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Department of Economics

Economic Research Paper No. 01/04

The Economic Modelling of Policing and the Measurement of Efficiency.

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February 2001
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The Economic Modelling of Policing and the Measurement of Efficiency.

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A recent report (Public Service Productivity Panel (PSP) (2000)) has developed a set of criteria whereby the economic analysis of police force efficiency is to be made standard. An aim of the government’s drive for efficiency rankings is to enable the Home Office to determine a ‘best practice’ reference set of forces, and thereby allow differential funding of police forces. This paper attempts to put this recent development into a historical/evolutionary context and discusses: the economic methodologies behind creating best practice reference sets; the techniques proposed by the PSP (2000) report; and how best to estimate the production of police forces.

KEY WORDS: Police; best value, cost and production functions, data envelopment analysis, stochastic frontier analysis, and efficiency.

INTRODUCTION.

Political, economic and sociological research on the British police service can be divided into four areas in the literature. The first concerns the operation of the service and its relationship with the community, which can be traced back to Banton (1964) - see Reiner (1995), Morgan and Newburn (1997), and for a literature review Reiner (1989). The second covers the historical development of the police force, from its beginnings in 19th Century London; see for example Rawlings (1995). The third area

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considers the accountability and politics of policing and ranges from how police actions affect civil liberties to the changing nature of the organisational structure, both from a national and local perspective, see for example Borooah (2001).

The final area of research that has emerged in the literature concerns the interaction of the neo-classical economic and sociological methodologies. That is, this economic based research programme considers in detail the microeconomic consequences of the cost of policing and the resource allocation problems inherent in managing forces, see for example, early papers by Warlzer (1972) and Darrough and Heineke (1978), and more recently papers linking police resources to crime prevention, such as Benson and Rasmussen (1998). Hence, the literature is concerned with the alternative production and input mix strategies that can be utilised in the reduction of crime incidences, and with the use of external ‘competition’, see, for example, Jones and Newburn (1995) for a review of the growing use of the private security sector. This methodology is also now associated with the local perspective of policing and how Local Police Authorities (LPA) draw up their plans in the assessment and operational stage, under the Police and Magistrates Act (1994) and subsequent legislation.

Hence, in an economic conceptualisation of the modern police force it is possible to introduce a value based methodology, and this is evident in the reorganisation of the police service following the Thatcher/Major government reforms, especially after the Sheehy Report (1993). Indeed, after the defeat of the Conservatives in the 1997 election, the new Labour government has also carried on this agenda of ensuring efficiency in police forces. For example, the Home Secretary has stated that any new increases in resources given to the police service would be made on the premise that forces are able to show a 2% efficiency saving redirected back into front line operations.

Two distinct views of the police are apparent in the terminology of police functions as prevention/proactive or response/reactive based. The latter can be attributed to the traditional Conservative description of what constitutes the major function of the police, as it is easy to quantify outcomes (for example, clear up rates) and hence link forces to performance tables, see Sullivan (1998) and Drake and Simper (2002). However, there has been a slight change in policy under new Labour in the sense that the former has been elevated to become an important attribute that
governs the police service. This prevention/proactive approach relates to securing what new Labour wants from the criminal justice system, and includes:

Dealing with crime in its social context, tackling the causes as well as the effects;
Stopping crime before it starts, rather than dealing with its consequences;
Looking at problems holistically, with the interested parties working together to tackle identified problems in an effective way;
Addressing the problems that really concern people in their own communities;
Promoting a culture of balanced rights and responsibilities.

The above five criteria imply that the efficiency of the police force, and how it is measured, will now include many unobservable factors, such as time patrolling the beat and crime prevention talks to the public. Hence, the commitment to ‘measurable’ and costed activity under the Conservative government has now been diminished. Indeed, Loveday (1997), argues that costing analysis linked to policing by targets (such as increasing the clear-up rate) led to an erosion of the ‘convention of constabulary independence’, with the setting of these targets by the Local Police Authorities, under the Police and Magistrates’ Courts Act 1994. Furthermore, only is it difficult to analyse what constitutes appropriate police inputs and outputs, but there are also local differences in economic (e.g., unemployment) and sociological (population of inner city) circumstances, such that the ‘soft’ performance measures utilised could lead to good management techniques being seen as a bad use of resources.

The concept of how to measure police performance has been moved to the forefront of the political agenda in the new Labour governments second term. Indeed, the recent Public Service Productivity Panel (PSP) (2000) report has stated that two quantitative techniques; the nonparametric Data Envelopment Analysis (DEA), and the parametric Stochastic Frontier Analysis (SFA), be utilised to enable efficiency rankings of forces. It is an aim of this paper, therefore, to outline the techniques that have been proposed by the PSP to assess police force efficiency. This outline will include an introduction to the managerialism, and hence best value implementation, within the service (see also Alexander (2000)), and to the aforementioned techniques that can be utilised to measure efficiency.
THE MANAGERIALISM OF THE POLICE SERVICE.

The analysis and estimation of efficiency in English and Welsh police forces, as proposed in the PSP (2000) report, is based on a background of change within the service which includes; changes to the culture and core tasks (see Walker (1996)), and the introduction of business and economic techniques in costing and output measurement. This latter reform of the police service has been linked to the efficiency drive instigated by the Conservative Government and prompted by the steady increase in crime since 1979, and the disproportionate increase in the fear of crime. Furthermore, as the crime rate appeared to rise with the economic cycle, contrary to many economic theories, commentators began to question police effectiveness. Stephens (1994), for example, has identified the growing cost of, and increasing levels of crime, coupled with the declining public standing of the police force (associated with, miscarriages of justice such as the Guildford Four and the Birmingham Six, and the miners’ strike in 1984/85, for example) as a major impetuous in the re-evaluation of police functions.

These factors led to an inspection and review of the police, firstly under the Conservative government which included agencies such as Her Majesties Inspectorate of Constabulary (HMIC) and the Audit Commission, and the introduction of various public charters including the Citizen’s Charter and the Victim’s Charter (for a discussion see Stephens (1994) and Sullivan (1998)). The comprehensive review of the service resulted in several publications which promoted renewed interest in the efficiency of the police and included: Audit Commission (1990); Home Office (1993); Police Research Group (1993) and the Sheehy (1993) report which led to recommendations included in The Police and Magistrates’ Courts’ Act 1994. One of the main recommendations of the Sheehy Report was to change the nature of police management from a public to a business-orientated organisation and to introduce efficiency targets co-ordinated with Local Police Authorities (known as Key Performance Indicators (KPIs)).

1 The quest for efficiency in the Thatcher years began with a Home Office circular, 114/83 Manpower, Effectiveness and Efficiency in the Police Service which gave way to the ‘civilisation’ of the force in the Home Office Circular 105/88, Civilian Staff in the Police Service.
The introduction of managerialism in the police can therefore be traced back to the 1980’s, and the Economist (Sept 4th 1993) characterised this period as the ‘privatisation’ of the service and the start of ‘civilianisation’ and ‘securitisation’. The former meant hiring ordinary civilians to undertake tasks once considered within the police domain, such as lost property, garage repairs for police vehicles, etc. Securitisation of the police force led to increases in the numbers, and economic income, of the private security sector, which includes bodyguards and security consultants for offices and retail establishments. For example, Jones and Newburn (1995) found, using British Telecom’s Business Database and the Labour Force Survey, that by the early 1990’s there were 7842 private security firms employing over 164,000 people in Britain. That is, private security guards employed in Britain out-numbered policemen, and the sector had an estimated turnover of more than £2 billion, a third of that of the Police Service.

However, the analysis of police efficiency and the concept of Value For Money (VFM) in the public sector can be traced back even further to the Planning Programming and Budgeting (PPB) during the period 1969 to 1974. This considered the outputs of the police service and its inputs, so as to enable the valuation of scarce resources (see, Southgate (1985)). This initiative was also associated with the increased expansion of the service and, as Sinclair and Miller (1984) argued, the fact that police managers found the traditional “‘seat of the pants’ approach to management increasingly difficult.” (page. 4). However, this initiative was found to be unworkable due to a lack of systems in place enabling the easy interpretation of inputs and outputs, and it was not until a reinterpretation of policing activity under the Conservative government’s 1983 Home Office Circular 114, that efficiency of the service was scrutinised. In an approach designed to make forces explicitly state their aims and use of resources, the Home Office circular had four criteria, of which the fist, as Burrows (1989) argues, was deemed the most important. That is, police

2 That is, “managerialism referred to the belief that all state services do better when reconceived and restructured in terms of the business community’s values of efficiency and effectiveness” Sullivan (1998) (p. 307).
expenditure “increases will only be given to forces whose resources are directed in accordance with ‘properly determined objectives and priorities.’” (page. 22).

Since being elected in 1997, the new Labour government has carried on this agenda of promoting efficiency in the police force (see the Home Office Inspectorate of Constabulary (HMIC) (1998) report “What Price Policing”). The report reiterated the previous Conservative government’s efficiency drive in the police service with the HMIC arguing that, “police managers need to work harder to ensure that VFM is achieved, for competitive pressure has to be created internally. The costing of activity with subsequent measurement and comparison of performance provide the means by which such encouragement is given” (para. 10).

In addition, the Key Performance Indicators (KPIs) were refocused in 1998/99 to include; youth offending; local partnerships to enable a reduction in crime; and reducing drug related crime, which came about as a result of the Crime and Disorder Act 1998. Since 1999 these KPIs have been updated in response to the Macpherson Report on the death of Stephen Lawrence. The new updated KPIs implemented after June 2000 included the additional aim to increase the ‘trust and confidence in policing amongst minority ethnic communities’ (Report of Her Majesty’s Chief Inspector of Constabulary 1999/2000). Based on these KPIs, the target expressed in the PSP (2000) report is to ensure differentiation between forces, such that “top performers should get a tangible reward,” and hence be given “preferential access to discretionary funding mechanisms, such as the Crime Fighting Fund. This type of approach would also ensure that the extra funding available would be going to those forces that have the track record to show that they could do the most with it.” (page. 39).

The assessment of English and Welsh policing activity, as discussed above, can be traced back over 30 years. However, the methodology underlying the current efficiency measurement programme can be traced back to the Home Office Report “Measures of Police Effectiveness and Efficiency”, Sinclair and Miller (1984). In this report the authors conducted interviews with senior policemen to gauge an

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3 The process of the police rationalisation can also be seen after the Conservative Government’s drive to efficiency and the concept of value for money in all public services. For example, the Home Office policy in the evaluation report, “Review of Police Core and Ancillary Tasks” published in 1995, by the then Home Secretary Michael Howard, stated that the report was “designed to help police managers
understanding of the complexities of measuring both inputs and outputs, as required in any evaluative technique designed to enable improvement in the efficiency of the service. Recent publications have re-assessed the economic evaluation of policing tasks, for example, Stockdale et al (1999) in a Police and Reducing Crime Unit report, “Applying Economic Evaluation to Policing Activity” (1999). The latter report states that, “there is a growing need for the police to make resource allocation decisions transparent, to evaluate outputs and outcomes, and to demonstrate that resources are being used to generate the best returns.” That is, “economic evaluation involves the costing of inputs and valuing of outputs and outcomes, with particular emphasis on assigning monetary measurements wherever possible.” (page. v).

This report, using the proactive/preventive methodology states that there are three “relevant approaches” to analysing policing efficiency; performance; cost effectiveness analysis; and cost benefit analysis. In consideration of previous analyses, they state that, “for proactive policing, economic evaluation is currently only practicable in the context of specific initiatives, the application was not so easily applied to functional changes or to changes in ethos.” (page viii). Indeed, Stockdale et al (1999) state that there has been “greater emphasis on proactive policing. Forces have been urged to adopt intelligence-led policing and many have responded by introducing crime desks and crime management units, as well as undertaking specific initiatives.” (page. 2). In this context, “proactivity refers to the strategic deployment of resources in order to target ‘criminally active’ individuals, so as to obtain evidence for a successful prosecution. Such strategic action is intelligence-driven, with intelligence informing decisions about resource allocation to implement specific proactive operations and to support action in the broader arena of crime reduction.” (page. 5).

However, the PSP (2000) report “Improving Police Performance”, although noting the importance of proactive/preventive policing, proposed that any model should take into account all factors of policing. That is, “the selected outcome measures capture the essence of police outcomes and thus, implicitly or explicitly, the many dimensions to policing… The focus of the outcome measures should be on what the police are being expected to achieve for the money they have. This is

cope with the rising demand by considering if there are tasks which the police no longer need to carry out, or where their involvement can be reduced or streamlined.”
different from trying to model everything that forces do on a day-to-day basis.” (page. 16). Hence, an efficiency model should have its outputs/outcomes based on a set of BVPIs from both the proactive/preventive and response/reactive methodologies, see Department of the Environment, Transport and the Regions., (1999) for a list of BVPIs.

A further implication of the report is that a modelling strategy that can allow for the joint interaction between the input and output set should be developed. Therefore, standard operations management input-output based techniques, to enable the measurement of police performance and optimal resource allocation decisions (see Correa and Wakefield (1996)), will be unlikely to discriminate adequately among forces. The report states that as this interaction and ‘complete’ modelling strategy using a set of input and output/outcome variables is important, economic techniques such as production and cost function estimation should be utilised. Hence, it was argued that multi-input/multi-output non-parametric techniques, such as Data Envelopment Analysis (DEA), and parametric techniques, such as the stochastic frontier approach (SFA) be used in tandem thereby allowing a broader set of variables to be used in the estimation analysis.

EFFICIENCY MEASUREMENT TECHNIQUES.

The estimation of the two modelling techniques (DEA and SFA), implies that there can be posited a production or cost function equation of policing activity. In the literature there have been two methodologies that have been proposed in respect of the estimation of a police force cost or production function. The first follows Darrough and Heineke (1979) (see also Gyimah-Brempong (1987)), where we assume that a police force chooses the level and mix of input to maximise the net value of police output. The second methodology is based upon the former model in that we can estimate its dual, a cost function for a multi-input/multi-output police force (see Carrington et al (1999), Drake and Simper (2000) and (2002)).

4 The problems associated with the current empirical methods used by the Home Office in the allocation of funds have been discussed by Carr-Hill (2000). This paper considers models which are
Thus, in both modelling frameworks (and underlying the PSP (2000) report), we assume that the police function can be neatly classified within the neo-classical economic paradigm. That is, in the Darrough and Heineke (1979) specification we assume that police administrators are concerned with crime i until the marginal cost (MC) of that crime is equal to a weight $p_i$, the value of the crime solved. In Carrington et al (1999) and Drake and Simper (2000) and (2002), the model assumes that the aim of the police is to minimise their input set while keeping output constant, that is, both models are based on similar premises. Hence, we can assume in both specifications that police forces, through the Value For Money (VFM) argument, aim for cost minimisation. The latter statement has important implications for all police forces when it comes to analysing efficiency. For example, an aim of BVPI analysis is to ensure forces reduce the marginal cost of catching and arresting criminals in addition to other police functions. In this context, both the response/reactive and proactive/preventive jobs of policing must be undertaken with the aim of cost minimisation in the input set of variables and their subsequent transformation enabling increases in outputs/outcomes. If this is not undertaken effectively, through the optimal allocation of resources to output/outcomes, an examined force is unlikely to be found efficient relative to its peers.

The PSP (2000) report highlights two “state of the art” techniques that are able to assess the efficiency of police forces. Indeed, it goes further by stating that, "DEA and SFA should be used to provide an assessment of the relative efficiency of police forces in delivering police outcomes." (page. 7). The first method is concerned with the objective of constructing an efficient frontier for the police force’s cost minimising activities. The term Data Envelopment Analysis (DEA) was coined by Charnes et al (1978) and is a linear programming technique for constructing extremal piecewise frontiers as originally developed by Farrell (1957). DEA is a leading analytical technique for measuring relative efficiency and has been widely used by both academics and practitioners in evaluating the efficiency of decision making units (DMUs) within an organisation or industry in terms of converting resources/inputs into outputs.

supposed to overcome the difficulties mentioned by Carr-Hill (2000) by estimating economic models of cost and production functions.
The technique was originally developed in order to develop performance measures in non-profit making organisations where the usual monetary criteria of return on assets/capital, etc, were not appropriate, for policing, see Carrington et al (1999), Drake and Simper (2000 and 2002) and Nyhan and Martin (1999). The constructed relative efficiency frontiers are non-statistical or nonparametric in the sense that they are constructed through the envelopment of the decision making units (DMUs), with the "best practice" DMUs forming the non-parametric frontier. Hence, a particular attraction of DEA is that no knowledge is necessary of the underlying production or cost function. All that is required is that some correspondence exists between inputs and outputs/outcomes across the DMU.

An alternative approach to the non-parametric frontier measurement techniques (DEA) is that of stochastic frontier models suggested by Aigner, Lovell and Schmidt (1977). These models typically involve the specification of a stochastic production or cost frontier, in which a cost function can be rewritten more formally as follows:

\[
\ln C_{it} = \ln C(y, w)_{it} + \varepsilon_{it}
\]

\[
\varepsilon_{it} = \ln u_{it} + \ln v_i, \quad v_i \geq 0
\]

Where \(\ln C\) represents the natural logarithm of total costs, \(y\) is a vector of outputs/outcomes, \(w\) is a vector of input prices and \(\varepsilon_{it}\) is a composed error term that reflects both statistical noise and the X-inefficiency (see below) of the police forces in the sample. The component \(u_{it}\) is assumed to be symmetrically distributed around a zero mean but \(v_i\) is assumed to be non-negative (non-positive in the case of a stochastic production frontier). Hence, \(v_i\) represents the deviations above the minimum cost frontier (X-inefficiency) associated with either technical inefficiency (excessive use of inputs in the production of outputs/outcomes) or allocative inefficiency (the failure to utilise the cost minimising input bundle given input prices and the level of outputs/outcomes). However, to obtain inefficiency scores, it is necessary to make assumptions concerning the distribution of the X-efficiency error term, \(v_i\), such as the half normal or truncated normal, see Drake and Simper (2001).
Indeed, estimation utilising other distributions, such as the gamma distribution (see Greene (1993)), could lead to different efficiency ranking and scores, although Berger (1993) argues that if a panel data series is utilised (where data is available over a number of years), an approach can be adopted in which it is not necessary to specify an exact distribution for the inefficiency term, see Drake and Simper (1999).

As alluded to previously, a particular advantage of non-parametric techniques such as DEA, relative to statistical or parametric techniques such as stochastic frontier analysis (SFA), is that the latter must assume a particular functional form which characterises the relevant economic production function or cost function (traditionally a Translog cost function).\(^5\) Hence, any resultant efficiency scores will be partially dependent on how accurately the chosen functional form represents the true production relationship (i.e., the relationship between inputs/resources and outputs/outcomes). As DEA is non-parametric and envelops the input/output data of the DMUs under consideration, the derived efficiency results do not suffer from this problem of functional form dependency.

An aim of the PSP (2000) report is to use DEA and SFA to aid efficiency rankings, i.e., by police rank quartiles, for example. That is, "differentiated efficiency targets - to improve the level of police outcomes for the funding available - should be introduced thereafter based on the banding system." (page. 7). However, in respect of the disadvantages of DEA, it must also be remembered that DEA can produce a number of jointly efficient units, i.e., all ranked at 100. In these cases, no further relative efficiency discrimination is possible across these units in the basic DEA analysis. Hence, this creates a problem in respect of banding because we might find that a large number of forces are placed in the top band.\(^6\)

\(^5\) Indeed, even though Darrough and Heineke (1979) and Drake and Simper (2000b) begin with different premises for their methodology, they both utilise the Translog cost function to estimate their chosen function of police activity.

\(^6\) It is interesting to note that there has not been a substantial discussion over how these 4 quartile groups are derived. This could mean that a force could challenge the method (by eye?) that the Home Office used in order to place them in the second rather than the first, for example. Of course, this is important, as millions of pounds of additional funds would be lost. However, given the first eyeballing stage, statistical tests, such as Multidiscriminant Analysis or ANOVA could be used to verify groupings.
A further potential criticism, given the non-parametric nature of the DEA approach, is that any deviations from the efficient frontier are interpreted as inefficiencies as a consequence of the absence of a random error term. Hence, there is the possibility that DEA actually overstates inefficiency levels by failing to allow for “bad luck”, measurement error, etc. DEA efficiency measurements can also be sensitive to outliers. This possibility arises from the fact that the efficient frontier is itself derived from the actual input/output configurations of the sample firms/units. Hence, the level of efficiency may be largely self determined in the case of outliers as there may be no similar units in the relevant input/output region from which to form the efficient production frontier.

For these reasons, together with the other well known pros and cons of non-parametric versus parametric efficiency measurement techniques, the PSP (2000) report advocated that the results obtained from DEA should be contrasted with a comparable parametric approach (the stochastic cost frontier). The latter model is less prone to the outlier problem and does not tend to produce units which are jointly 100% efficient. Hence, SFA can produce more discrimination across the most efficient units than DEA. Furthermore, given that both DEA and SFA have different sets of pros and cons, it follows that the fairest and most accurate reflection of police force relative efficiency will be produced when the non-parametric and parametric results are combined (see Drake and Simper (2001)).

The problem of outliers is linked in part to scale economies/efficiency in policing, and hence to force size. Whereas, scale inefficiency relates to the failure to operate at constant returns to scale (i.e., the presence of either increasing or decreasing returns to scale), technical inefficiency relates to inefficiency in respect of translating inputs (resources) into outputs/outcomes. Drake and Simper (2000 and 2002) confirmed that significant scale effects exist in respect of English and Welsh police forces. In consideration of US studies, Gyapong and Gyimah-Brempong (1988) find constant returns to scale for the Michigan police force, while Gyimah-Brempong (1987) finds decreasing returns to scale in Florida police forces. Finally, Carrington et al (1999), who modelled 163 police patrol districts of the New South Wales police force, found that there were; 55 increasing, 29 constant, and 79 decreasing returns to scale forces in their sample. Hence, if relative police force efficiencies were to be assessed on the assumption of constant returns to scale, both small and large police forces would be disadvantaged by virtue of their high levels of
scale efficiency. Hence, it might be argued that the focus should be on technical efficiency since scale efficiency is largely outside the control of individual police forces.

It follows from this that the DEA analysis should be conducted using the variable returns to scale (VRS) model, and that the cost function specified in the SFA analysis should be sufficiently flexible to allow for variable returns to scale. It should be noted in this context, therefore, that both the linear and Cobb-Douglas models which could be used in SFA analysis are inappropriate as neither allow for variable returns to scale in policing. In addition, in order for the DEA and SFA results to be contrasted (and possibly combined) in any meaningful way, it is essential that both models are estimated using the same set of variables. If this is not the case, it will be impossible to ascertain whether any efficiency variations are due to differences inherent in the techniques, or due to the different set of variables specified.

CONCLUSIONS

This article has attempted to demonstrate that the recent moves towards the development of robust measures of relative police force efficiency, and of associated police force efficiency rankings/bandings. Indeed, the latter is a logical development of the trend towards managerialism in policing and the drive for value for money evident since the 1980s. As empathised previously, the use of both nonparametric (DEA) and parametric (SFA) techniques appear to be the best way forward in terms of developing such robust measures.

As an initial caveat, however, PSP (2000) recognises that there are limitations to both efficiency measurement techniques (DEA and SFA) and that "the techniques cannot be used mechanistically or interpreted simplistically. If they are, the wrong conclusions will be drawn. Careful analysis and judgement must be applied to the results." (page. 5). This is particularly important in the context of external factors which may impact on police force efficiency, but which are outside the control of individual forces. A possible solution to the problem, however, is to

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7 The difficulties of choosing inputs and outputs in the modelling techniques advocated in PSP (2000) will be discussed in a future paper.
use DEA and SFA to produce police force efficiency bandings, and then to consult with forces to establish whether these results are due to external factors which have not been taken into account. If this is the case, adjustments can be made and further analysis undertaken.
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