

**Neighbourhoods Matter: Fixed and Random Effects in Police
Satisfaction Surveys in the UK**

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Abstract

The present research is concerned with logistic multilevel modelling of public satisfaction with the London Metropolitan Police Service. Data from the 2000 Policing for London-Responding to Diversity survey, merged with The Indices of Deprivation 2000 from the Office of the Deputy Prime Minister, creates the complete data set. Approval ratings are an important indicator of the potential success of new police initiatives. High levels of satisfaction correlate to an increased likelihood of reporting crime, thus enabling the police to provide better services. Following previous research and theory, individual level variables are tested and selected for the final model. Ward identifiers and the index of deprivation comprise the level-two variables. Previous research identifies neighbourhood environments as an important predictor of satisfaction, but research has been slow to model or understand neighbourhood effects. Furthermore, previous models failed to model within group dependence, i.e. the likelihood that citizens in the same Ward will be more similar than individuals in different Wards. Consequently, simple models underestimated standard errors and yielded overly narrow confidence intervals. This paper seeks to avoid such fallacies by employing multilevel models to study satisfaction with the police. The findings of this research conclude that neighbourhood effects persist after controlling for area deprivation and possibly attenuate the effects of race.

1. Introduction

1.1 Overview

In the last 20 years there has been no shortage of research studying public satisfaction with the police. The majority of these surveys have investigated how individual characteristics such as age, sex, and ethnicity, and contact with the police affect satisfaction. Surveys that have looked at the relationship between neighbourhoods and satisfaction have concluded that differences do exist between areas (Kusow et al., 1997; Cao et al., 1996; Dunham and Alpert, 1998; Sampson and Bartush, 1998). However, few studies have assessed these affects concurrently. These models have used aggregate area level data and assumed that the same associations held at the individual level, leading to an ecological fallacy concern. Conversely, the models have assumed that individual associations held at the area level, which is an atomistic fallacy (Lindstrom, 2003).

While a handful of American researchers (Reisig and Parks 2002; Sampson and Bartush, 1998) have employed multilevel modelling techniques to explore how neighbourhood effects explain area differences in satisfaction, the use of multilevel models in police satisfaction surveys is sparse. To date, the majority of research on citizen satisfaction with the police has focused on interpreting the 'fixed effects' of empirical models. Random effects have hardly been explored, let alone interpreted. Random effects are important for assessing whether the estimated effects are uniform or hold only for some groups of individuals (Tseloni, 2000).

For example, the common finding that minorities are more dissatisfied with the police may not hold for all neighbourhoods or in different kinds of neighbourhoods. It might be that for some neighbourhoods, blacks and whites have similar levels of satisfaction, whereas in other neighbourhoods, blacks are indeed less satisfied than whites. If this were the case, efforts by police to improve their approval ratings would benefit from differentiating between areas with large estimated fixed and random effects and neighbourhoods where the individual

characteristic, in this case race, was not critical. This could also be used to help allocate resources (Tseloni, 2000).

Multilevel models also account for with-in group dependence. To explain this more clearly, social science data is often hierarchically structured. Level one units are grouped within level two units (within level three units). Typically, units within the same cluster are more similar than units from another group (Goldstein, 1995). Simple OLS models assume that the covariance between individuals in the same neighbourhood equals zero. However, if we accept that persons in the same neighbourhood are more likely to have similar opinions of the police than individuals from a different neighbourhood, then the covariance of the individual error terms of persons from the same neighbourhood is not zero. Previous satisfaction surveys which employed OLS models ignored group influencing and the natural hierarchical structure of data which may have lead to underestimated standard errors and too narrow confidence intervals.

A key aim of this research is to investigate how explained and unexplained neighbourhood differences affect the probability of being dissatisfied with the Metropolitan Police Service (MPS). Employing multilevel modelling, this study hopes to provide more accurate estimates of the fixed effects by accounting for individual clustering in neighbourhoods. While random effects have been analysed in police satisfaction surveys in the United States in the last 5 years, to my knowledge, no multilevel analysis of citizen satisfaction with the police has been done in the UK. While random effects are likely to be significant in this research, Ellfers points out that 'Criminology is not as yet famous for a well crystallized body of theory which specifies neighbourhood influence to such a depth that it will be clear in many cases what type of question should be addressed' (p. 350). This project seeks to establish a baseline study of neighbourhood effects and their relationship with satisfaction. The application of multilevel models to this area of research will lead to more accurate estimates and a better understanding of the role neighbourhood context plays in shaping individuals satisfaction. In

addition, this will help better direct policy initiatives aimed at improving approval ratings and better allocate police resources.

1.2 Research History

Through the 1950's the United Kingdom experienced high levels of public support for the police (Reiner, 1994). The police in the UK represented the 'role model of successful policing, with the Scotland Yard detective and the British bobby representing popular ideals of crime investigation and peacekeeping' (Reiner, 1992b, p.435). The Scarman report of the 1981 disorders in Brixton, South London marks the erosion of that popular image (Bowling and Foster, 2002). From the 1970's onwards, there has been a universal decline of public support for the police in the UK (Rowe, 2002).

Beyond newspaper opinion polls, large-scale surveys about the police and attitudes towards the police were rare before the Scarman report (Reiner, 2001). The urban riots in the United States in the last 50 years have made it blazingly obvious what disastrous results can occur when high dissatisfaction with the police is present and subsequently ignored. "Negative attitudes and perceptions of the police fuelled these riots, which were, in a large part, responses to actions taken by the police" (Brown and Benedict, p.544). In both the United States and the UK there has been a considerable increase in the amount of survey work devoted to understanding and measuring dissatisfaction as the result of both the declining popularity of the police and the consequences of ignoring low levels of support have become clearer.

Today, the British bobby and Scotland yard struggle to maintain a crime fighting image despite the reality that the bulk of modern day police work is peacekeeping, order maintenance, and responding to calls for help (Reiner, 1994). Rowe observes that the "public no longer has a consistent, or even coherent, set of expectations for the police to fulfil" (p. 440). As the role of the police has become more varied and complex, traditional assessments

of police performance which relied on crime rates, response time, and arrest rates fail to assess the performance of the police in their additional responsibilities (Reiner, 1992b). Traditional measurements do not assess the police's ability and success in their new roles as peacekeepers (Reisig and Parks, 2002).

Only in the last 10 years or so has the UK government and the MPS looked at low levels of satisfaction and ways to assuage the problem. The 2004 report *Confidence in Justice* commissioned by the Home Office spends a considerable amount of time devoted to unravelling trends in public confidence (Hugh and Roberts, 2004). Throughout this report, attention is paid to the relationship between communities and area level conditions, yet there is no actual analysis of neighbourhood effects. Instead, the bulk of research on satisfaction with the police in the UK has focused solely on individual explanatory variables and fixed effects.

Increased dissatisfaction with the police is part of an overall decline in satisfaction with a broad range of public services. This trend is not unique to the UK. Hough and Roberts (2004) argue that satisfaction with the police is more important than confidence in other public services because "confidence is intrinsic to the effective operation of a criminal justice system in a way that is distinctively different from services such as health or education" (p.7). Dissatisfaction with the police affects the safety of the entire public and thus it is important that particular attention be given to dissatisfaction with this particular public service.

1.3 Satisfaction

While traditional measures of police effectiveness still deserve attention, the public's satisfaction with the police is an important component of the evaluation of the police (Brown and Benedict, 2002). The police are public servants, and as such, their overall performance must be measured not only by their ability to reduce crime, which is their first priority as an organization, but also by how satisfied the public is with the service they are providing, the

bulk of which is now customer service orientated. The British police are legally allowed to use force to govern the citizens in the UK. The police need to be concerned that their operation and use of force is perceived as legitimate because the legitimacy of the police as an organization can only be maintained if policing methods are perceived as the 'right' way for police to police (Bowling and Foster, 2002).

The legitimacy of the police should be a concern for government officials whose careers are at stake depending on public approval and support for the police.¹ A more real and identifiable consequence of low levels of satisfaction with the police is reduced police effectiveness, increased crime, and further distrust of the police (Brown and Benedict, 2002). Citizens who are dissatisfied with the police are less likely to contact the police to report crimes and are less likely to aid officers when they investigate crimes (Hough and Roberts, 2004; Brown and Benedict, 2002). Trust, legitimacy and satisfaction all contribute to the overall ability of the police to control crime. If the police cannot control crime they will not be able to effectively reduce crime. Furthermore, officer's performance, not only their ability to fight crime, is associated with citizen's satisfaction (Reisig and Parks, 2000, taken from Smith and Hawkins, 1973).

In order for the police to effectively police, they must have good working relationships with the public. (Bradley, 1998; Bowling and Foster, 2002). If police actions reflect the expectations of the citizens (provide efficient, effective, courteous, and respectful services) the public will consent to the legitimacy of the police (Rowe, 2002). Research in the United States on support for the police has determined that the only variables that consistently predict satisfaction with the police are age, contact with the police, ethnicity, and neighbourhood type (Brown and Benedict, 2002). As different communities have different needs and expectations

¹ Elected officials are evaluated by the quality of service they provide and if satisfaction with the police is low, many political careers will be in jeopardy. Even if it is only for self-serving reasons, the police and the government should be concerned when there are high levels of dissatisfaction with public services.

combined with the evolving role of the police from crime fighter to peacekeeper, it comes as no surprise that there is a strong relationship between neighbourhoods and satisfaction with the police.

1.4 Neighbourhood Effects

Neighbourhoods mould and shape the opinion of individuals living within them. Individuals appear naturally in clusters, and within those clusters they share a number of similarities, which may be of importance in analysis. Different neighbourhoods have different norms of behaviour, tolerance of crime, and experience different types of crime (Raudenbush et al, 2003). Neighbourhoods also explain variations in crime that are not attributable to aggregated demographic variables (Raudenbush et al., 1997). Contributing to all of this is the notion that different areas have different needs and expectations of the police.

Sampson and Groves (in Lindstrom, 2002) conducted a study using British crime data and concluded that neighbourhoods where there is a sense of community identified by tight friendships, active local organizations and clubs were areas that experienced fewer crimes such as muggings and burglaries. Sampson and Groves identified area differences in crime rates, which were explained by area level social capital. Their work relied on aggregate area level data, and thus, associations at the individual level were impossible to identify. Nevertheless, their work supports the hypothesis that neighbourhood variables such as area level social capital have a significant and important relationship with satisfaction.

Social capital is one of many variables that varies between neighbourhoods. Stockdale et al. (2004) hypothesize that people's perceptions of deprivation and negative experiences of policing may serve to reinforce each other. They hypothesizes that differences in satisfaction may be due to expenditures in that area, i.e. the poorest neighbourhoods have the poorest services. Lindstrom et al. (2003) suggest that area differences in satisfaction are due to

neighbourhood 'rumours' about police contact which then influence individual perceptions of the police.

Brown and Benedict's (2002) extant review of past findings of the perceptions of the police concludes by saying "it is conceivable that the relationship between residential conditions and perceptions of the police will vary from one area to the next" (p.566). Stockdale's research also supports our hypothesis that neighbourhood effects exist and affect satisfaction with the police. This is backed up by Elffers' claim that "characteristics of the inhabitants of neighbourhoods are presumed to be influenced by characteristics of these neighbourhoods; recognizing the nested structure of inhabitants and neighbourhoods, lends to multilevel analysis" (p.347).

This project will employ multilevel analysis to research if and how neighbourhood differences explain some of the variation in satisfaction with the London MPS. Using a multilevel logistic regression model, with individuals as the level one units and wards as the level two units, area level affects will be modelled and attempts will be made to understand the role fixed and random effects play in shaping levels of support for the police. This research will estimate and interpret both the fixed and random effects, as well as study random effects in terms of fixed effects.

Section 1 gave an overview of previous survey work. Section 2 will outline the data used for analysis. Section 3 will outline variables. Section 4 will describe the model. Section 5 will interpret the results of the model. The last section will discuss findings and offer suggestions for future research.

2. The Data

Secondary data analysis of The 2000 Policing for London Survey (PFLS) was used for this project. The survey was designed to explore Londoners' satisfaction and dissatisfaction with

the Metropolitan Police Service (MPS). The concept for the survey originated from the MPS, but the survey itself was funded by three independent charities, the Nuffield Foundation, the Esmée Fairbairn Foundation, and the Pail Hamlyn Foundation. The MPS gave full co-operation with the survey. The survey itself was undertaken by the National Centre for Social Research (NCSR) and was first analysed by FitzGerald et al. at the London School of Economics.

The original sample consists of 2,800 people aged 15 and over from 313 Wards. In order to encapsulate enough minorities to support analysis by ethnicity, the NCSR used a two-stage sampling design which over-sampled postcode sectors with a high density of ethnic minority addresses. They then selected addresses within postcode sectors using ‘focused’ enumeration, a procedure that involved asking the randomly selected interviewees if their neighbours were of a minority. If the answer was yes then NCSR attempted interviews with the neighbour as well. This was done to expand the core sample and further increase the number of minority interviews.

Focused enumeration has proven an effective means of increasing the number of minority interviews. Focused enumeration sampling techniques limit the accuracy of estimating non-response rates. The NCSR estimate that the overall response rate was 49% with a higher response rate for minorities.²

The final sample size selected for analysis in the present project included 2416 persons from 304 Wards. Individuals were dropped from analysis if they did not respond to the outcome variable of interest. Two individuals were dropped because it was not possible to identify which ward they were from. In this analysis, the average number of cases in each

² This is high estimated non-response rate. Non-respondents may have been different than respondents in some way. It may be that persons who were dissatisfied with the police were more likely to participate in the survey than persons who were satisfied. Analysis of results from surveys with high non-response rates must be analysed with caution.

neighbourhood ranged from 1-48. The consequences of a small number of level one units within a large range of level two units will be discussed in the conclusion.

3. Variables

3.1 Individual Level Variables

Four variables, age, contact with the police, neighbourhood and race have consistently proven to influence attitudes toward the police (Brown and Benedict, 2002). These four variables along with additional variables are discussed below.

Race

Research from a number of studies about satisfaction (Bradley, 1998; Brown and Benedict, 2002; Cao et al., 1996; Dunham et al., 1988; FitzGerald et al., 2002; Hough and Roberts, 2003; Kusow, 1997; Reiner, 1992a, 1992b; Rowe, 2002; Sampson and Bartush, 1998; Stockdale, 2002) has shown that minorities have been the least satisfied and have the least confidence in the police. Blacks are the most often-studied minority group. Research indicates that blacks view the police less favourably than whites (Brown and Benedict, 2002; Weitzer and Tuch, 1999).

It is argued that blacks typically hold more negative views towards the police for two reasons. First, blacks are more likely to have had personal negative contact with the police. Second, blacks live in areas with higher levels of crime. The PFLS intentionally over sampled minority groups. The study targets individuals who identified themselves as black, Indian, Pakistani/Bengladeshi, and other (which included other-asian).³

Most of the research on satisfaction has taken place in the United States where blacks (and more recently Latinos) make up the majority of the minority population. In London,

³ There were 9 ethnic categories in the original survey, which were subdivided into 5 mutually exclusive categories for this research. Please see the Appendix for the survey question and responses.

however, a significant percentage of the minority population is Indian and Pakistani/Bangladeshi. Furthermore, the black population in the UK is distinctly different from the black population in the United States in that blacks in the UK tend to have an Afro-Caribbean background.

One of this project's secondary aims is to study how ethnicity relates to satisfaction in the UK where the minority population has a different composition than in the United States. Brown and Benedict (2002) report, "recent research in racially diverse metropolitan areas indicates that the effects of race [on satisfaction with the police] are influenced by contextual variables at the neighbourhood level" (p.567). This project will explore if a relationship between race and satisfaction persists after accounting for neighbourhood deprivation and area heterogeneity.

Age

Age has consistently shown to be a significant predictor of satisfaction with the police. Young people are more likely to be dissatisfied with the police than older people (Brown and Benedict, 2002; Bradley, 1998).⁴

Contact with the Police

Contact with the police has consistently been shown to be a significant predictor of satisfaction with the police. Scaglione and Condon found that contact with the police has a greater effect on satisfaction than age, race, or socio-economic status. There is speculation that contact with the police attenuates the effects of race on satisfaction (Scaglione and Condon, 1980). Models that employed sophisticated multivariate techniques to study contact

⁴ Age is measured as a continuous integer in the PFLS, but was divided into 4 categorical groups (15-25, 26-39, 40-59, and 60+) for analysis purposes and to make comparisons between different age groups easier.

with the police and satisfaction report mixed findings pertaining to race (Reisig and Parks, 2000).

It is not clear what type of contact affects satisfaction the most. Positive interaction with the police has been shown to improve attitudes towards the police. Negative contact has shown the opposite effect, i.e. negative contact influences negative opinions. Informal contact with the police such as asking for directions or the time, tends to promote positive levels of satisfaction (Hough and Roberts, 2004).

The majority of surveys on individuals' encounters with the police are limited in that they only survey respondents who have come into contact with the police. These surveys then compare how different types of contact affect satisfaction. Consequently, comparisons between citizens who have had contact and those who have not is not possible. In many of these surveys it has been impossible to compare non-contact respondents to contacted respondents who are satisfied or dissatisfied within a specific type of contact (Reisig and Parks, 2000).

The PFLS was specifically designed to study the relationship between satisfaction and certain type of variables such as contact with the police. The PFLS asked a range of questions about contact with the police, thus allowing contact to be studied by a series of variables about different types of contact. The survey broke down contact into 4 major headings.

Respondent Initiated Contact- Apart from Personal Victimization (satisfaction)⁵

Personal Victimization

Stop and Search- Police Initiated Contact (satisfaction)

Police Initiated Contact – Not Stop and Search (satisfaction)

⁵ Please see Appendices A and B for a detailed description of the methodologies used to create this series of variables

It is important to note here that differences in opinion may not be due to direct contact with the police. It is highly possible that people who have (negative) contact with the police are people who would have had significant dissatisfaction with the police had they not been contacted, i.e. people who typically have contact may somehow be different from people who do not have contact in other ways beside contact. In this secondary data analysis, it is impossible to separate the effects of contact with the police because an individual's opinion was not measured prior to contact. The only possible measure is to control for it. This study will explore if a relationship between satisfaction and race exists controlling for contact or vice versa.

Voting

Voting is not a direct measure of social capital, but it is theorized that voters are more likely to be active in the community than non-voters (Lindstrom et al., 2003). Hypothesizing that voting tendencies might correlate with individuals' involvement in the community and thus be indicative of social cohesion, voting was explored in the model as a possible proxy for questions about neighbourhood involvement (which were not asked).

Residential Tenure

Authors Raudenbush et al. (1997) hypothesize that residential tenure directly influences social cohesion. Social cohesion promotes collective efforts to maintain social control. This measure was also explored as a possibly proxy for individuals' social interaction with the community. Tsleoni found a relationship between tenure and victimization rates.

Neighbourhood Type

This variable that asked how individuals' perceived their area was included as a proxy measure for perceived social capital. Like voting and residential tenure, it is possible the perception of neighbourhood type may explain some of the variation in satisfaction.

Gender

There is no conclusive decision about the effect gender has on satisfaction. Some research concludes that women, in general, hold more favourable views. Overall, however, most studies that included gender as a variable concluded that there was no effect (Brown and Benedict, 2002). Bradley's 2002 qualitative study contradicts the quantitative research by identifying gender differences. Gender was included in this project to see if any differences in satisfaction in this survey were partly explained by gender.

Socioeconomic

Priest and Carter (1999) included socioeconomic status in several different models measuring satisfaction with the police, and found that income has no impact on minorities' views of the police. In their work, there was a high correlation between socio-economic status and ethnicity and thus much of the effect of class was captured by ethnicity (in Brown and Benedict, 2002). A general overview of the literature about the effects of social class, income and other measures of social status reveals that socio-economic status, when included in a model with race, has no significant effect on perceptions of the police. Income and social class were explored in this project to see if this data presented any relationship between these variables and satisfaction that other surveys failed to identify.

Worry

Perceptions of area conditions and neighbourhood decay affect levels of satisfaction with the police. Reisig and Parks (2002) found that if "citizens perceive incivilities to be problematic, they will express significantly more negative sentiments about the police" (p.610).⁶

⁶ They go further to argue that citizens hold the police personally accountable for neighbourhood conditions.

There are several indicators that can be used to measure citizens' perception of neighbourhood conditions and decay. Robinson et al. (2003) identifies two, emotional fear and worry. She writes that questions such as 'how safe do you feel being alone at night?' or 'how safe do you feel walking alone in the evening?' are questions that measure emotional fear. Robinson defines worry as a five-item index. These questions specifically mention worry by asking 'how worried are you about being beaten up?' or 'how worried are you about being burglered'. Robinson claims that the worry index captures the more cognitive aspect of fear and crime.

Worry is distinctly different from perceived incivilities. Jackson (2004) argues that worry "exaggerates the prevalence of emotion"(p.2). Robinson et al. (2003) agree with Jackson, explaining that the 'incivilities thesis refers to a family of theoretical notions explaining how local physical deterioration and disorderly social behaviour inspire concern for personal safety and community viability and interfere with local attachment' (p. 238). Although it would have been preferable to analyse and compare the differences between a worry index and an incivility index, the Policing for London Survey 2000 did not ask questions about perceived incivilities. Thus, worry is employed as a measure of perceived neighbourhood decay.

To create the variable 'worry', Robinson's index was followed. The index is composed of 4 questions which refer to worry about having one's home broken into, being mugged or robbed, physically attacked, and worry about being insulted or pestered in a public space. While there were additional questions asked about worry, such as how worried are you about having your car stolen, being raped, or being a victim of a racial attack, these questions were not asked to the entire survey population and were thus excluded from factor analysis.

The multivariate technique of factor analysis was employed to determine whether or not these 4 questions represent the latent unmeasurable variable 'worry'. There was a strong initial

correlation between each of the questions that indicates that indeed these questions might represent a common source of influence. A factor analysis was run using maximum likelihood estimation. The communalities of the variables (Appendix D) show that for each of the questions, over 75% of the variance in each question is explained by one factor. Further analysis reveals that a one-factor model yields an Eigen value of 2.773, which explains 69% of the variance of the model. The one factor solution was used to create the continuous variable worry, where negative values represent an individual who is very worried, and positive values an individual who is not very worried.

3.2 Area Level Variable

Individuals who reside in impoverished neighbourhoods are more likely to have negative views of the police (Hartnagal, 1979). Despite this, few studies attempt to link police statistics to indices of deprivation. Those that do, limit their coverage to focusing on how crime rates relate to deprivation (Stockdale, 2004).

One of the benefits of multilevel modelling is the ability to model area level explanatory variables such as deprivation concurrently with individual level variables. OLS models, which compare neighbourhood differences and individual demographic variables in the same model, do so by including areas as a set of dummy variables. Models such as these are restricted from including area level explanatory variables. Models that use aggregate area level variables are unable to describe relationships at the individual level. Deprivation is explored in this research as both a fixed and random effect. Additionally, the research seeks to uncover if area level differences persist after controlling for area level deprivation.

3.3 Outcome Variable

In 2003, nearly 25% of British households experienced some form of criminal victimization (Reiner, 1992a). With such a large percentage of the population experiencing personal victimizations, it is unclear what percentage of dissatisfaction is acceptable.

The PFLS measured satisfaction with the police by asking ‘Taking everything into account, would you say the police in your area do: a very good job, a fairly good job, a fairly poor job, or a poor job?’.⁷ Cases with no-response or who did not know (308 respondents) were dropped from the analysis.

In this survey, there were two questions asked about satisfaction with the police. The first addressed satisfaction with the national police and the second with area police. The role of the media in shaping the public’s satisfaction has gone unacknowledged thus far. Indeed, the media does play a role in shaping individuals satisfaction with the police. However, contact with neighbourhood police (by reporting a crime or assisting in a criminal investigation or simply asking for directions) is more likely to influence satisfaction with area level police. While there was a high correlation of satisfaction with area police and national police in this survey, the overall proportion of people who were satisfied with the national police was lower than the proportion of people who were satisfied with the area police. Area level satisfaction is a better indicator of how likely a person is to aid their local police, which in turn makes the police more effective (which is why approval ratings are important). Secondly, area-level satisfaction has less ‘static’ from media biasing (Roberts and Hugh, 2004).

4. The Statistical Model

4.1 The Logistic Multilevel Model

MlwiN1.0 was used to estimate a logistic multilevel model. A multilevel model is a modification of OLS modelling that takes differences in areas and covariance between individuals and other individual demographic variables into account. The logistic multilevel model derives in a straightforward manner as an extension of the basic multilevel model.

⁷ Reiner (1992a) argues that the “meaning of views expressed in response to the general question ‘are the police doing a good job?’ is difficult to interpret” (p.472). However, he goes further to argue that the response to this sort of question does allow researchers to pinpoint pockets of rejection. The answer to this question in this research was used to measure satisfaction, which was what the question was designed to measure.

First, the basic multilevel model is defined. The response, y_{ij} is satisfaction of individual i in area j . The individual differences and area difference can be included by writing:

$$y_{ij} = B_{0j} + B_1x_{ij} + e_{ij} \quad \text{Equation 1}$$

$$B_{0j} = B_0 + u_{0j}$$

Substitution leads to the model:

$$y_{ij} = 'B_0 + B_1x_{ij}' + 'e_{ij} + u_{0j}' \quad \text{Equation 2}$$

The model can now be split into two parts. The first part in equation 2 is called the fixed part and the second part is the random part. The new term in the random part of the model, u_{0j} represents random variation (error terms) at the neighbourhood level (level two) compared to the e_{ij} which is the error term associated with the individual (level 1). This basic multilevel model assumes that the covariance between individuals from different areas (u_j, u_k) equals zero. It also assumes that the covariance between error terms of individuals in different areas is zero (e_{ij}, e_{kl}). Finally, the covariance between a neighbourhood effect and an individual in a different area (u_j, e_{ik}) is zero.

The main interest in this model is in seeing how the combinations of our explanatory variables (ethnicity, worry, age, contact, deprivation) influence the probability of being satisfied with the police and the extent of between-ward variation.

As previously explained, the response variable is binary (satisfied- 0, dissatisfied-1). Let π_{ij} be the probability that the i^{th} respondent in the j^{th} ward was dissatisfied with the police. We define this probability as a function of the logit:

$$\text{Logit} (\pi_{ij}) = B_1x_{1i}, \text{ where } B_{1j} = B_1 + u_{1j} \quad \text{Equation 3}$$

$$y_{ij} = \pi_{ij} + e_{ij}$$

The coefficient, B_{1j} indicates that one is modelling a random intercept, i.e. every Ward will have a different intercept.

Unlike continuous response multilevel models that typically follow a normal distribution, binomial response variables typically follow binomial distributions. We write this distributional assumption as:

$$y_{ij} \sim \text{Binomial}(n_{ij}, \pi_{ij})$$

Equation 4

MLwiN typically uses this distributional form to model proportions, where each proportion, y_{ij} is based on n_{ij} observations and has a denominator n_{ij} so that the variance of e_{0ij} will be $\pi_{ij}(1 - \pi_{ij})/n_{ij}$. Binary data is a special case where $n_{ij} = 1$ and $y_{ij} = 0$ or 1 for every unit.

Therefore, the variance of e_{ij} is $\pi_{ij}(1 - \pi_{ij})$, but MLwiN requires users to specify a vector of 1's for n_{ij} for the denominator ('denom'). MLwiN requires 2 other vectors of 1's, $bcons$ and $cons$, to run a multilevel logistic model (Goldstein, 1995).

In logistical multilevel modelling, level one variation, e_{ij} is defined as having a mean of zero and a variance which is constrained to equal 1. Setting this assumption implies that our model follows a binomial distribution.⁸ Otherwise, the same assumptions hold as for the continuous response model.

The most simple variance components model in MLwiN format where $rp01$ is the response variable satisfaction appears as Figure 1.

This model is estimated using 1st order linearization and marginal quasiliikelihood estimation (MQL) methods. Penalised quasiliikelihood (PQL) estimation was also tested because MQL tends to underestimate variance parameters when there are few level 1 units per level 2 units,

⁸ Tests for extra binomial variation were performed and found to be insignificant at $p < .001$.

or where higher level variances are large. PQL estimates are the least biased, but sometimes fail to converge. In this model, both techniques produced the same results.

Figure 1. The Variance Components Model as it Appears in MlwiN

$$\left. \begin{aligned}
 \text{rpol}_{ij} &\sim \text{Binomial}(\text{denom}_{ij}, \pi_{ij}) \\
 \text{rpol}_{ij} &= \pi_{ij} + e_{0ij} \text{bcons}_{ij}^*
 \end{aligned} \right\}$$

$$\text{logit}(\pi_{ij}) = \beta_{1j} \text{cons}$$

$$\beta_{1j} = -1.129(0.058) + u_{1j}$$

$$[u_{1j}] \sim N(0, \Omega_u) : \Omega_u = [0.199(0.067)]$$

$$\text{bcons}_{ij}^* = \text{bcons}_{ij} [\pi_{ij}(1 - \pi_{ij}) / \text{denom}_{ij}]^{0.5}$$

$$[e_{0ij}] \sim (0, \Omega_e) : \Omega_e = [1.000(0.000)]$$

It is easy to extend this simple variance components model to include a larger number of parameters in both the fixed and random parts. Further elaborations in this project will include individual level explanatory variables, as well as area level deprivation. The variance components model assumes that the only variation between wards is in their intercepts. As noted in the introduction, police satisfaction surveys have yet to establish a baseline or theory of what individual effects should be allowed to vary, and thus this project will explore if (and if so which), individual variables such as age, ethnicity, etc, be random at level-2, i.e. should allow for the possibility that different wards will have different slopes for different demographic variables.

4.2 Fitting the Model

Fitting a multilevel model is a more burdensome task than fitting simple OLS models because in addition to individual explanatory models, there are also random parameters that need to be

Table 1. One-Way ANOVA by Demographic Characteristics

		Satisfaction with the Police			
		N	Mean	SD	P-value
		% dissatisfied			
Sex					
	Male	1190	0.27	0.44	0.017*
	Female	1271	0.23	0.42	
Age					
	15-25	500	0.35	0.48	0.001 ^a
	26-39	900	0.25	0.43	
	40-59	666	0.23	0.42	
	60+	387	0.15	0.36	
Class					
	Missing	253	0.24	0.43	0.319
	non-manual	1192	0.24	0.43	
	manual	1016	0.26	0.44	
Voter					
	Tory	240	0.22	0.42	0.261
	Labour	1070	0.24	0.43	
	Other	101	0.24	0.43	
	non-voter	1050	0.27	0.44	
Income					
	Unreported	357	0.22	0.42	0.473
	under £20,000	1235	0.26	0.44	
	more	869	0.25	0.43	
Tenure					
	0-2 Years	296	0.24	0.43	0.006 ^b
	2-5 Years	423	0.19	0.39	
	5+ Years	1742	0.27	0.44	
Neighbourhood Type					
	Missing	28	0.25	0.44	0.001 ^c
	Help Each Other	828	0.17	0.38	
	Go Your Own Way	1193	0.31	0.46	
	Combination	412	0.22	0.41	

* $p < .05$, *

^a Age: Bonferonni multiple comparison tests showed that there was no statistical difference between 26-39 year old and 40-45 year olds at $p < .05$.

^b Tenure: Bonferonni tests showed that only 2-5 years and 5+ years were different at $p < .05$.

^c Neighbourhood type: Bonferonni tests showed that combination areas were not statistically different from combination areas at $p < .05$.

explored and estimated. It is quite easy to over fit a model. To avoid over fitting, I employed a strategy whereby I began by fitting a variance components model to assess the average probability of being satisfied with the police along with the between-ward variation, before adjusting for other demographic variables. By starting with the simplest model and gradually building up the model by introducing explanatory variables and random parameters, the final model should be a parsimonious, well-fitting model.

To begin, a series of one-way ANOVA models were fitted using all of the previously explained variables in section 3. Table 1 shows the ANOVA models for all categorical variables apart from contact and ethnicity. Bonferroni multiple comparison tests, which allowed for direct comparisons of groups consisting of unequal sizes, were employed.

This first set of variables reveals that there is a significant difference in mean dissatisfaction between men and women at $p < .05$. As expected, there were also differences between age groups. However, the difference between 26-39 and 40-59 year olds was not significant. There were also significant differences between different neighbourhood types and residential tenure. There was no significant difference at $\alpha = .05$ between voters, class, or income.

The next set of variables, race and ethnicity, were also compared using ANOVA models. Table 2 shows the while there is a statistical difference at $\alpha = .05$ between the dichotomous variable, race and other, the only statistically significant difference in ethnicity occurs between whites and Pakistani/Bangladeshi's. Because ethnicity provides more information about how differences in satisfaction vary between different racial groups, ethnicity will be included in future models.

Table 2. One-Way ANOVA of Ethnicity

		Satisfaction with the Police			
		N	Mean	SD	P-value
		% dissatisfied			
Race	White	598	0.20	0.40	0.002*
	Minority	1863	0.26	0.44	
Ethnicity	White	598	0.20	0.40	0.002 ^a
	Black	529	0.25	0.43	
	Indian	547	0.25	0.43	
	PakBeng	614	0.30	0.46	
	Other	173	0.22	0.42	

* $p < .05$, *

^a Ethnicity: Bonferonni tests show that the only significant differences between means is between whites and Pak/Beng at 95% confidence.

Finally, one-way ANOVA models of contact variables were analysed. The results are shown in Table 3. As expected, stop and search was highly significant. Further, there were statistically significant differences in satisfaction between people who initiated contact with the police. There were also differences in satisfaction for people who were victimized. However, police initiated contact apart from stop and search was not highly significant. Although its counterpart variable, police initiated contact apart from stop and search-satisfaction was significant, neither of these variables will be included in the future models because the initial variable measuring contact was insignificant.

ANOVA analysis provided an informative first look at satisfaction and patterns in the data but failed to control for spurious effects or area differences. This initial analysis helps support the inclusion or exclusion of variables in our future models in the absence of deviances (explained in the following section).

Following ANOVA analysis a stepwise procedure introducing variables to the variance components model one at a time was employed to analyse individual variables and their relationship with the response variable, satisfaction. One of the more common ways to compare various OLS and multilevel models is to use the deviance (-2loglikelihood). The deviance is twice the natural logarithm of the likelihood (-2L) when maximum likelihood is used to estimate the parameters in the model. The deviance indicates the lack of fit between the model and the data. Nested models can be compared by taking the difference in deviances and using the additional number of parameters as the degrees of freedom and comparing this to a chi-square distribution. The deviance is used to test whether reliability is reduced when new parameters are introduced to the model. In multilevel models with normal distributions, MLwiN produces a deviance test statistic (-2loglikelihood) that can be used to help test the significance of adding new variables. While it is possible to calculate a deviance in MLwiN for logistic multilevel models, the estimated deviances use iterative least squares (IGLS) estimation which runs a normal chi-square distribution and does not account for the fact that

Table 3. One-Way ANOVA of Contacts

	Satisfaction with the Police			
	N	Mean	SD	P-value
	% dissatisfied			
Initiated Contact Apart from Personal Victimization				
Missing	14	0.21	0.43	0.003 ^a
No Contact	1792	0.23	0.42	
Serious	564	0.31	0.46	
Minor	91	0.22	0.42	
Initiated Contact Apart from Personal Victimization (Satisfaction)				
No Contact	1806	0.23	0.42	0.001 ^b
Satisfied	375	0.19	0.40	
Dissatisfied	204	0.49	0.50	
Contacted No Response	76	0.28	0.45	
Police Stop and Search				
Missing	2	0.5	0.71	0.001*
Not Stopped	1392	0.20	0.40	
Stopped	1067	0.31	0.46	
Police Stop and Search Satisfaction				
Not Stopped	1394	0.20	0.40	0.001 ^c
Satisfied	217	0.27	0.45	
Dissatisfied	106	0.65	0.48	
Contacted No Response	744	0.27	0.45	
Police Initiated Contact-Not Stop and Search				
Missing	1	0	.	
No Contact	2122	0.24	0.43	0.242
Minor	179	0.28	0.45	
Witness	40	0.33	0.47	
Suspect	119	0.31	0.46	
Police Initiated Contact-Not Stop and Search Satisfaction				
Not Contacted	2123	0.24	0.43	0.002 ^d
Satisfied	231	0.26	0.44	
Dissatisfied	62	0.45	0.50	
Contacted No Response	45	0.24	0.43	
To Report a Personal Crime				
Not-Victim	1870	0.22	0.41	0.001*
Reported	591	0.34	0.47	
Number of Incidents				
Missing	3	0.33	0.58	0.001 ^e
None	2035	0.23	0.42	
One	86	0.38	0.49	
Two	153	0.33	0.47	
More than 3	184	0.37	0.48	

* $p < .05$, *

^a Initiated contact with the police apart from personal victimization: the only differences in means were between individuals who were not contacted and serious contact at $p < .05$.

^b Initiated contact with the police apart from personal victimization-satisfaction: no contact is different from dissatisfied. Satisfied is different from dissatisfied at $p < .05$.

^c Stop and Searched satisfied: Not stopped is not different from stopped and searched satisfied or no response at $p < .05$.

^d Police Initiated Contact not stop and search-satisfaction: the only difference was between the dissatisfied group and all other groups at $p < .05$.

^e Number of Incidents: None is different from 1,2, 3+. But 1,2,and 3+ are not different from each other at $p < .05$.

the estimation being used in this model is Restricted Iterative Least Squares (RIGLS). RIGLS is used for binomial distributions (Goldstein, 1995). Nevertheless, IGLS estimated deviance is used to help guide variable selection.^{9 10}

Because deviances could only be used as a rough guide of overall model fit, theory and Wald tests of the parameters guided model selection. Variables were explored in different combinations. From theory, contact with the police, ethnicity, age, and neighbourhood were variables that have usually been significant predictors of satisfaction. Variables such as voting, income, neighbourhood type, and residential tenure, which have inconclusive relationships with satisfaction were also included. As mentioned earlier, there is no consensus about what variables should be treated at random, and thus, all individual variables were reviewed with and without level 2 variation.

4.3 Single Variable Models

Our first task is to test whether or not a multilevel model is necessary. To do this, an empty model with no explanatory variables was fit. The intercept of the empty model without random area effects is $-1.099 (.047)$.¹¹ The model with random intercepts has an intercept at $1.129 (.058)$.¹² Not only are random intercepts significant using Wald tests, but the deviance from the simple OLS model was compared to the deviance of the multilevel model (as a rough estimate) and was highly significant at $p < .05$. Since theory supports

⁹ Correspondence with Joop Hox: *Yes, you get the IGLS Likelihood instead of the RIGLS. As I understand it the deviance is rather approximate and should not be used to compare models formally. You could calculate the AIC or BIC from the deviance and use that as a rough guide, but these would of course also be approximate.*

Best regards,

-Joop Hox

¹⁰ Two approaches can be used to evaluate likelihoods in binomially distributed multilevel models, estimated numerical methods and approximated closed form approximations. The results are then maximized using standard methods. Both of these approaches were beyond the scope of this research project. Even the best approximate estimates can be substantially biased for random parameters.

¹¹ Appendix Table A1.

¹² Appendix Table A2.

neighbourhood effects, and since the random parameter is significant, and because the standard error of the intercept term in the simple model is underestimated, the simple variance components model is accepted as the baseline model for future analysis.

Using the baseline model we estimate that the median proportion of people who are dissatisfied $([1+e^{-(1.129)}]^{-1} = .244)$ is 24.4%. This is close to the overall mean $(613/2461) = 24.91\%$ but is not the exact overall mean because the link function is non-linear.

While the level 2 variance, σ_u^2 of .199 is small, it is significantly larger than its standard error $(.067 \times 2 = .134)$. We use this to construct approximate confidence intervals and significance tests.¹³

If we assume that y_{ij}^* is a continuous latent variable¹⁴ and that we only observe binary y_{ij} when $y_{ij} = 1$ when $y_{ij}^* > 0$ and $y_{ij} = 0$ otherwise, then it is possible to calculate the intraclass correlation which is estimated by:

$$\hat{\rho} = \frac{\sigma_u^2}{\sigma_u^2 + (\pi^2/3)}$$

Equation 5

In this model, $\hat{\rho} = .052$, so an estimated 5.2% of the variance is due to area affects.

Following the empty variance components model, each variable was introduced separately to the model. Appendix Tables A3-A19 present each of the variables which were added in turn to the variance components model.

¹³ To attain more accurate intervals, use either the MCMC methods or the bootstrap methods.

¹⁴ In this model it is possible to assume that if someone is satisfied with the police, there is a range of satisfaction. However, in this model, the response variable is dichotomised. While not a direct intraclass correlation, it gives an idea of the amount of variance in the data caused by area differences rather than differences between individuals.

Worry

Worry was highly significant ($p < .001$) at the 5% level. For every 1-point increase in worry (i.e. a person is less worried) the odds of being dissatisfied decreased by 22.6%.

Index of Mass Deprivation (IMD)

IMD was highly significant ($p < .001$) at the 5% level. For every 1-point increase in deprivation (i.e. a more deprived area), the odds of being dissatisfied increased by 1.3%.

Age

As expected, all 4 categories of age were highly significant ($p < .001$), and as expected, persons aged 15-25 were the most dissatisfied, and people aged 60 and over were the most satisfied.

Race

The effects of race were tested in two different forms. First, I used a dichotomous variable, race (white and other). In this model, race (white was the reference category) was significant ($p < .009$) at the $\alpha = .05$ significance level. Following the significance of this test, I tested the variable ethnicity, which as described earlier had 5 categories. In this model, only Pakistani/Bangladeshi was significant at the 95% significance level. Both black and Indian were significant at the 10% level, and the category 'other' was highly insignificant. Because the dichotomous variable race was highly significant, and because Pakistani/Bangladeshi was also significant, ethnicity, rather than race, will be included in further analysis. To suppress the important information ethnicity contributes to the model would erroneously hide valuable information.

Contact with the Police

Respondent Initiated Contact Apart from Personal Victimization (Satisfaction)

The first variable which was created, contact not personal, was categorized as no-contact, serious contact, and minor contact. Minor contact was highly significant in this model.

People who initiated contact, even for minor reasons, had 1.5 times the odds of being dissatisfied as someone who did not initiate contact. Serious contact was not significant. The second variable, initiated contact apart from victimization-satisfied, was significant for people who were dissatisfied, but not for people who were satisfied, or did not respond at $\alpha=.10$.

People who initiated contact and were dissatisfied, were 3.1 times more likely to be dissatisfied with the police than people who did not contact the police. As expected, people who were satisfied with contacting the police were more satisfied with the police, on average, than people who did not initiate contact (note this variable was not significant). However, because of the powerful and highly significant effect of initiating contact and being dissatisfied, this variable was included in the further analysis.

Victimization

Both variables, the number of times an individual had been victimized as well as the dichotomous variable victimized and not, were significant. Because the aim of this project is not about trying to understand the difference between reported victimization and actual levels of crime, this study chose to model the dichotomous variable over the number of victimization.

Stop and Search-Police Initiated Contact (Satisfaction)

Both variables that measured stop and search were highly significant. However, the variable which looked at satisfaction with stop and search offered very insightful information. An individual who was stopped was more likely to be dissatisfied with the police than someone who was not stopped. However, someone who was stopped and satisfied had 1.4 times the odds of being dissatisfied as someone who was not stopped. An individual who was stopped and dissatisfied had 6.3 times the odds of being dissatisfied as someone who was not stopped. The stopped and searched-satisfaction variable was used in future models.

Police Initiated Contact-Not Stop and Search

None of the categories in the variable police initiated contact-not stop and search were significant. For this reason, neither police initiated contact apart from stop and search and its counterpart measuring satisfaction were considered in the final model.

Sex

When sex was introduced to an empty variance components model, gender was significant. Women were more likely to be satisfied than men. Although theory does not support differences due to sex, the variable sex was considered in further models because it was significant in the stepwise model.

Neighbourhood Type

This variable was highly significant. As expected, citizens' who describe their area as one where people help each other had .715 times the odds of being dissatisfied as someone from a mixture area. Someone from an area which was described as one where people go their own way was 60% more likely to be dissatisfied than someone from a combination area. This variable was included in further model explorations.

Voter, Tenure, Income and Class

None of these variables were significant using Wald tests. The deviance was consulted as a rough guide and the deviances that were estimated were also not significant. These variables were also not significant in the one-way ANOVA's. There were subsequently dropped from future analyses.

Initially, the random effects of covariates were tested in the single variable models. In these models, the results of the random parameters were tested using Wald hypothesis tests and the deviance as a rough guide. None of the chi-square values for any of the individual variables

was significant at the 95% significance level. Covariates which give non-significant or zero-random effects do not contribute random effects in the model.¹⁵

5 Results

5.1 General Remarks

While the proceeding section gave a preliminary glimpse of the effect of each variable on satisfaction, models in the previous section were examined without controls. Such analyses were necessary in the absence of reliable deviance test statistics.

Table 4 presents three estimated models. Model 3 includes all the variables which had estimated coefficients which were significant in the stepwise models. If the coefficient of at least one category of a non-binary qualitative variable was significant at $\alpha=.05$, then all of its categories were retained. As discussed, tenure, income, social class, and voting were dropped from this model.

Model 3 in Table 4 includes the variable sex in the model as it was significant in preliminary analysis. However, throughout model selection, sex was highly insignificant when it was studied within several different model combinations. There is a strong correlation between sex and our factor score 'worry'. As sex was highly insignificant in the final model, it was dropped from the analysis.

¹⁵ The findings in this survey that none of the level 1 or level 2 variables present random variation contradicts with Tseloni's findings which found that tenure, sex, marital status, individual's lifestyle (shopping), evenings out, car ownership, income, neighbourhood watch, urban environment, and population were all random parameters. However, Tseloni studied the outcome measure personal victimization, and thus, his results should be slightly different from ours. Tseloni also worked with a sample size 154,019 individuals, which would have allowed for more accurate estimates of random parameters.

Table 4. Hierarchical Binomial Models for Satisfaction with the MPS

Variables	Model 1			Model 2			Model 3		
	B	exp(b)	SD	B	exp(b)	SD	B	exp(b)	SD
<i>Fixed Effects</i>									
Intercept	-1.831		0.246*	-1.884		0.238*	-1.732		0.226*
Individual Level									
Worry	-0.241	0.79	0.055*	-0.236	0.79	0.054*	-0.254	0.78	0.056*
Age (15-25)									
26-39	-0.366	0.69	0.134*	-0.371	0.69	0.132*	-0.37	0.69	0.134*
40-59	-0.311	0.73	0.147*	-0.302	0.74	0.145*	-0.32	0.73	0.147*
60+	-0.628	0.53	0.189*	-0.638	0.53	0.188*	-0.65	0.52	0.191*
Stopped (Not Stopped)									
Satisfied	0.347	1.41	0.183*	0.332	1.39	0.181*	0.314	1.37	0.186*
Dissatisfied	1.839	6.29	0.236*	1.882	6.57	0.235*	1.799	6.04	0.239*
No Response	0.536	1.71	0.121*	0.543	1.72	0.119*	0.506	1.66	0.125*
Victim (Not Victim)									
Victim	0.381	1.46	0.116*	0.361	1.43	0.114*	0.38	1.46	0.116*
Initiated Contact (Not Init)									
Satisfied	-0.41	0.66	0.155*	-0.416	0.66	0.154*	-0.406	0.67	0.155*
Dissatisfied	0.877	2.40	0.166*	0.874	2.40	0.164*	0.873	2.39	0.166*
No Response	-0.116	0.89	0.291	-0.1	0.90	0.287	-0.122	0.89	0.291
Area Type (Combo)									
Help Each Other	-0.36	0.70	0.162*	-0.305	0.74	0.16*	-0.361	0.70	0.162*
Own Way	0.38	1.46	0.145*	0.398	1.49	0.144*	0.376	1.46	0.145*
Sex (Male)									
Female							-0.108	0.90	0.111
Race (White)									
Black	-0.05	0.95	0.176	-0.072	0.93	0.171	-0.056	0.95	0.176
Indian	0.211	1.23	0.17	0.242	1.27	0.16	0.189	1.21	0.171
PakBeng	0.353	1.42	0.175*	0.358	1.43	0.168*	0.329	1.39	0.177*
Other	0.084	1.09	0.231	0.07	1.07	0.287	0.061	1.06	0.232
Area Level									
IMD	0.009	1.01	0.004*	0.01	1.01	0.003*	0.009	1.01	0.004*
Random									
σ^2	0.159		0.066				0.159		0.066

* $p < .05$, *

Model 2 in Table 4 displays the parameters of the final model without a random intercept.

Comparing Models 1 and 2, one will see that the standard errors of all of the explanatory variables are slightly underestimated. In addition, the random intercept term in Model 1 which accounts for differences between wards and within-group dependence is more than

twice its standard error, signifying that the random effects contribute important information about differences in satisfaction.¹⁶

5.2 Fixed Effects

From Equation 3 in the model section, it follows that the intercept is the natural logarithm of the mean satisfaction when the continuous variables equal zero (here worry and deprivation).

¹⁷ When interpreting qualitative categorical variables, the intercept refers to the individual who is described by all the reference categories. For Model 1, the reference individual scores zero on the worry index, is aged 15-25, white, has never been stopped, has never been a victim of crime, lives in an area described as one where people both help each other and go their own way, and lives in an area with zero deprivation. The fitted probability of being dissatisfied with the police is .14. This prediction is based on zero random effects, i.e. the individual is from an average area.

The estimated fixed effects of the individual characteristics are now discussed. To understand the effect of coefficients in logistic models, the parameters must first be converted to their exponentials to understand how the odds vary for different individuals. The exponential parameters beside the logged parameters give the odds of being of being dissatisfied compared to the reference category in that variable. For example, being a victim of crime increases the odds of being dissatisfied by 1.46 (calculated as $e^{.381}$) compared to someone who is not victimized. Therefore, persons who are victimized are 46% more likely to be dissatisfied. The following discussion focuses on the fixed effects model and assumes no random area level variation.

¹⁶ Using the deviance as a rough guide confirms this finding at $p < .05$.

¹⁷ Table A20 in the Appendix shows the mean, standard deviation and maximum and minimum of these variables.

First, as individual worry decreased, satisfaction with the police increased. For every 1-point increase on the worry index, an individual had .78 times the odds of being dissatisfied.

Younger individuals are more likely to be dissatisfied with the police than older individuals. Persons aged 60 and over were the most satisfied with the police. An interesting finding in this survey was that individuals in the 40-59 category were more dissatisfied than persons aged 26-39. This does not follow theory. However, as noted in the preliminary analysis, there is no significant difference in mean satisfaction for 26-39 and 40-59 year olds in one-way ANOVA analysis at $p < .05$. The results here may simply be due to any of the biases present in the study such as low non-response rates.

All persons who were stopped, regardless of satisfaction with the stop, were more likely to be dissatisfied than persons who were not stopped. Persons who were stopped and satisfied were 41% more likely to be dissatisfied with the police than persons who were not stopped. Persons who were stopped and dissatisfied were 529% more likely to be dissatisfied with the police. The odds of being dissatisfied are 4.44 times higher for persons who were stopped and dissatisfied than persons who were stopped and satisfied (calculated as $e^{1.839-.347}$). There is a drastic difference in overall approval ratings between persons who had a positive stop and search experience versus persons who described themselves as being dissatisfied with the stop and search.

People who initiated contact with the police and were satisfied with the experience were 34% less likely to be dissatisfied with the police than individuals who never initiated contact. This supports previous work that suggests that positive contact with the police improves approval ratings of the police. Persons who initiated contact and were dissatisfied were 140% more likely to be dissatisfied with the police than persons who never initiated contact. So positive initiated contact (apart from reporting personal victimization) has a more positive effect on satisfaction than no contact at all.

With respect to neighbourhood type, persons who describe their area as one where people help each other, are 30% less likely to be dissatisfied than persons who describe their areas as combination types. People who live in an area they described as one where people go their own way are 46% more likely to be dissatisfied than combination area. Persons who describe their area as one where people help each other have .44 times the odds of being dissatisfied as someone who describes their area as one where people go their own way.

With respect to ethnicity, we must recall that the only significant category was Pakistani/Bangladeshi. Because the other categories of this variable are not significant, it is difficult to interpret them. Persons who are black have close to the same levels of satisfaction as whites, but are slightly more satisfied in this model. However, this variable should be treated with suspicion as it is not statistically significant. Persons who describe themselves as any other minority besides black are more likely to be dissatisfied than the reference category white. This variable was included in the final model because of the high statistical significance of the variable Pakistani/Bangladeshi and because the dichotomous variable, race, was significant.

Apart from individual characteristics, area deprivation also affected levels of satisfaction. For every 10-point increase in deprivation, the odds of being dissatisfied increase by 9.4% (calculated by $e^{(10 \cdot .009)}$).

5.3 Random Effects

The variance of the intercepts is σ_u^2 (the variance of log odds), is difficult to interpret. When σ_u^2 is small, which it is in this case (.159), it is useful to calculate fitted probabilities to get a better idea of the variation of σ_u .

We begin by fitting the probability of being dissatisfied with the police for an individual who has the mean of the worry index (in this case, zero), is aged 26-39, has never been stopped, has never been victimized, has never initiated contact, describes their area as a combination area, and is Pakistani/Bangladeshi. The person resides in an area with the mean deprivation of the population, 37.12.

Table 5. Fitted Probabilities

Where Worry=0; Age:26-39;Never Victimized;Never Initiated Contact;Combination Area Type; Pakestani/Bengladeshi; Area Deprivation=37.12

Fitted Probabilities					
O _u	-2	-1	0	1	2
	9.10%	13%	18%	25%	33%

Table 5 shows the fitted probabilities of this individual in areas that range from 2 standard deviations below the average area to 2 standard deviations above the average area.¹⁸ If the individual with these characteristics lives in an area that is 2 standard deviations above the average area (the mean intercept), that person’s probability of being dissatisfied is 33%. However, if this same individual, with the same characteristics, lives in an area that is two standard deviations below the average area, the probability of being dissatisfied falls to just 9.1%. Even controlling for area level deprivation, there is an unexplained random area effect.

Table 6. Fitted Probabilities

Where Worry=-1; Age:40-49; Never Stopped, Victimized; Initiated Contact and was Satisfied Describes their area as one where people go their own way; White; Deprivation=37.12

Fitted Probabilities					
O _u	-2	-1	0	1	2
	12%	17%	23%	31%	40%

Table 6 shows the fitted probabilities of an individual who is fairly worried (worried =-1), is aged 40-59, has never been stopped, has reported a personal victimization, initiated contact

¹⁸ Take the square root of .159=.4 to calculate areas that are 1 or 2 standard deviations away from the mean due to unexplained heterogeneity.

and was satisfied, lives in an area they describe as one where people go their own way, and is white. This person also lives in the average deprivation area of 37.12.

As you will see from Table 6 the fitted probability of an individual with these characteristics who resides in an average area has a 23% probability of being dissatisfied with the police. A person who lives in an area that is two standard deviations above the average area has a 40% probability of being dissatisfied and, a person who lives in an area that is two standard deviations below the average area only has a 12% probability of being dissatisfied.

This research supports the initial hypothesis that area level differences exist even after controlling for the individual variables and area level variables in the model. Dissatisfaction for individuals ranges from 12-40% depending on some unexplained area effect, even after controlling for area deprivation. This supports the theory that the probability of being satisfied varies by area in some unmeasured or unmeasurable way. Individuals who live in areas whose intercepts are above the mean intercept are more likely to be dissatisfied.

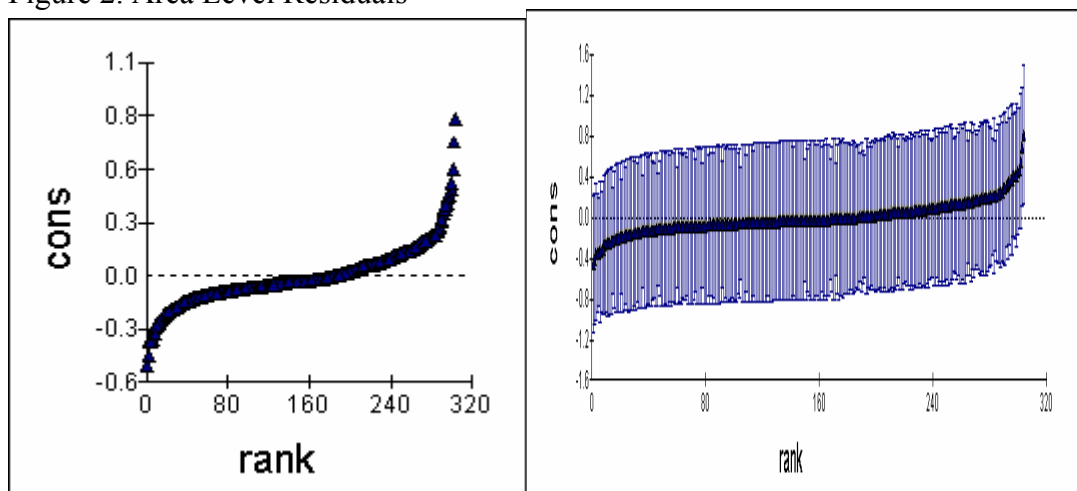
6. Discussion and Conclusions

This paper models dissatisfaction with the police in London allowing for the within-group dependence of individuals from the same Ward. The estimated model offers important new insights into satisfaction surveys by no longer underestimating the standard errors of the fixed effects, by including area level explanatory variables concurrently with individual variables, and most importantly through the specification of unexplained area level variation which has gone overlooked in previous empirical studies of this nature. Individual and area level predictors as well as unexplained area variation are important predictors of satisfaction.

Persons who live in areas whose estimated standard errors are above the mean intercept are more likely to be dissatisfied than persons who live in areas whose estimated standard errors are below the mean intercept even after controlling for individual and area level

characteristics including area level deprivation. One way to study how areas differ in their intercept is to look at the residual plot and mean intercepts of the different areas. Table 7 shows the area level residuals with and without 95% confidence intervals. The confidence intervals of the estimated random area level variation all overlap. This is most likely an effect of the small number of individuals in each individual Ward, with many cases having only one individual per Ward. In order for the police to estimate or create ‘league’ tables which can then be used to design policies which address unexplained area differences, a survey would have to be designed with multilevel modelling in mind in order to create narrower confidence intervals which do not overlap. However, this research does find that significant unexplained area level differences exist beyond area level deprivation. Thus, it would serve the police well to tailor initiatives to improve satisfaction rates by not only studying demographic variables, but also by targeting specific neighbourhoods.

Figure 2. Area Level Residuals



Currently, few police departments in the UK are making efforts to determine community attitudes and needs prior to developing community-oriented programs (Brown and Benedict, 2004). Research should build upon the findings established in this report to better understand how area level effects affect individual attitudes. Community-based programs should be based on sound empirical evidence about ‘fixed’ and ‘random’ effects.

There has been a major shift and call for ‘segmented’ policing in the UK. This style of policing would treat areas as distinct publics rather than one entity. While there would be no difference in the standard of policing for these distinct publics, there would be different approaches to policing which reflect different groups needs and target negative perceptions (Brown and Benedict, 2004). If the police in the UK are to adopt a segmented style of policing to address differences in group needs, more research, in line with the research in this project, must be undertaken to understand how areas differ in ways that are not explained by individual characteristics, ethnic composition, or area deprivation. As the research currently stands, there is no understanding of how or why neighbourhood differences exist controlling for the above-mentioned variables. Segmented policing will not be effective if unexplained area differences are not accounted for or understood when area specific polices are constructed.

Furthermore, understanding how dissatisfaction varies in terms of different fixed and random effects will help the police better allocate resources in limited budget situations.

The effects of improving satisfaction with the police extend beyond increased police effectiveness and reduced crime. Stockdale (2004) argues that increasing satisfaction with the police ‘increases positive perceptions of the local area, which will in turn lead to a higher quality of life. This creates an environment of positivity, increase(d) investment, jobs, health, and education’ (p.10). Increased satisfaction with the police is an important way to improve society’s social capital at large. Increasing a society’s social cohesion and social capital can only lead to positive benefits.

One of the secondary findings of this research project found that the effects of race are perhaps attenuated when contact with the police, area deprivation, and unexplained area variation are included in the model. While ethnicity was included as a predictor of satisfaction in our final model, it was only due to the high significance of the

Pakestani/Bengladeshi parameter. All the other categorical responses within this variable were insignificant at $p < .05$. More quantitative and qualitative research, which focuses on this minority group, is necessary before we can begin to understand how ethnicity affects satisfaction. This research suggests that perhaps ethnicity is not significant after controlling for other variables.

Rowe (2002) notes that while minority groups may prefer different styles of policing, ultimately, their needs are likely to be consistent with those of society at large. Perhaps it is not as important to consider differences in ethnicity as it is to consider differences in areas. This work supports this hypothesis, but further work is necessary to confirm that the effects of race are small or attenuated in satisfaction surveys that account for police contact, age, and neighbourhood effects (explained and unexplained).

Although attitudes towards the police are important, they should not provide the only basis for police decisions. That being said, attitudes towards the police must be a factor that is taken into account when the police are evaluated.

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Appendix A

Respondent Initiated Contact- Apart from Personal Victimization (satisfaction)

This question asked respondents about initiating contact with the police apart from reporting a crime, which happened to them personally. Respondents were allowed up to three different responses to this question. Following this series of questions, respondents were then asked what was the most recent contact. However, the question regarding most recent contact excluded persons from answering 'because they were told to do so', or 'to ask for directions', a 'social chat', or 'the time'. The wording of the most recent contact question presented several methodological challenges to creating a variable, which measured respondent initiating contact. Theoretically, it made the most sense to consider the most recent contact question rather than the first response to any initiated contact under the hypothesis that most recent contact would have greatest impact on satisfaction. However, using the most recent contact question involved backtracking if someone had ever initiated contact for directions or time, or was told to contact the police. If there was no response to most recent contact, but there was a response to any initiated contact, I looked at the type of contact the respondent had when they answered any initiated contact. If they were told to contact the police, I coded this as 1, for serious contact, and if they contacted the police to ask for directions or for a social chat, that was coded as minor contact, 2. The most recent contact responses were also coded into serious and not-serious contact. Responses 1-8 (See Appendix B) were coded as serious contact, along with question 12. Responses 9 and above (excluding 12) were coded as not serious. If a respondent said they had initiated contact and then did not specify the type of contact, they were coded as having serious contact. If the respondent did not answer the questions, the new variable was also coded as missing. There were 655 respondents who initiated contact with the police other than to report a personal crime and the new variable was the same.

If a respondent answered that they had initiated contact with the police, there were a series of follow up questions, one of which asked if the respondent was satisfied or dissatisfied with contact. From this variable, I then created another variable, which measured satisfaction with the police when the respondent initiated contact other than to report a personal crime. This variable had 4 categories, no-contact, satisfied, dissatisfied, and contacted no-response.

Personal Victimization

The survey question which measured personal crimes was done in a unique way so that researchers could analyse the difference in victimization rates and reported crimes. However, this formatting presented several methodological challenges. First I looked at the number of incidents of personal victimization a respondent experienced, and created a categorical variable, never experienced victimization, one incident, 2 incidents, and more than 3 incidents. The survey was designed to identify which type of crimes go unreported, so each type of victimization, burglary, car theft, pick pocketing, anything stolen, damaged, attacked, or other was followed by a series of follow up questions about the event, which then asked the respondent if they reported the incident. I then created a variable through a series of filters which identified individuals who had reported crimes and those who did not experience victimization, or did not report the incident.

Stop and Search- Police Initiated Contact (satisfaction)

To create this variable I filtered responses to 'have you ever been stopped in a car or motorbike' and 'have you ever been stopped on foot'. From this I created a dichotomous variable, 'stopped' and 'not-stopped'. Then, through the follow up questions which were asked to respondents who were stopped, I created a categorical variable 'not-stopped', 'stopped and satisfied', 'stopped and dissatisfied', and 'stopped no-response'.

Police Initiated Contact – Not Stop and Search (satisfaction)

The series of questions which asked about police initiated contact apart from stop and search met similar methodological challenges as respondent initiating contact apart from reporting personal victimization. I once again began with a backward stepwise procedure using the most recent contact filling in the missing components. I also divided this contact variable into 'contacted other', 'contacted witness', 'contacted suspect', and 'no-contact'. I also had the variable subdivided into the same dissatisfied/satisfied categories as the other variables.

Appendix B

Ethnic Group:

(Looking at this Card_ What is ^ your/^name's ethnic group?

- 1) White-British
- 2) White-Irish
- 3) White-Other (please specify in a note)
- 4) White and Black Caribbean
- 5) White and Black African
- 6) White and Asian
- 7) Any other mixed background (please specify in a note)
- 8) Asian-Indian
- 9) Asian-Pakistani
- 10) Asian-Bangladeshi
- 11) Any other Asian background (please specify in a note)
- 12) Black-Caribbean
- 13) Black-African
- 14) Any other Black background (please specify in a note)
- 15) Chinese
- 16) Any other (please specify in a note)

Neighbourhood Type:

In general, what kind of neighbourhood would you say you live in?

Would you say it is a neighbourhood in which people do things together and try and help each other, or one in which people mostly go their own way?

- 1) Help each other
- 2) Go own way
- 3) Mixture

Number of Victimizations:

Some of these things could have happened at the same time. For example, you might have been assaulted and had something stolen at the same time. How many of these incidents that have happened over the past 12 months are we talking about?

Respondent Initiated Contact of Police

Apart from reporting crimes that have happened to you personally, have YOU YOURSELF contact the police ^interviewer month 1999 for any of these reasons? (Prompt as necessary: include anything already talked about. Contact=in street, calling at station, and telephone.

If Yes: Then

For what reasons on this card have you yourself contacted the police (in the last 12 months)?

- 1) To report a crime of which someone else, NOT YOU PERSONALLY, was the victim
- 2) Because you were told or asked to do so (e.g. to show documents, give a statement)
- 3) To report a traffic accident or medical emergency
- 4) To report a burglar alarm ringing
- 5) To report a car alarm going off

- 6) To report any other suspicious circumstances or persons
- 7) To report any type of disturbance, noise or nuisance (apart from alarms going off)
- 8) To report a missing person
- 9) To report that you had lost something (including animals)
- 10) To report that you had found something (including animals)
- 11) To tell them that your home was going to be empty
- 12) To report any other type of problem or difficulty
- 13) To ask for directions or the time
- 14) To ask for any other sort of advice or information
- 15) To give them any sort of other information
- 16) Just for a social chat

If answered the above question:

(Apart from being told to contact the police, ask for directions, or having a social chat) which of these contacts was the most recent to you?

Overall, were you satisfied or dissatisfied with the way the police handled this matter?

- 1) Very satisfied
- 2) Fairly satisfied
- 3) A bit dissatisfied
- 4) Very dissatisfied

Police Initiated Contact-Not stop and search

APART FROM anything else you have already told me about, have the police contacted you at all in the last 12 months for any of the reasons on this card?

- 1) To return missing property or an animal
- 2) To deal with ringing burglar alarm
- 3) Investigate other noise or disturbance
- 4) Asking for information in connection with a crime that had been committed, in which you were a suspect
- 5) Asking for information with a crime that have been committed in which you were a victim/witness
- 6) Investigate an accident or traffic offence in which you were involved as a suspect
- 7) Investigate an accident or traffic offence in which you were involved as a victim/witness
- 8) To search your house
- 9) To make an arrest
- 10) To ask you to move on
- 11) Other reason

Most recent police initiated contact-not stop and search

(Apart from the police contacting you to return missing property, to return a missing animal or to deal with a ringing burglar alarm), which of these contacts with the police was the most recent?

Appendix C

Table A1. Empty Model without Random Effect

Parameter	B	SD
Intercept	-1.099	-0.05

Table A2. Empty Model with Random Effect

Parameter	Baseline	
	B	SD
Fixed		
Intercept	-1.129	0.058
Random		
ou^2	0.199	0.067

Table A3. Worry

Worry	Baseline		
	B	EXP(b)	SD
Intercept	-1.131		0.057
Worry	-0.226	0.798	0.049
Random			
ou^2	0.166		0.063

Table A4. Deprivation

Deprivation	Baseline		
	B	EXP(b)	SD
Fixed			
Intercept	-1.617		0.131
IMD	0.013	1.013085	0.003
Random			
ou^2	0.123		0.056

Table A5. Age

Age	B	Exp(b)	SD
Fixed			
Intercept	-0.63		0.101
Age (15-25 Reference)			
26-39	-0.49	0.6145	0.124
40-59	-0.58	0.5599	0.134
60+	-1.1	0.3332	0.173
Random			
ou^2	0.15		0.061

Table A6. Race and Ethnicity

Parameter	Race			Ethnicity		
	<i>B</i>	Exp(<i>b</i>)	SD	<i>B</i>	Exp(<i>b</i>)	SD
Fixed						
Intercept	-1.355		0.106	-1.351		0.107
Level 1 Variables						
Race (White Reference)						
Black	0.261	1.298	0.15			
Indian	0.246	1.279	0.151			
PakBeng	0.486	1.626	0.144			
Other	0.125	1.133	0.213			
Ethnicity (White Reference)						
Other				0.312	1.366	0.121
Random						
σ^2	0.143		0.059	0.155		0.061

Table A7. Respondent Initiated Contact apart from Personal Victimization

Initiated Contact Apart from Personal Victimization			
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.224		0.066
Level 1 Variables			
(Reference is No Contact)			
Minor	0.396	1.4859	0.109
Serious	-0.049	0.9522	0.263
Random			
σ^2	0.184		0.065

Table A8. Respondent Initiated Contact Apart from Personal Victimization-Satisfaction

Initiated Contact Satisfaction			
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.22		0.066
Level 1 Variables			
Reference No contact			
Sat	-0.203	0.816	1.146
Dis	1.146	3.146	0.153
NoResp	0.221	1.247	0.268
Random			
σ^2	0.18		0.065

Table A9. Number of Incidents of Personal Victimization

Parameter	Number OF Victimizations		
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.253		0.064
Level 1 Variables			
Reference is None			
One	0.716	2.0462	0.234
Two	0.509	1.6636	0.184
More than Two	0.735	2.0855	0.165
Random			
<i>ou</i> ²	0.195		0.067

Table A10. Dichotomous Victimization

Parameter	Victimization		
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.292		0.067
Level 1 Variables			
(Reference Not Victim or Not Reported)			
Victim	0.613	1.846	0.106
Random			
<i>ou</i> ²	0.202		0.068

Table A11. Stop and Search-Police Initiated Contact

Parameter	Police Initiated Contact Stop and Search		
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.434		0.078
Level 1 Variables			
Not Stopped			
Stopped	0.633	1.8833	0.098
Random			
<i>ou</i> ²	0.224		0.071

Table A12. Stop and Search-Satisfaction

Parameter	Stop and Search-Satisfaction		
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.384		0.08
Level 1 Variables			
Not Stopped Reference			
Sat	0.367	1.443	0.182
Dissatisfied	1.846	6.334	0.223
No response	0.393	1.481	0.115
Random			
<i>ou</i> ²	0.096		0.054

Table A13. Police Initiated Contact-Not Stop and Search

Police Initiated Contact Not Stop and Search			
	<i>B</i>	<i>Exp(b)</i>	<i>SD</i>
Fixed			
Intercept	-1.168		0.061
Level 1 Variables			
Reference-Not Stopped			
Other	0.194	1.214	0.18
Witness	0.453	1.573	0.346
Suspect	0.364	1.439	0.209
Random			
<i>ou</i> ²	0.187		0.065

Table 14. Class

Parameter Class			
	<i>B</i>	<i>Exp(b)</i>	<i>SD</i>
Fixed			
Intercept	-1.147		0.074
Level 1 Variables			
(Non-Manual Reference)			
Manual	0.086	1.0898	0.101
Random			
<i>ou</i> ²	0.128		0.061

Table A15. Sex

Sex	<i>B</i>	<i>Exp(b)</i>	<i>SD</i>
Fixed			
Intercept	-1.02		0.074
Level 1 Variables			
Sex - Female	-0.21	0.8114	0.095
Random			
<i>ou</i> ²	0.18		0.064

Table A16. Neighbourhood Type

Parameter Area Type			
	<i>B</i>	<i>Exp(b)</i>	<i>SD</i>
Fixed			
Intercept	-1.293		0.128
Level 1 Variables			
Area Type- Combo			
Help	-0.336	0.715	0.156
Own	0.475	1.608	0.139
Random			
<i>ou</i> ²	0.237		0.073

Table A17. Voter

Parameter	Voter		
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.224		0.16
Level 1 Variables			
Voter (Tory Reference)			
Labour	0.028	1.0284	0.175
Other	0.084	1.0876	0.284
Non-Voter	0.195	1.2153	0.174
Random			
σ^2	0.179		0.064

Table 18. Residential Tenure

Parameter	Years in Area		
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.165		0.142
Level 1 Variables			
Years in Area (0-2 years Ref)			
2-5 years	0.295	1.3431	0.187
5+ Years	0.121	1.1286	0.149
Random			
σ^2	0.179		0.064

Table A19. Income

Parameter	Income		
	<i>B</i>	Exp(<i>b</i>)	SD
Fixed			
Intercept	-1.169		0.1
Level 1 Variables			
Income Under £10 Ref			
Unreported	-0.106	0.899	0.162
£10,000-19,000	0.102	1.107	0.135
£20 +	0.092	1.096	0.125
Random			
σ^2	0.193		0.066

Table A20. Mean, Standard Deviation of Worry and Deprivation

Continuous Variables				
	Mean	Minimum	Maximum	SD
Worry	0.001	-1.63752	2.17949	1
Deprivation Index	37.12	2.64567	73.11359	17.37

Appendix D- Factor Analysis of the Variable Worry

Correlation Matrix

		How worried about being Mugged/Robbed	How worried about being Burgled	How worried about being Physically attacked by strangers	How worried about being Insulted/Pestered in street/public place
Correlation	How worried about being Mugged/Robbed	1.000	.612	.697	.564
	How worried about being Burgled	.612	1.000	.526	.470
	How worried about being Physically attacked by strangers	.697	.526	1.000	.665
	How worried about being Insulted/Pestered in street/public place	.564	.470	.665	1.000

Communalities

	Initial	Extraction
How worried about being Mugged/Robbed	1.000	.770
How worried about being Burgled	1.000	.916
How worried about being Physically attacked by strangers	1.000	.814
How worried about being Insulted/Pestered in street/public place	1.000	.840

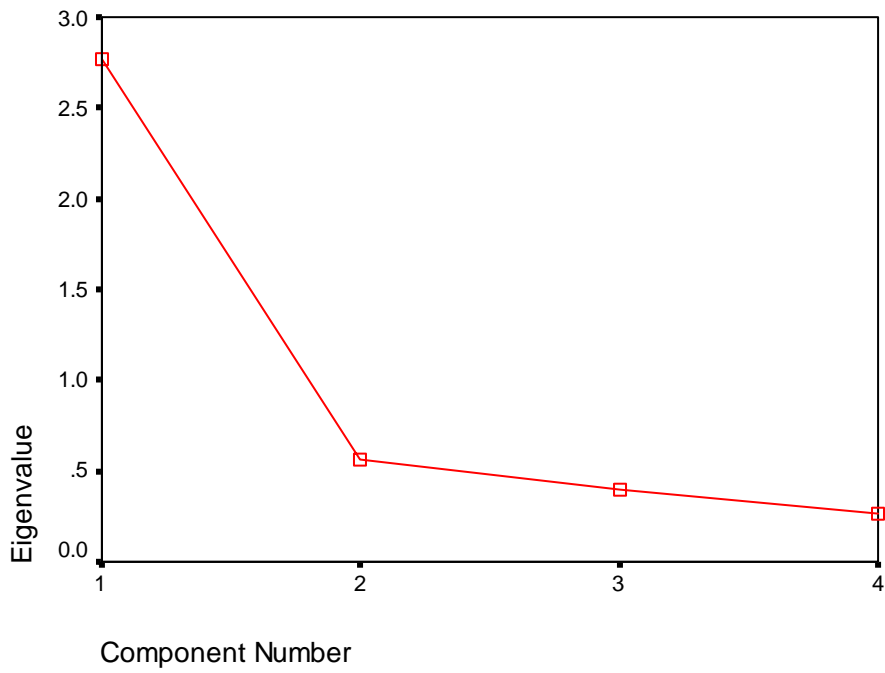
Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.773	69.323	69.323	2.773	69.323	69.323
2	.567	14.184	83.507	.567	14.184	83.507
3	.392	9.802	93.309			
4	.268	6.691	100.000			

Extraction Method: Principal Component Analysis.

Scree Plot



Component Matrix(a)

	Component	
	1	2
How worried about being Mugged/Robbed	.869	.123
How worried about being Burgled	.774	.564
How worried about being Physically attacked by strangers	.875	-.223
How worried about being Insulted/Pestered in street/public place	.809	-.430

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

