

1. THE ECONOMICS OF CRIME

Considerable attention has been devoted by economists in recent years to analysis of criminal behaviour. Following the lead given in 1968 by Gary Becker of the University of Chicago a significant amount of research, both theoretical and applied, has emerged - with a particular concentration of contributions from individuals associated with Columbia University, Chicago University and the National Bureau of Economic Research in the United States and the University of York in Britain.

The major studies advancing economic analysis of crime include Becker (1968), Ehrlich (1973, 1975), Sjoquist (1973), and Carr-Hill and Stern (1973, 1975). In Australia surveys of some of the relevant theoretical issues are given by Jacobi (1976) and Baldry (1977). The economic literature in the area has grown sufficiently for books of readings (e.g. Rottenberg, 1973) and textbooks (e.g. Rogers, 1973) to emerge on the economics of crime and punishment.

The literature referred to is a coherent body of writings united by the formal application of the traditional economic theory of choice to criminal behaviour. It is thus differentiated from informal, descriptive or institutional analyses of crime by individuals trained as economists, and from management oriented cost-effectiveness analyses of particular procedures in criminal justice or police administration, which draw upon systems analysis and operations research.

The focus of most studies in the formal economic analysis of crime has been to analyse the way in which criminal behaviour depends upon the various risks and costs (including opportunity cost) associated with criminal activity, the expected gains from crime and various demographic and social factors. Particular attention has been paid to the deterrent effect of punishment for crime: the extent to which an increase in the probability of conviction or severity of punishment for a particular offence category will decrease the number of such offences committed.

Because of this primary orientation of the literature, analysis of police has been largely peripheral and derivative. There are few specific analysis of police services and where reference is made to the role of police it is usually only as police force size or police expenditure affects the probability of apprehension. In this latter context the police are an environmental influence only and the major analytical focus remains upon the criminal's choice process.

An extensive bibliography of the economics of crime literature is provided by Jacobi (1976). In this Working Paper we will concentrate discussion on items that deal in any substantive way with the question of police manpower. Of course there are many reports and studies on police manpower outside the economics literature. But this survey deals only with economics contributions.

It should be noted that economics of crime models following Becker have been the subject of considerably controversy and attack, especially by sociologists and criminologists. In part the criticism is misplaced since it misinterprets the meaning of the economic analysis, a problem no doubt due in no small part to the economists' lack of concern for presenting their results in a form intelligible to non-economic audiences. Most of the criticism relates to the motivation for criminal behaviour, however, so that a police manpower study need be less concerned with the issues so raised.

2. POLICE MANPOWER STUDIES

Economic studies of police manpower can be classified by whether they deal with supply or demand or both supply and demand.

The literature search did not reveal any formal simultaneous equation supply and demand studies for police manpower. There are supply and demand elements included in what is, in fact, a reduced form equation (i.e. mixed supply and demand factors without separate identification) in some simultaneous equation studies of the crime rate.

The Carr-Hill and Stern Model

An example of the reduced form approach is Carr-Hill and Stern (1975) who present and estimate the following simultaneous equations model of the supply and control of recorded offences in England and Wales:

$$Y = f(P, C, F, A, S, U, E) \quad (1)$$

$$P = f(Y, C, A, S, N, E, V, U) \quad (2)$$

$$C = f(Y, P, M, V, U) \quad (3)$$

where:

- Y is all indictable offences per head of population
- F is proportion of offenders given custodial treatment
- S is proportion of population that is working class
- U is proportion of the area of the police district that is urbanised
- E is total police expenditure per officer
- A is proportion of young (15-24) males in population
- N is population
- V is proportion of offences that are violent
- M is proportion of the population that is middle class
- P is proportion of crimes deemed to have been solved
- C is number of policemen per capita.

The model is estimated on 1971 cross-section data using full-information maximum-likelihood (FIML) estimation techniques. Equation (3) in the model defines the determination of the number of policemen per capita. Carr-Hill and Stern justify the specification of equation (3) as follows:

"This process is influenced by central allocation, local pressures and demands, and recruitment. The centre looks at the number of offences per capita, clear-up rates, and the proportion of the area urbanised, and therefore these variables were included. The proportion of offences that are violent and the proportion of the population that is middle

class were included as an attempt to capture local pressures for 'law and order.' (pp. 133-134)

The outcome of estimation is a positive relation between number of police and number of offences, and between the number of police and the clear-up rate, reflecting a presumption of increased efficiency and formality with increasing force size - particularly since this effect was not observed for similar analyses for 1961 and 1966. A positive relation is also found for urbanisation and middle class character as they affect police per capita. These results conform to expectations from sociological analysis.

More unexpected is a negative relation between police and violent offences. Carr-Hill and Stern argue that this reflects recruitment problems. The more violent offences the less attractive it is to be a police officer.

This analysis by Carr-Hill and Stern comes closest among the general criminal behaviour studies to analysing police manpower. Most other economic studies which do separately model the police role in crime and punishment typically analyse police expenditure rather than police manpower e.g. Greenwood and Wadycki (1973), Avio and Clark (1976). Where police manpower enters such an analysis it does so as an exogenous variable used to explain other variables. The level of police employment is not itself explained, except in Carr-Hill and Stern.

Now the point to be made for the work of Carr-Hill and Stern itself is that it is a reduced form equation only so that separation of supply and demand effects on police manpower is not immediate which restricts the analytical and policy value in manpower matters, and the equation used is quite ad hoc and so runs the risk of bias in the parameters estimated due to "specification error". This leads to the argument that what is required for police manpower analysis is specification of the structural equations of demand and supply so that they can be identified separately, and the derivation of that specification from a priori theory not from intuition.

This is not necessarily to imply that the Carr-Hill and Stern model is inappropriate for its own primary concern of the supply of offences. For this purpose determination of police numbers is a "control" variable only. However where police manpower itself is a focus a less casual approach is required to the police employment function. Then an offence rate equation becomes a "control" function to assist in identification of other functions of more immediate interest.

The tasks indicated by the discussion so far are:

- a) specification of separate demand and supply equations for police labour;
- b) integration of supply and demand of police labour for simultaneous estimation.

The Carr-Hill and Stern model provides the sort of framework for point b) provided we can better specify the structural form of their police employment equation. We turn now to studies appropriate to item a).

The Chapman Model

There is available one study which does explicitly derive from a theory of governmental decision a demand function for police and which also embodies this function in a simultaneous model of crime rate determination. This is the paper by Chapman (1976).

It can be assumed that citizens desire public provision of police services. The provision is public for both efficiency (public good) and equity reasons, though additional private protection is purchased in the market.

Public decision-makers are assumed to respond to citizens' demand for police services and allocate funds to a police department to meet this demand. The funds are to a large part expended on purchasing police labour, which is thus a derived demand from citizens' desire for protection.

Chapman (1976) has specified the form of this demand for police as

follows: Assume

1. demand for protection is met by police labour services
2. there exists a homogeneous set of citizens with common tastes for private and public goods.

On this basis a citizen utility function is postulated:

$$U_i = X_i G_0 G_p^\alpha \quad (4)$$

with:

- U_i = utility of citizen i
- X_i = private good consumption of citizen i
- G_0 = non-police labour public good
- G_p = police labour
- α = exogenous taste parameter

This function is maximized subject to the budget constraint:

$$Y_i = X_i + \frac{1}{N_i} (G_p WP + G_0) \quad (5)$$

with:

- WP = police wage
- N_i = population
- Y_i = real income

The resultant first order maximization condition gives the police demand function:

$$\left(\frac{G_p}{N}\right) = f(WP, Y_i, \frac{G_0}{N}, \alpha) \quad (6)$$

This tells us that the demand for police per capita will be a function of police wages, income per capita, other public goods per capita and tastes. Chapman specifies ad hoc the taste variables as being:

- TC = traffic congestion
- CR = crime rate
- OS = occupational structure.

The following signs on partial derivatives are predicted:

$$\partial(G_p/N) / \partial WP < 0$$

$$\partial(G_p/N) / \partial Y > 0$$

$$\partial(G_p/N) / \partial(G_0/N) < 0$$

$$\partial(G_p/N) / \partial TC > 0$$

$$\partial(G_p/N) / \partial CR > 0$$

$$\partial(G_p/N) / \partial OS < 0$$

Briefly the rationale for these sign predictions are, in order: that with a given police budget higher wages mean fewer officers employed; the higher are incomes the more there is to be protected and the more such protection can be afforded; the higher is demand for other government services the less can be provided for police from a given total government budget; the more traffic congestion the more demand for police to reduce that congestion; the more crime the greater the physical and psychological desire for more police services; finally, measuring the occupational structure by the percentage of blue collar workers, then for sociological reasons the less reliance will be placed upon the importance of police.

However the severity of the simplifying assumptions used to derive the demand equation and the ad hoc specification of taste variables make Chapman's demand model less than completely compelling. Accordingly it may be useful to also examine several variants of the model as alternative specifications. In particular one might wish to consider:

- (a) the possibility of capital-labour substitution as reflected in a suitable price of capital variable;
- (b) the possibility of police-civilian labour substitution as reflected in a relative wage variable;
- (c) other taste variables such as age structure of the population.

Finally Chapman himself does not specify a separate supply function of police labour so that there is a real question as to whether, in his empirical work, he has accurately identified a demand function for police. This problem can be remedied by also specifying and estimating a police labour supply function.

First the Carr-Hill and Stern and now the Chapman models have been discussed at length since it is intended to adapt them for use in the present Project. There are other models that could be discussed - but we will deal with them only briefly. Still on the subject of demand for police there are other U.S. studies that deal with determinants of local and state public expenditures of which one form is police expenditure e.g. Bergstrom and Goodman (1973), Borcharding and Deacon (1972). However the primary focus is not police, and police equations are embedded in multi-equation models that also include equations for all other forms of local and state expenditure. Specific accuracy of police equations is likely therefore to be limited since their form is derived from a much more general model that does not take account of any of the unique features of particular forms of expenditure. One model that deals with police expenditure only is Nakamura (1972), but the analysis is slight and does not distinguish manpower at all.

A multi-equation model that deals with police employment rather than expenditure is Ehrenberg (1973). The Ehrenberg model also has the virtue that it attempts to allow for administrative processes in a more realistic manner than most economic models, so that it is perhaps worth considering in more detail.

The Ehrenberg Model

For each individual assume a basic utility function:

$$U = U(V_G, V_P) \quad (7)$$

with:

V_G = utility from government activities

V_P = utility from private activities.

Ehrenberg assumes that there are no quality differentials in the services supplied across regions and that there is no factor substitution in production, assumptions also made by Chapman.

Next looking at public activities only the utilities obtained are given by:

$$V_G = V_G \left(\frac{M_1}{P} - \frac{b_1}{P}, \frac{M_k}{P} - \frac{b_k}{P}, \dots, \frac{M_n}{P} - \frac{b_n}{P} \right) \quad (8)$$

where:

M_k = full time equivalent government employment in the k^{th} category ($k = 1, \dots, n$).

b_k = minimum required employment of type k

P = population.

Now if bureaucratic decision-making processes are taken account of we can specify an incremental decision-making process based on previous budget and employment as given by:

$$b_k = \alpha_k M_{k,t-1} \quad 0 \leq \alpha_k \leq 1 \quad (9)$$

The limiting cases for this specification would be $\alpha = 1$ which would be strictly incremental, and $\alpha = 0$ which would be pure decision.

The process described in this way is that a government first budgets for existing employee levels and then distributes remaining budget funds for more employees.

Now assume the basic utility function $U = U(V_G, V)$ is strongly separable and then maximise U subject to the constraint on government resources, where this is a function of per capita personal income, federal grants, and prices of the various private and government services. This then gives two-stage maximisation with the steps being:

(a) branch total expenditure determined;

(b) intra-branch expenditure determined.

Then reverting to the non-factor substitution assumption made earlier this further gives:

$$(a) \quad \ln(B/P) = S_0 + S_1 \ln(RW) + S_2 \ln(G/P) + S_3 \ln(Y/P) \quad (10)$$

where:

B = total employment budget

RW = relative cost of public vs. private goods and services.
(e.g. government vs. manufacturing relative wages)

G = federal grants

Y = personal income.

(b) Given B/P then max (8) subject to (9) and the budget exhaustion constraint. This gives a general system of government employee demand equations:

$$\frac{M_{j,t}}{P} - \frac{\alpha_j M_{j,t-1}}{P} = F(W_1 \dots W_n, \frac{B - \sum_k W_k \alpha_k M_{k,t-1}}{P}) \quad (11)$$

$$j = 1 \dots n$$

and Ehrenberg adopts the specific form:

$$\ln\left(\frac{M_{j,t}}{P} - \frac{\alpha_j M_{j,t-1}}{P}\right) = b_{0j} + b_{1j} \ln W_j + b_{2j} \ln\left(R - \sum_{k=1}^n W_k \alpha_k M_{k,t-1}\right)/P \\ + \sum_{k=1}^m C_{Rj} \ln \text{SDR} \quad (12)$$

where:

SDR = sociodemographic variables

$$j = i, \dots, n.$$

This assumes that own-wage only is important (to avoid multicollinearity), and that SDR measures factors affecting quality of services differences across space.

Experimentation by Ehrenberg gave as the sociodemographic variables:

1. population density
2. 5-17 age group as proportion of population
3. > 65 age group as proportion of population.

All equations are estimated as a system for 11 categories across 48 states over 12 years (pooled) i.e. (11 x 546 observations = N).

The Ehrenberg model thus goes beyond Chapman in incorporating bureaucratic considerations as these affect demand and in estimating these simultaneously for all public employment types. It shares the limitations to Chapman's model of non-factor substitution and the assumption of infinitely elastic supply of labour. And it has the further weakness of being specified generally for all employment for all local government functions rather than just for police employment. To meet this latter concern various ad hoc amendments might be required.

Another model that looks at police employment along with other local government employment is Devine (1969). Looking specifically at nurses, teachers and police Devine argues that local governments experience persistent shortages in these categories, though not for other workers, because they are sufficiently large employers of teachers, nurses and police to be monopsonists in the labour market, while they are competitive employers for other job categories. And economic theory tells us that a monopsonist who is unable to engage in wage discrimination will experience job vacancies in equilibrium, and will neither raise wages nor increase recruitment expenditures sufficiently to eliminate them. Devine uses descriptive evidence from Los Angeles local government employment patterns to demonstrate the plausibility of this explanation of local government employment "shortages" in the United States.

Quite apart from empirical questions of the existence of similar "shortages" in Australia, there are problems with Devine's analysis. These have been thoroughly reviewed by Wolitz (1974). Wolitz points in particular to:

1. the competition between local governments for employees in the U.S., so that the degree of monopsony power may be small;
2. the way in which monopsony power can be exercised through other choice dimensions (e.g. raising hiring standards). A wage less

than the competitive wage but greater than the monopsony wage can be set to allow room for both selectivity from a queue of applicants and also remaining vacancies

3. Whether government agencies are the profit maximizing entities postulated in monopsony theory. It could be that other analysis is more suitable with public agencies maximizing service subject to fixed budgetary constraints or engaged in incremental budget exercises or complex political bargaining or some combination of these.

Wolitz own addresses itself to the first two of these problems, though in a general and descriptive way, and as we have seen Ehrenberg provides some insights on the third point raised.

Police Labour Supply

Chapman, Ehrenberg, Devine and Wolitz all concentrate on the demand for police. The former two studies assume supply of police is infinitely elastic. The latter two studies imply a positive sloping supply curve, for monopsony to be relevant. It is important to resolve which is the correct specification even if one is only interested in demand. This is because both qualitative and quantitative conclusions on demand will differ according to the nature of supply relations.

Only one formal economic study of police labour supply was discovered in the literature. This is Hamer (1974), who uses police for the analysis of occupational choice developed in military manpower supply economics. This provides Hamer with the following supply equation which he estimates for Los Angeles and Tucson police:

$$A = f(WP, WO, RA, UA, C) \quad (13)$$

where:

A = applicants for police patrolmen positions

WP = beginning police wages

WO = average manufacturing wages
RA = police recruitment advertising
UA = unemployment rate
C = draft inductions.

Hamer diverges from previous U.S. work on military manpower supply by defining the relevant dependent variable as applicants rather than recruits. This ensures that the variable is not biased by quality demand changes. He also specifies the wage variable as the police-civilian difference rather than ratio which accords with Becker's theories on labour supply, and he includes a recruit advertising variable which is often neglected in the military studies.

A similar supply function using these same variables and a taste variable (Hamer implicitly takes non-pecuniary preferences as given) was provided for Australian army applications and enlistments by Withers (1972). In Withers' work, which preceded Hamer, the underlying model of occupational choice is more fully developed. Because of the model's prior successful application to Australia and to police work in the U.S. it seems suitable for incorporation in a police manpower model as the basic supply specification. The empirical results on the wage parameter will indicate whether neglect of supply would have been important in a study focussing on demand - as has been more common in U.S. work.

3. CONCLUSION

In the economics literatures dealing with crime and public employment, police manpower has received only peripheral attention. In Australia it has received no academic attention at all from economists.

There is however available in the literature suitable components for a full model of police employment. Demand for police and supply of police have been analysed sufficiently, though separately, to provide useful specifications for incorporation. The inter-relation of demand with criminal behaviour is also adequately treated.

Treatment of joint determination of total public expenditures by function and of total public employment by function is also available. But for present purposes estimation error from neglect of these simultaneities is likely to be of relatively small magnitude. More productive is to focus on the police sector itself in order to define more accurately its own particular features, but with due attention to the interaction between demand and supply for police and between police employment and criminal activity. There is little prior attention in the literature to the further police capital-labour interaction and some modelling effort might also be usefully directed at this input choice question.

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