Differentiation in Police Services in City Neighborhoods

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The demand for security depends on several socio economic characteristics such as income, property, family size that may affect the demand for pure public security or private security. In the case of a homogeneous population, the identical demands lead to an equal use of the shared public good along with an equal sharing of payments. In a heterogeneous population with a rectangular distribution of demands, security will be composed of both the pure equally shared public security along with private security that is paid individually and purchased in different quantities as a supplement to the pure public security. This combination could be applied permanently in order to achieve a social welfare improvement in comparison to the solely public security provided for the heterogeneous population.

Key Words: local public goods, police services, heterogeneous customers
JEL Classification: H3, H42, D6

Introduction

It is often observed that localities with similar crime patterns and security needs exhibit constant provision of public police and private security services. However, constituents' preferences differ among localities, and may evolve differently overtime. Thus, local policymakers need to apply policy which devises different combinations of the supply for both public and private security to better address preferences of their constituents.

Tiebout (1956) in his seminal paper suggested that differences among communities in the same metropolitan areas emanate from a more unified structure of tastes within a community than among communities. Thus, new households moving within or to the metropolitan area choose the locality that provides the level and mixture of public services that best match their preferences. That variability of public services increases social welfare more so than a unified structure of services throughout the metropolitan area. The spatial Tiebout model rests on the model of monopolistic competition that yields higher social welfare than pure competition provides.

This paper suggests a model complementary to Tiebout's general model which addresses just the case of public and private security services. It supplements the spatial Tiebout economic model with a public administration hypothesis. Tiebout explains why households choose a specific community within a metropolitan area which best reflects their specific preferences. In our model households are already located in a given community with existing demands and supply of public security which differ from the individual's preferences while payments through taxes are the same for all. Individual households supplement their missing security services by paying privately for various forms of private security. This behavior of all households creates a mosaic of security services consumed within the locality. Our model complements the Tiebout model by allowing household obtain additional security services to permanently satisfy long-run varying specific preferences. Again, the model explains variation among localities in a given metropolitan area in public police services and their supplementation with private security.

Historically, in the US and Great Britain, there has been changing reliance on the relative roles of public and private police. Early in its development, the US followed the British practice of relying on nongovernmental enforcement of law and order. Private police did not satisfy the needs of the general public, especially the growing security problems in urban area, leading to the growth of public police. The first public police force was established in New York City in 1844. However, since government at the time was small with limited resources, many groups still utilized the services of private forces. Even in the US civil war, President Lincoln used Pinkerton, the private company security company for his protection. During much of the 20th century, the role of government has increased in the US leading to expansion in public police. The expansion of government led to a trend towards privatization where government

services, including police, are contracted out to private firms. Beginning in the 1980s the public police share in total security has declined relative to private security. Private police have been contracted out to perform some of the traditional functions of public police like escorting prisoners to court, hospital, and to other prisons, crime laboratory investigation, guarding police stations and public facilities, and responding to burglar alarms (Blackstone and Hakim 2013; Müller and Wright 1994). Further, the growth in the ethnic and income heterogeneity of the population has led to differentiation in demands of residents and businesses for security, giving additional impetus for private security. Also, the almost monopolistic public police have traditionally addressed the same types of violent and property crimes. However, the mosaic of crime has changed where the extent and share of these crimes has declined since the 1970s while new crimes like identity theft, internet related crimes, counterfeit goods, credit card fraud, and business espionage have grown. State and local police are not well equipped to deal with these crimes and their wide geographic occurrence and origins. The police also have limited interest in dealing with them. Market driven private police have been entering the void by providing security services to specific cliental with varying demands. Indeed, private security personnel are estimated to be three times that of public law enforcement agencies of federal, state and local levels (McCrie 1992; Shearing and Wood 2003).

Local public services within small suburban communities reflect the preferences of the residents and changes in those preferences. A main reason why local governments are sensitive and react to changes of preferences is the 'political' distance between residents and both the local policymakers and local government officials. In relatively small suburban localities, each vote is important. Further, greater acquaintance with residents requires local elected and non-elected officials to address individual and specific concerns. As the size of the community increases, the 'distance' between residents and local officials grows. Thus, the importance of individual voters and their concerns becomes diminishes, and as a result public services reflect a consistent shrinkage of residents' well-being. Local decision makers and officials become more rigid to change and address more the median voter. As such, in the larger localities more enclaves of residents are not satisfied with the level and composition of public security services, become more pessimistic about their chances of being able to make changes, and resort to the use of private, volunteer and self-security. Also, based on the Tiebout model, smaller localities

incorporate homogeneous socio-economic residents with similar preferences about the quantity of police services desired. Larger localities include greater variability in socio economic characteristics, and sufficient population threshold to reflect wide spread preferences that are more difficult to be accommodated by existing average resident oriented police force, and thus yield greater and consistent search for non-public security services. There is ample evidence that there is positive and permanent correlation between the size of the locality and the greater reliance of non-public security services. Gated communities usually exist in larger localities with residents mostly of higher income and older.

Literature Review

The level and composition of public police in a community are determined through the political and the executive systems and presumed to satisfy the median voter (Holcombe 1989). Households chose to locate in one of multitude of communities available in the metropolitan area that is the closest to their set of preferences (Tiebout 1956). However, the demands of most residents still deviate from the actual quantity of services offered by public police. Further, the literature of Public Choice suggests that households' preferences change overtime but unlike competitive markets, the monopolistic government does not adjust the level and mixture of services to better reflect these changes. The complexity and rigidity of local governments does not allow individual concerns to be easily addressed. Often, the transaction costs to the household wishing in changing local public supply consistently exceed the expected private benefits.

Lack of satisfaction of households with public police also emanates from the supply side factor of congestion. The burden on public police has substantially increased since the 1990s because of the 911 system, increased demand for response to burglar alarm activations, and since 2001 homeland security obligations. This has created congestion (for discussion of congestion of public goods, see Oates 1988 and McMillan 1898). Police have changed their nature of activities from an umbrella like protection to response to specific incidents.

A second choice for the household is to resort to private supply of security services. Examination of the host of services offered by public police runs the gamut from club goods to totally private. A club good is a pure public good where exclusion is feasible (Buchanan 1965). Examples include security for gated communities and commercial or residen-

tial districts where defined populations who pay for the security receive the services.

Some scholars argue for the adverse effects of private security. Private security personnel are of lower skill than sworn officers and therefore their performance is weaker. Also, public police are more accountable than profit seeking private security and therefore less likely to act abusively. The wealthy are using private security causing crime to be displaced to less protected neighborhoods (see sources and evaluation of these issues in Blackstone and Hakim 2013).

The Theoretical Model

The question is whether we consider public security like police patrol as a pure local public good that should be financed by government through tax revenues, or should public security be privatized and financed by payments of private individuals. This issue is raised in several papers in the literature. The main concern arises when consumers have different requirement and needs for public safety, either because they have different requirements or needs for public safety or because they have different tastes or incomes and properties (wealth levels) and therefore their real benefits from the sense of security they gain are different. As we see below, equal needs that lead to equal sharing the cost burden of uniform coverage is efficient in welfare terms. This is not the case where the different needs that are represented by different distributed demands require coverage through uniform pricing. Then the question becomes as to who pays and how the cost burden is distributed between or among customers and furthermore, how much public safety will be supplied. It is possible that too much security may cause damages and disabilities to several customers, but for others it can be still important and very valuable.

Another issue is the possibility that public security is not homogeneous in its characteristics. Thus, we cannot add all kinds of police activity under one umbrella, and as a matter of fact the cost side of paying for police protection can also be more complicated, since not all of them should be sworn officers who graduate from the police academy. For some security activities like controlling car traffic or helping young students cross the road to school only very limited and basic training are required. On the other hand, some sophisticated economic crimes involving the underground economy or the internet require very specific talents on a much higher level that a standard police academy graduate can supply. The simple aggregation of demands for distributed qualities of security should be

decomposed on both sides of the demand and the supply simultaneously. This is the purpose of our current paper.

Let us start with the model where all consumers for the public security, G, are identical in taste income or demands. This is described in case 1 below:

CASE 1

Let us assume that in the market we have N identical consumers whose identical demand to the public security, G, is as follows:

$$D_i: P_i = A - \alpha G \quad \text{for all} \quad 1 \ldots N. \tag{1}$$

The aggregate demand of the market for G can be derived by vertical summarization:

$$D: P = N \cdot P_i = NA - \alpha NG. \tag{2}$$

Assuming a linear cost function of G with marginal cost per unit, C, the cost function is:

$$TC = C \cdot G. \tag{3}$$

According to the simple Lindhal solution for pure public good we can find the optimal value of G as follows:

$$MC = \sum P_i. \tag{4}$$

From (3) – (4) we get:

$$C = NA - \alpha NG. \tag{5}$$

Or, we can find the optimal value of G:

$$G = \frac{NA - C}{\alpha N}. \tag{6}$$

From (6) and (5) we can measure the total consumer's surplus, TCS, as follows:

$$TCS = \frac{(NA - C)^2}{2\alpha N}. \tag{7}$$

For simplicity of presentation we assume further that $\alpha = 1$, therefore consumers surplus of case 1 can be rewritten as:

$$TCS_1 = \frac{(NA - C)^2}{2N}. \tag{7'}$$

CASE 2

In the following case we assume heterogeneous customers so that on average the representative consumer I, has the same demand for G as at (1) above. However, the demand curves of all N consumers are rectangular (uniformly) distributed. Therefore the demand of any consumer i is defined as (8) below:

$$D_i\colon P_i = A + \frac{N}{2} - i - G. \tag{8}$$

Further, since we face some consumers with very low reservation price that is equal to $A_i + \frac{N}{2} - i$, for specific consumer I, it is possible to gain disutility from certain level of G demonstrating negative consumers' surplus. Those citizens (consumers) are 'fed up' from too much police patrol and too many policemen controlling their habits and interfering with their lives and do not feel that they need as much service supplied by the government. In order to simplify our analysis we ignore the possibility of negative marginal utility from excess supply of the public good.

Therefore we can introduce the demand curves for different value of G as follows

$$P = \begin{cases} A \cdot N + \frac{N^2}{2} - \frac{(1+N)\cdot N}{3} - 0 \cdot N & G = 0 \\ A \cdot N + \frac{N^2}{2} - \frac{(1+N)\cdot N}{3} - 1 \cdot N & G = 1 \\ \vdots & \vdots \\ \vdots & \vdots \\ A \cdot N + \frac{N^2}{2} - \frac{(1+N)\cdot N}{3} & \\ \quad -(A + \frac{N}{2} - N)^2 \cdot N = \frac{N\cdot(N-1)}{2} & G = A + \frac{N}{2} - N \\ \vdots & \vdots \\ 0 & G = A + \frac{N}{2} - 1 \end{cases} \tag{9}$$

In more general terms we can write the equations of (9) in reduced forms as:

$$P = \begin{cases} A \cdot N + \frac{N^2}{2} - \frac{(1+N)\cdot N}{2} - N \cdot G & G \le A - \frac{N}{2} \\ \frac{(N-i)\cdot(N-i-1)}{2} & G > A - \frac{N}{2} \end{cases} \tag{9'}$$

We assume that government ignores the differences in preferences, and treat identically all constituents, like in case 1. We assume also that all

local governments in the metropolitan area have the same cost function as above: $T = CG$ to determine the same level of (6′).

$$G = \frac{N \cdot A - C}{N} = A - \frac{C}{N} \tag{6′}$$

and charge all customers the equal cost sharing burden as follows:

$$P_i = \frac{C}{N}. \tag{10}$$

For any customer we can define his consumer surplus as:

$$P_i = A + \frac{N}{2} - i - \left(A - \frac{C}{N}\right) = \frac{N}{2} - i + \frac{C}{N}. \tag{11}$$

Therefore the total consumers' surplus in case 2 is:

$$TCS_2 = \sum_{i=1}^{N} \frac{\left(A + \frac{N}{2} - 1\right)^2}{2} - \sum_{i=1}^{i^*} \frac{\left(\frac{N}{2} + \frac{C}{N} - i\right)^2}{2} - \left(A + \frac{C}{N}\right). \tag{12}$$

Or,

$$\begin{aligned} TCS_2 = {} & \left(A + \frac{N}{2}\right)\left(A - \frac{N}{2} - 1\right) \cdot \frac{N}{2} + \frac{N(1+N)(2N+1)}{12} \\ & - \frac{1}{2} \cdot \left(\frac{N}{2} + \frac{C}{N}\right)\left[\left(\frac{N}{2} + \frac{C}{N}\right)\left(N + \frac{2C}{N} - 4\right) + 1\right] \\ & - C\left(A - \frac{C}{N}\right). \end{aligned} \tag{12′}$$

For simplicity of exposition, let us define three values of W, X and Y as follows:

$$W \equiv \left(A + \frac{N}{2}\right)\left(A - \frac{N}{2} - 1\right) \cdot \frac{N}{2}, \tag{13}$$

$$X \equiv \frac{N(1+N)(2N+1)}{12}, \tag{14}$$

$$Y \equiv \frac{1}{2} \cdot \left(\frac{N}{2} + \frac{C}{N}\right)\left[\left(\frac{N}{2} + \frac{C}{N}\right)\left(N + \frac{2C}{N} - 4\right) + 1\right]. \tag{15}$$

Thus, TCS_2 is:

$$TCS_2 = W + X - Y - C\left(A - \frac{C}{N}\right). \tag{16}$$

Comparing TCS_1 to TCS_2 yields (17):

$$TCS_1 = \frac{(NA - C)^2}{2N} \gtreqless W + X - Y - C\left(A + \frac{N}{2}\right) = TCS_2. \tag{17}$$

From (7′) and (17) we can see that $TCS_1 - C\left(A + \frac{N}{2}\right) > W$.

The other two values at (17) are X and Y that have different signs. We can see very easily that for large population N the value $\frac{C}{N}$ approaching zero, i. e. $\frac{C}{N} \to 0$. Therefore it is most likely that $X > Y$, this is because:

$$\frac{N^3}{4} - N^2 + \frac{N}{2} < 2N^3 + 3N^2 + N. \tag{18}$$

Therefore, we conclude that since (19) holds

$$A + \frac{N^2}{2} + \frac{N}{2} < \frac{1}{12}\left(\frac{7N^3}{4} + 4N^2 + \frac{N}{2}\right), \tag{19}$$

$$TCS_1 < TCS_2. \tag{20}$$

CASE 3

We now extend case 2 assuming the same demand distribution between or among the heterogeneous customers so that only the median customer is satisfied with the public supplied quantity of G_0; however many other customers, $\frac{N}{2}$, are willing to add additional units of private security that might be supplied as supplement in order to increase their consumer surplus. In this case we allow more flexibility in consuming security either by consuming pure public goods shared by all customers or by extra/additional private security, *PS*, provided individually/privately by part of the population ($\frac{N}{2}$ individuals) with high reservation prices. We use several assumptions for the extension of case 3.

- *A* public good and a private good are full substitutes.
- *C*, per unit cost, for the private and public good are the same.
- The burden of a public good is shared equally, but the supply of private security is totally paid by individuals (figure 1; G_0 is optimal pure public good quantity that was determined above at case 2, consumer surplus of median is S_{ABC}, consumer surplus of high demand is S_{DEBC}).
  Since G_0 is determined simultaneously and no private security is supplemented privately *SEBF* is *DWL* to high demand customer. If *C*, the cost of a unit of the private good production is constant then private security can be composed/combined as a supplement of pure

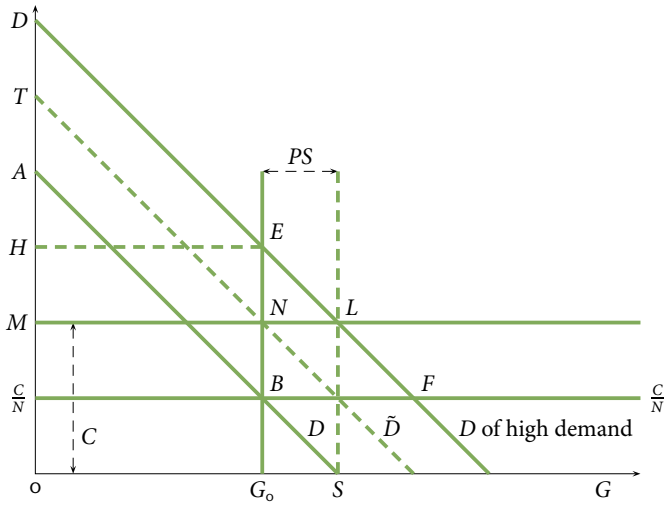

FIGURE 1

public security, G_o, and then the *CS* of the high demand customer increases. If additional *CS* can be obtained by S_{ENL} that can be obtained by G_o of pure public security and that will be added privately by the high demand customer for security.
However, if *N* is large enough then it is more likely that private security will be added to supplement public police.

- We totally ignore the disutility of customers who pay for too many units of the pure public good and are not compensated.

An extension of case 2 is that the negative utilities of low demand for public security may encourage a policy maker to reduce the quantity of the pure public good, lowering the burden of having it and instead maintain a higher provision of private security by individuals who pay a higher cost per unit of *C*.

In the figure we plot two extreme demands: The demand of the median customer who has no incentive to add any private security and is satisfied only with G_o units of the pure public good. The second customer has the highest demand for security of any kind and who has, therefore, the highest demand for supplementary units of private security. Since we have a whole distribution of demands in case 2 whose reservation prices are above *OA* but less than *OD* we have to investigate their attitude/behavior towards purchasing privately private security units. Since each of them finances the private security by himself and each unit costs

C, it is possible that they will not buy extra private security. This will happen to the customers whose reservation price is less than the size of $OA = OA + BN = OA + AT$. However the customer with a higher reservation price, i. e., $OD >$ reservation price $> OA + BN$ will benefit from the private security supply which will yield additional consumers surplus. The demand of the 'borderline' customer will not yet purchase private security.

At this stage we want to find the extra net social welfare of all customers who buy the private security, *PS*, in addition to the supply of the public good. For this purpose we introduce first the 'leftover' demand for the private security and extra units to the public good supplied.

For this purpose we introduce first to the leftover demand of the highest demand customer that is as follows:

$$P = \left[A + \frac{N}{2}\right] - \left[A - \frac{C}{N}\right] = \frac{N}{2} + \frac{C}{N}.$$

At equilibrium we can measure the quantity demanded for private security of this customer as follows. His demand is:

$$P = \left(\frac{N}{2} + \frac{C}{N}\right) - PS.$$

Since $P = C$ we find the highest *PS* of this customer as

$$PS = \left(\frac{N}{2} + \frac{C}{N}\right) - C.$$

For each other customer, *I*, the demand for *PS* is

$$P_i = \left[A + \frac{N}{2} - i\right] - \left[A - \frac{C}{N}\right] = \frac{N}{2} + \frac{C}{N} - i - PS. \tag{21}$$

The term in the first left bracket is the highest reservation price of individual i for security and the second term in the bracket is G_o the optimal supplied quantity of the pure public good.

For each customer, i, the 'leftover' demand for the private security, *PS*, is obtained as follows:

$$P_i = \left[A + \frac{N}{2}\right] - \left[A - \frac{C}{N}\right] - i - PS - C. \tag{22}$$

From (22) we find that PS, the demand for extra private security for each customer *i*, is:

$$PS = \frac{C}{N} + \frac{N}{2} - i - C. \tag{23}$$

As *i* is higher, *PS* purchase of customer *i* is smaller, and *PS* is approaching zero when

$$PS = 0 = \frac{C}{N} + \frac{N}{2} - i - C, \tag{24}$$

or

$$i = \frac{C}{N} + \frac{N}{2} - C. \tag{24'}$$

The extra consumer surplus of each customer *I*, for consumer *i* ($i = 0, 1, 2, \ldots, \left(\frac{N}{2} + \frac{C}{N} - C\right)$) is:

$$\sum_{i=0}^{\left(\frac{N}{2}+\frac{C}{N}-C\right)} S_{ENL} = \frac{PS^2}{2} = \frac{\left[\frac{N}{2} + \frac{C}{N} - i - C\right]}{2}. \tag{25}$$

Therefore, we get (11′) from (12′) and (25) the extra/additional welfare resulting purchase of private security as supplement to the optimal public security, G_0 as follows:

$$\Delta W = \sum_{i=0}^{\left(\frac{N}{2}+\frac{C}{N}-C\right)} S_{ENL} = \frac{\left[\frac{N}{2} + \frac{C}{N} - C\right]^2 - 2\left(\frac{N}{2} + \frac{C}{N} - C\right)i + i^2}{2}, \tag{25'}$$

or,

$$\begin{aligned} \Delta W = \Bigg[& \left(\frac{C}{N} + \frac{N}{2} - C\right)^2 - 2\left(\frac{C}{N} + \frac{N}{2} - C + 1\right) \\ & - \left(\frac{C}{N} + \frac{C}{N} - C\right)^2 - 2\left(\frac{C}{N} + \frac{N}{2} - C + 1\right) \\ & + \frac{\left(\frac{C}{N} + \frac{C}{N} - C\right)^2 \left(\frac{C}{N} + \frac{N}{2} - C + 1\right)^2}{4} \Bigg] \div 2 \end{aligned} \tag{25''}$$

Therefore, the extra welfare obtained by private security supplement is

$$\Delta W = \frac{\left(\frac{C}{N} + \frac{N}{2} - C\right)^2 \left(\frac{C}{N} + \frac{N}{2} - C + 1\right)^2}{8} \approx \frac{\left(\frac{C}{N} + \frac{N}{2} - C\right)^4}{8}. \tag{26}$$

The total extra private security purchase by all customers in addition to the mutual consumption of the pure public good, G_o, is measured as follows:

The *PS* of the highest demand for private security is

$$PS = \left[\frac{C}{N} + \frac{N}{2} - C\right].$$

The next one is

$$\left[\frac{C}{N} + \frac{N}{2} - C - 1\right].$$

The last customer who prefers only the pure public security with any extra private supplement is customer

$$\left[\frac{C}{N} + \frac{N}{2} - C\right].$$

Thus, the total private security supplement units *TPS*, are

$$TPS = \sum_{i=0}^{\left(\frac{N}{2}+\frac{C}{N}-C\right)} PS = \left[\frac{C}{N} + \frac{N}{2} - C\right] \cdot \left[\frac{C}{N} + \frac{N}{2} - C + 1\right] - \frac{\left[\frac{C}{N} + \frac{N}{2} - C\right] \cdot \left[\frac{C}{N} + \frac{N}{2} - C + 1\right]}{2}, \tag{27}$$

or

$$TPS = \frac{\left[\frac{C}{N} + \frac{N}{2} - C\right] \cdot \left[\frac{C}{N} + \frac{N}{2} - C + 1\right]}{2} \approx \frac{\left[\frac{C}{N} + \frac{N}{2} - C\right]^2}{2}. \tag{28'}$$

In the next stage we want to investigate the mixture between total private security purchased unit and the total public security unit.

The ratio 'mixture' between the two kinds of security units are:

$$Mix = \frac{TPS}{G_o} = \frac{\left[\frac{C}{N} + \frac{N}{2} - C\right]^2}{2\left(A - \frac{C}{N}\right)} \tag{28}$$

In the next section we examine how in case 3 changes in the independent variables *A*, *C*, and *N* affect the dependent variables, G_o, *TPS*, *Mix*, and ΔW.

Comparative Static Analysis

$$\text{Since } G = A - \frac{C}{N} \text{ then } \frac{dG}{dA} > 0,$$

$$\frac{dG}{dC} = -\frac{1}{N} < 0, \text{ and } \frac{dG}{dN} = \frac{C}{N^2} > 0.$$

$$\text{Since } TPS = \frac{\left(\frac{C}{N} + \frac{N}{2} - C\right)^2}{2} \text{ then, } \frac{dTPS}{dA} = 0,$$

$$\frac{dTPS}{dC} = \frac{2\left(\frac{C}{N} + \frac{N}{2} - C\right)^2 \cdot \left(\frac{1}{N} - 1\right)}{2}.$$

Assuming $N \gg A$, and $N \gg C$ and always $A > C$, we get that $\frac{C}{N} \to 0$. Therefore,

$$\frac{dTPS}{dC} = \left(\frac{N}{2} - C\right)(-1) < 0,$$

$$\frac{dTPS}{dN} = \frac{2\left(\frac{C}{N} + \frac{N}{2} - C\right)^2 \cdot \left(-\frac{1}{N^2} + \frac{1}{2}\right)}{2} \Rightarrow \frac{dTPS}{dN} = \left(\frac{N}{2} - C\right) \cdot \frac{1}{2} > 0.$$

- $\frac{Mix}{dA} < 0$ More public security relatively to private supplement when reservation price is higher.
- $\frac{dMix}{dC} < 0$ Lower production cost per unit of supplied security increases the mixed supply between private security and public security, i. e., less public security relative to private security (see appendix 1).
- $\frac{dMix}{dN} > 0$ In most cases a larger community necessitates a larger mixture of private security in comparison to public security (see appendix 2).

Taking the derivatives of equation (14) on changes in the *Mix* values with respect to A, C and N yields the following

$$\frac{dMix}{dA} = \frac{(-2)\left[\frac{C}{N} + \frac{N}{2} - C\right]^2}{\left[2\left(A - \frac{C}{N}\right)\right]^2} = -\frac{\left[\frac{C}{N} + \frac{N}{2} - C\right]}{2} < 0.$$

Assuming $N \gg A$, $N \gg C$ and always $A > C$, we obtain

$$\frac{dMix}{dC} \approx -\frac{A - C}{4A^2} - \frac{N}{2} < 0$$

TABLE 1

Independent variable	Dependent variable change			
	dMix	*dG*	*dTPS*	*dΔW*
dA	–	+	0	0
dC	–	–	–	–
dN	+	+	+	+

From (26) and (27′) we find that ΔW is equal to $\frac{TPS^2}{2}$. Therefore, the signs of the values $\frac{d\Delta W}{dA}$, $\frac{d\Delta W}{dC}$ and $\frac{d\Delta W}{dN}$ are similar to the signs of the parallel values of $\frac{dTPS}{dA} = 0$, $\frac{dTPS}{dC} =<$, and $\frac{dTPS}{dN} > 0$.

All the results above are summarized in table 1.

Based on table 1 we determine several additional results regarding the effects of *A*, *C* and *N* on the optimal values of public and private security expenditures and the welfare effects.

Higher value of *A* that indicates a larger 'necessity' for security leads to higher spending on public security. However, it does not affect the private security supplement expenditures that are spent by each private individual since it is cheaper to finance security publicly. Moreover, higher values of *A* reflect higher social welfare from public security. However, it does not change the values of *TPS*, Total Private Security. To summarize, more requirements for security increase permanently the value added of social welfare, leading to a Pareto improvement. The effects of increase in *C*, the production cost of security, on the decision variables are straightforward. It reduces the attitude to spend money on security of any kind, public or private. However, higher *C* of individually paid private security is more significant than collectively paid public security. Thus, the *Mix* decreases too. The most important results in our comparative static analysis relates to the population size, *N*, and has two contradicting effects. On the one hand, the increase in *N* increases the advantage of cooperation among consumers of sharing the burden of public spending. Moreover, the larger the population, *N*, the greater is the advantage of purchasing of more public security. On the other hand, the increase in *N* leads to groups with different demands for security. Therefore, in the specific rectangular distribution of demand and taste, public security increases by a lower percentage than private security. This leads to a higher mixture, *Mix*, and to a consistent increase in the importance of supplementing public police.

We may predict based on our results that in larger and more diversified communities the supplement of private security is more significant, while

in more homogeneous or small communities the population may rely on collective public security than in other large and non homogeneous communities.

The requirement that $N \gg C$ is crucial since it emphasizes the possibility of sharing the burden of public security before paying privately and individually for private security. A high level of C, may discourage many individuals from buying private security and from consistent increase in welfare.

Supplementing Public Police

The budgeting process of local government addresses the preferences of the 'median voter' which is determined through the political system. Specific preferences could be addressed by group of residents when their number reaches the economic threshold size. When the local political pressure to address the specific growth of services by the locality as a 'public good' is perceived difficult or fails then the group resorts to group effort like (1) private police or (2) volunteer effort like vigilante groups or specifically neighborhood watch. When such group action is difficult or involves high transaction costs by the individuals who wish to supplement public police then individual efforts are employed. Such individual activities include (3) self-protection, (4) property insurance, and (5) protection design. Self-protection includes deterrence, prevention, and detection measures. Individual preferences may motivate others to resort to acquire insurance policies with lower deductibles and greater coverage. The last security measure that is available typically when properties are built is environmental where access through windows and doors is made difficult, and access is controlled.

Private Police

Private police are estimated to be at least three times the combined federal, state, and local law enforcement (Blackstone and Hakim 2013). Some consumers and businesses desire more police protection than they normally can obtain. In particular, high income communities are the probable demanders of private security services. In the Central Business District of Philadelphia, Pennsylvania private security supplemented public police. In 1991 existing businesses in the CBD requested City Council to impose a permanent five percent surtax on their property taxes to fund private security. Between 1993 and 1994 crime decreased by six percent in the center l city business district but increased by 1 percent in the central police district which includes the center city business district. Further, 78

percent of area population believed that the center city business district was less safe prior to the arrival of the private security guards (Blackstone and Hakim 2010, 371). A similar situation occurred in Chicago where residents voted for a special district which involved a supplementary property tax to fund hiring private police. Unlike Philadelphia these officers were armed and acted much like the public police. Indeed 17 percent of their time was spent on serious crime related activities (Blackstone and Hakim 2010, 371).

New Orleans has similar such supplementation by private security. In 2012, e almost 30 districts within New Orleans voted to be taxed in order to procure private security services. The state legislature must approve the neighborhood's voting to create such a district. Each resident property is assessed an annual fee, 'usually hundreds of dollars' (McCarthy 2012). One official noted that people are concerned about their security, and want to see more officers available (McCarthy 2012). Some cities say such security districts are inequitable in that the wealthy receive better security. Further, it could be argued that citizens were already paying for protection and alternatively the entire city could add to its police force.

One New Orleans district, the Upper Audubon Security district, charges each property owner annually $500, has an annual budget of $200,000 and provides private patrol, personal home escorts, and residence checks. A larger security district, the Mid-City Security District, has a budget of $1 million and the district's president views the districts as a gated community (McCarthy 2012). This arrangement like the others discussed allows residents within a large governmental entity to obtain greater security services than normally would be provided them.

Oakland, CA has seen a growth of private security to supplement police services. Wealthy neighborhoods have contracted with private security to patrol their streets. The unusual aspect is the banding together of groups of neighbors to employ private security (Stein 2013).

Gated communities have been characterized as a kind of club good where residents band together to purchase collective services for their exclusive use. Included within those services is security. Physical and environmental barriers along with a cohesive community are employed to achieve such security (Csejalvay 2011, 736–7). Even in the 1990s, 2.5 million American families were already living in such gated communities (Blakely and Snyder 1998, 53). Access control is usually a prominent feature of gated communities which originally began in the West and then spread to the East. They usually exist in metropolitan areas and are rare in New England and the deep South. Surveys indicate that security was a pri-

mary motivation for living in gated communities. One survey found that 70 percent of gated community residents say that security was an important consideration in their decision to live in a gated community (Blakely and Snyder 2011). No surprisingly, income is an important element explaining who lives in such gated communities. The affluent residents are able to obtain more services including security than the less affluent city residents. The gated community allows residents to increase their use of security services.

Gated communities are most prevalent in Mexico where in 2010 an estimated 56 million people live in such gated communities of the total urban population of 88 million (see http://en.wikipedia.org/wiki/gated_community). Income differences and the fear of crime encourage such living arrangements. For example, the average 2008 income of Mexican urban residents was $26,654 while rural residents who often live close to urban areas average $8,403.

Around the world, gated communities are employed to protect residents from crime, clearly indicating that the residents want more security than provided by the public police. As in Mexico, gated communities with substantial private security are most common in nations with great disparity in income distribution. Examples include Brazil, Saudi Arabia, and South Africa.

Volunteer Efforts

This category includes neighborhood watch, safety control committees in apartment complexes, citizens serving as auxiliary unarmed police, and safe haven homes. Bennett, Holloway and Farrington (2006) report that in the early 2000s, six percent of UK homes or 27 percent of the population lived in areas covered by neighborhood watch. They note that there were 155,000 neighborhood watch organizations operating at the time. The US had 41 percent of its population living in neighborhood watch covered areas during the early 2000. These volunteer efforts were the largest supplement to public police, and provided information to the police on suspicious activities. The study also stresses the fact that such security alert groups was shown to deter criminals.

Self-Protection

When public police and local citizen group efforts are insufficient in addressing individual security preferences, self-protection measures are utilized. Residential Self- protection from crime is categorized into deter-

ring, prevention, and detection measures (Hakim and Blackstone 1997, 59–60). Deterring efforts are aimed to create the impression that the residence is occupied even when it is not. These measures are designed to encourage the burglar to dismiss the property from consideration when browsing for a target. It includes lights, active appliances, car always on driveway, the absence of accumulated mail and newspapers, and trimmed bushes near windows and doors. Prevention efforts are aimed to slow down or prevent by physical measures the entry of the intruder into the premises. These measures include bars on windows, deadbolt locks, and sash on windows. Detection measures are aimed to alert the police, private security or any pre-assigned person about a possible intrusion. The only such measure is a burglar alarm where a signal is dispatched. Interestingly, a yard sign which signifies the existence of a burglar alarm appears as a significant deterring measure (Hakim and Blackstone 1997, 66–70). In their empirical study which is based on residents' questionnaires, Hakim and Blackstone (1997, 70) showed that the motive for installing a burglar alarm is mostly for personal security.

Property Insurance

Insurance policy is a supplement for police aimed at recovering mostly monetary losses resulting from crime. Insurance is a normal good which is positively related to income and wealth. A supplement to public police is the acquisition of insurance policy. An insurance policy will be maintained as long as the expected costs of a break-in are higher than the discounted value of the annual premium payments. In a related matter, Hakim, and Blackstone (1997, 59–75) calculated that insurance discounts offered to owners of burglar alarms are beneficial to insurers. The premiums are beneficial to policy holders considering the costs of the associated treatments resulting from the violent crimes and the deductibles incurred on the property loss. Indeed, Loader (1997) notes the discounted insurance premiums for installing security hardware like burglar alarms, CCTV cameras, and deadbolt locks.

Environmental Design

Another personal supplement to public police is to restructure the physical layout of Communities to allow residents to control the area around their home. Newman (1972; 1996) pioneered the research and implementation of the defensible space. In his two books, Newman suggested design of streets, the grounds, and access to residents. He also dealt with the

design of the lobbies and hallways within housing complexes. His premise was to help people preserve those areas in which they can realize their community held values and lifestyles.

The key element in Newman's theory is to create a residential environment where physical characteristics including building layout and site plan function to allow inhabitants to observe their surroundings, and exercise control through effective ownership of their environment. By promoting a sense of 'belonging' for the interior and exterior common space, a criminal stands out and feels vulnerable. Newman also observed that smaller multifamily units create greater sense of belonging, better visibility of the environment, and thus make a long term safer living.

Conclusions

The Tiebout model suggests that a household moving to a metropolitan area chooses among the large number of suburban and urban localities to locate where the mix of public services best reflects its own preferences. The large number of localities provides greater social welfare. The result for a multi-communities region is that demands for public services are likely to be more diverse among than within communities.

This paper extends the traditional Tiebout model by considering security services, and suggesting based upon preferences the permanent mixture of public and private security for each community. The theoretical model shows how private security supplements public security and the magnitude varies among localities or preferences. The supplementing of public police with private security is implanted in the five forms of private police, volunteer efforts, self-protection, insurance, and environmental design. All these five forms result at different magnitudes among localities of varying preferences and without government intervention (the invisible hand). The use of private security exists, could increase, and varies among communities even when such services are perfect substitute to public police.

The paper investigates three models where quantity demanded for security varies within a community. In the case that the population is homogeneous in wealth, income, and preferences, supplementation is not needed. The society coordinates and shares the burden of optimal pure public good expenditures. This was illustrated by the first model. In the second model where population groups are heterogeneous either by location, properties, incomes, or preferences, a rectangular distribution of the demand for security is generated. In that case the solution of a solely pure public good supply according to the median representative consumer and

equally sharing the burden of finance is not the first best solution. By allowing a combination of a pure public good with private types of security, model three may lead under certain conditions to an improvement in social welfare. Several additional implications can be derived from our models. An increase need for security due to objective or subjective factors does not affect the demand for supplemental private security (which can be defined as 'neutrality of private security'), and will be supplied only by additional expenses on pure public security. These demand factors include, among others, changes in property values, income of all population groups, or uncertainty about economic and social conditions.

On the other hand, an increase in the production cost of security increases the demand for the pure public good and reduces private security expenses. The reason is that in relative terms, the public good is cheaper and private security becomes more expensive. Thus, the substitution effect permanently dominates in more public security and less private security. The mixture has changed, and in addition the total security level has unequivocally declined.

The last important finding is the impact of a change in population. An increase in the population has two effects: On the one hand the larger community yields greater demand for either public or private security. However, there is another effect of the increase in population in our model; a larger community also leads to a larger diversification of demands. These two effects lead to the important conclusion that as population increases public security as well as private security both increase. However, the former increases in smaller percentage terms than the latter. Thus, the ratio of private security to public security increases as the population grows.

Appendix 1

$$\frac{dMix}{dC} = \frac{8\left(\frac{1}{N}-1\right)\left[\frac{C}{N}+\frac{N}{2}-C\right]\left(A-\frac{C}{N}\right)-\frac{4}{N}\left[\frac{C}{N}+\frac{N}{2}-C\right]^2}{\left(4\left(A-\frac{C}{N}\right)\right)^2}$$

$$= 4\left[\frac{C}{N}+\frac{N}{2}-C\right] = \frac{\left[\left(\frac{1}{N}-1\right)\left(A-\frac{C}{N}\right)-\left(\frac{C}{N}+\frac{N}{2}-C\right)\right]}{\left(4\left(A-\frac{C}{N}\right)\right)^2}$$

$$= 4\left[\frac{C}{N}+\frac{N}{2}-C\right] = \frac{\left[\frac{A}{N}-\frac{C}{N^2}-A-\frac{N}{2}+C\right]}{\left(4\left(A-\frac{C}{N}\right)\right)^2}$$

$$= 4\left[\frac{C}{N}+\frac{N}{2}-C\right] = \frac{\left[-(A-C)-\frac{N}{2}-\frac{C}{N^2}+\frac{A}{N}\right]}{\left(4\left(A-\frac{C}{N}\right)\right)^2} \leq 0$$

Assuming that $N \gg A$ we find that $\frac{A}{N} \to 0$, therefore

$$\frac{\left[-(A-C)-\frac{N}{2}\right]}{4A^2} < 0.$$

Make more sense if the attitude towards C is to join mutual financing by customers of pure public security.

Appendix 2

$$\frac{dMix}{dN} = \frac{-4\left(-\frac{C}{N^2}+\frac{1}{2}\right)\left[\frac{C}{N}+\frac{N}{2}-C\right]\left(A-\frac{C}{N}\right)-\frac{2C}{N^2}\left[\frac{C}{N}+\frac{N}{2}-C\right]^2}{4\left(A-\frac{C}{N}\right)^2}$$

or

$$\frac{dMix}{dN} = \frac{2\left(\frac{C}{N}+\frac{N}{2}-C\right)\left(A-\frac{2AC}{N^2}-\frac{3C}{N}+\frac{C^2}{N^3}+\frac{C^2}{N^2}\right)}{4\left(A-\frac{C}{N}\right)^2}$$

Assuming that $N \gg C$ we find that $\frac{C}{N} \to 0$, therefore

$$\frac{dMix}{dN} = \frac{2\left(\frac{C}{N}-C\right)\cdot A}{4A^2} > 0.$$

Otherwise the sign of $\frac{dMix}{dN}$ is ambiguous.

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