of Public Economics* 5 (January/February): 119–30.

Rosen, Harvey, and D. Fullerton. 1977. "A Note on Local Tax Rates, Public Benefit Levels and Property Values." *Journal of Political Economy* 85:433–40.

Solow, Robert M. 1972. "Congestion, Density and the Use of Land in Transportation." *Swedish Journal of Economics* 74:161–73.

———. 1973. "Congestion Costs and the Use of Land for Streets." *Bell Journal of Economics* 4:602–18.

Stull, William J., and Judith C. Stull. 1991. "Capitalization of Local Income Taxes." *Journal of Urban Economics* 29:182–90.

Summers, Anita, and B. L. Wolfe. 1977. "Do Schools Make a Difference?" *American Economic Review* 67:639–52.

Thaler, Richard. 1978. "A Note on the Value of Crime Control: Evidence from the Property Market." *Journal of Urban Economics* 5:137–45.

White, Halbert. 1980. "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity." *Econometrica* 40:817–38.

Wilson, John Douglas. 1991. "Optimal Public Good Provision with Limited Lump-Sum Taxation." *American Economic Review* 81:153–66.

Yinger, John, Howard Bloom, Axel Börsch-Supan, and Helen Ladd. 1988. *Property Taxes and Housing Values*. New York: Academic Press.

Zipin, P. M., R. H. Mabry, and C. L. Dyer. 1974. "Crime Rates and Public Expenditure for Police Protection: A Comment." *Review of Social Economy* 32:222–25.