The determinants of local police spending

The Determinants of Local Police Spending[*]

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Abstract

Since 1995, police forces in England and Wales have obtained the right to raise revenues locally to supplement central government grants in order to fund their activities. The extent to which they have used these local revenue-raising powers varies significantly across area and time. We seek to explain this variation in locally raised police revenues over the 2000s, unpicking the role of local differences in preferences, central government funding, the production of public safety given police inputs, and certain political economy features of the local decision making process. We find that around three-quarters of the variation in local revenues per capita can be explained by differences in incomes, prices and preferences. We also examine whether changes in service provision by other agencies spillover into the local demand for policing by affecting the local tax price of police activities.
JEL: H41, H71
Key words Police funding Fiscal federalism Local tax price

1 Introduction

Economists have long been interested in the appropriate division of economic responsibilities between federal and local jurisdictions but there has been relatively little discussion in recent years of local service provision, especially in the United Kingdom. The balance of responsibility for providing local services rarely changes radically in the short run and academic studies tend to identify the role of local and national preferences for services, and other relevant variables in the determination of local spending levels, off cross-sectional differences in area provision. The econometric pitfalls of such an approach are well known. A case study that involves a radical change in the division of responsibilities over time as well as across localities is provided by recent reforms to the funding of the police service in England and Wales. This paper constructs and tests an economic model in order to explain variations in the extent of local funding of police forces that have arisen as a result of these changes.

The police service in England and Wales provides a classic illustration of a central facet of fiscal federalism: that decentralisation of spending powers to local jurisdictions need not be matched by equal decentralisation of revenue-raising powers Smart (2007).[1] Policing in England and Wales has traditionally been carried out locally by independent police forces with no national law enforcement agency akin to the FBI.[2] Despite mergers of local city and county forces, there are still 43 separate territorial police forces in England and Wales with almost complete operational independence. At the same time, these police forces have, from the 1850s until the 1990s, been almost wholly centrally funded by grants from government departments. This vertical imbalance between expenditure and

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[1] The standard references on fiscal federalism include Musgrave (1959) and Oates (1999).

[2] Until the late 1990s there was no national agency to deal with national crime (as opposed to agencies intend to collaborate with other police forces internationally). The Serious Organised Crime Agency was established in 2006. Only in 2013, with the establishment of the National Crime Agency as the lead agency to tackle economic and organised crime in the UK, has such a body been established.

revenue exists despite many of the standard arguments for revenue centralisation such as tax competition and service externalities being less pertinent to policing.

This extreme revenue centralisation in the context of the police has, however, been significantly weakened as a result of changes in local taxation in recent years. In 1993, the government reformed local taxation, replacing the politically unpopular poll tax with a new Council Tax. The latter is a domestic property tax levied in bands according to the value of the property in 1991[3]. Shortly after this change, in 1995, the government for the first time allowed local police authorities to levy an additional supplement to the local council tax, known as the police precept, to provide additional finance for local police services.

Initially, as we shall show, this 'police precept' was capped at a standard low rate across police authorities, and contributed little to police budgets. However from the late 1990s, levies of the police precept as a share of police revenues grew rapidly: between 1995-96 and 2009-10, real precept revenues grew by 181% whereas the real value of grants from central government grew by only 25%. Moreover precept revenues grew unevenly across police forces: with a growth range in nominal terms over the same period varying from +87% in one police authority to +374% in another. As a result, police spending financed from local sources now accounts for almost one third of total police spending but the range varies widely: in one police area, local revenue accounts for around half of total finance whereas in another it is a little over 10%. This differential shift in funding provision provides an interesting case study of changing fiscal decentralisation.

Our aim is to understand the determinants of this differential rise in the police precept and, more generally, what it tells us about the nature of fiscal decentralisation in England and Wales. The growth of precept rates could arise directly as a result of the methodologies by which central government grant allocations

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[3]A revaluation of properties has not been undertaken since that time. However properties in Wales were revalued in 2003; hence many properties in Wales are in higher bands than equivalent properties in England due to house price inflation.

to police forces are determined, and we shall explain these in the next section. However, the growth of precept revenues could also arise from differences in local preferences for policing, from differences in local taxable capacity and in the effective tax price of policing, from differences in police resource efficiency and from other factors such as local politics. Finally, it could stem from the desire of some police forces to increase their autonomy relative to attempted regulation by central government. Some evidence for this last point is indicated by the finding of Crawford & Disney (2014) that police forces with higher capacity to raise precept revenues were able to circumvent Home Office regulations requiring stricter control of early retirement of police officers. However, HM Treasury seems to retain the more prosaic explanation that certain police authorities utilised the new source of revenue simply to evade central government spending caps: the 2015 Spending Review announced that it would implement:

> [...] greater flexibility [for police forces] in their local funding decisions by rewarding those areas which have historically kept council tax [i.e. precept] low.[4]

A moment's reflection would suggest that a policy of encouraging police authorities to spend more if they had historically raised less, and vice versa, is incompatible with several of the possible explanations outlined above.

In this paper we construct a model of the determination of police precept levels across areas with three components: the production of 'public safety', a grant allocation model and the area demand for local services. We also extend the 'public safety' component to allow for other police activities that do not directly impinge on public safety. Using econometric methods, we show that changes in police precept across police forces for the period 2000-01 to 2010-11 can be explained by variables in this model. In particular, precept rates are positively

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[4]HM Treasury, 2015.

associated with variations in average incomes across police areas, negatively associated with variations in the local tax price, and positively associated with differences in police costs. Precepts are also affected by variations in the levels of grants from central government, by local political affiliation and by the 'salience' of the precept relative to the billing authority that is levying the council tax.

We also extend the model to allow for variations in police activities that are not related to the provision of the public good of 'public safety', thereby inducing variations in the implicit tax price of producing public safety. We show that these activities do thereby affect the precept rate through the implicit tax price. Our paper is the first to analyse police spending decisions in the UK, and in particular the role of the police precept, in any detail but it has wider policy implications insofar as proposed reforms to local government finance in the UK raise similar, under-researched, issues[5].

The rest of this paper proceeds as follows. In section 2 we briefly describe the institutional context and funding arrangements for the police in England and Wales. In section 3 we present a theoretical model of local demand for police services, illustrating the factors expected to play a role in determining local police funding. In section 4 we discuss our empirical strategy and data, and in section 5 we present our results. We conclude in section 6.

2 Police financing in England and Wales

Law enforcement in England and Wales is undertaken by 43 territorial forces operating at the county or metropolitan level, as well as a few specialist forces such as the British Transport Police[6]. Each police force is an autonomous or-

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[5]The Department of Communities and Local Government proposed in 2016 that local authorities globally retain 100% of local taxes levied on property ('the business rate') rather than receiving direct grants from central government. And in late 2017, the government announced that police forces in England and Wales were permitted to create additional funding of up to £450 million by permitting then to raise precept levels by up to 12 per household in 2018-19.

[6]Scotland and Northern Ireland each have a unified police force.

ganisation, with its own budget and responsibility for financing police services in its area. In this paper we focus on the 41 police forces outside London, as the City of London Police and the Metropolitan Police Service have slightly different financing and governance arrangements.

Over the period studied in this paper, police forces received funding from four sources: a general grant from the government department responsible for law and order and security issues (the Home Office); a general grant from the government department responsible for many local services (the Department of Communities and Local Government: DCLG); a locally-levied addition to the Council Tax levied on property known as the police precept, and specific grants from central government for spending on particular activities. Police forces may also charge for special services such as policing sporting events and rallies, but they are not allowed to make a profit from these services.

Figure 1 illustrates the relative importance of these funding streams, and how the composition of real revenues per capita has changed over time. In 2000, the locally-raised precept accounted for 19% of total revenues on average, while the Home Office general grant (CG in Figure 1) accounted for 46%, the DCLG grant (LG in Figure 1) for 34% and specific grants (only introduced that year) for 1%. By 2010 precept revenues had increased to 29% of total revenues, while the central and local government general grants had fallen to account for 37% and 28% respectively, and specific grants accounted for 6%.

Figure 2 illustrates how precept revenue per capita varied across the country in 2010. At first sight, there is no obvious pattern to this variation. One of the most affluent areas in England and Wales has the highest precept (Surrey, at £95 per head) and one of the poorest areas, the lowest precept (Northumbria, at £28 per head). But there is no simple "story" (such as a "North-South", or rural-urban divide) and the variation suggests that a multitude of potential factors may underlie the differential growth in precept revenues since 1995.

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Figure 1: Composition of revenues over time
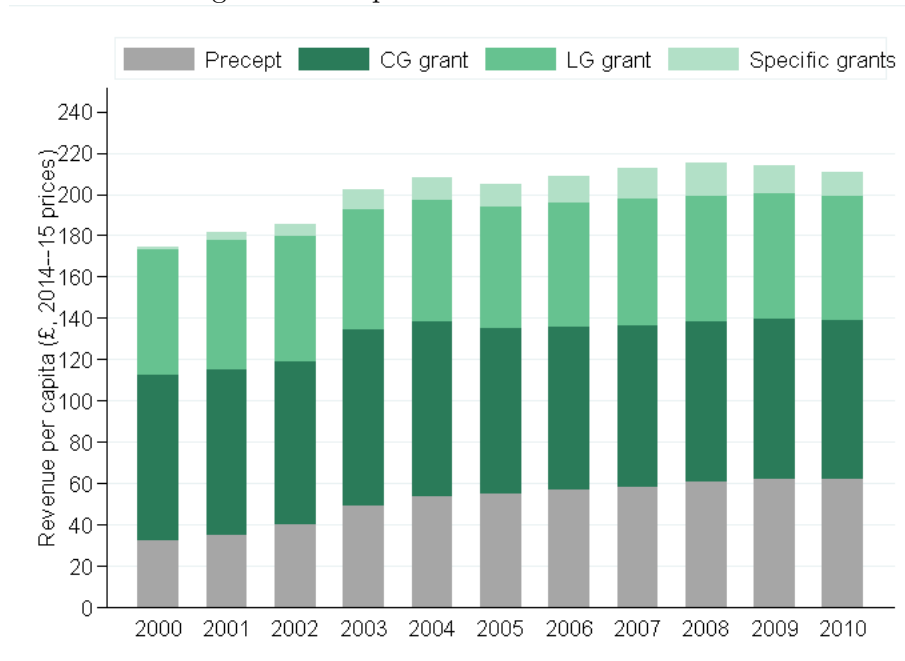
Notes: Aggregate composition of revenues across forces outside of London.

2.1 The allocation of central grant funding between forces

One important factor in determining how much local tax (precept) is raised is grant funding received from central government. Grant funding from both departments of central government is allocated to individual police forces on the basis of a "relative needs" assessment. This allocation attempts to take into account the different level of police services required to provide a given level of public safety in different areas, and to a lesser extent the differential costs of providing those services in different areas. For example, areas with higher proportions of unemployed young males would get a greater grant than an otherwise similar area on the basis that their population has a higher potential to commit crime; areas with a greater distance of major roads would get greater grant than an otherwise similar area with a lower distance on the basis that there will be more road traffic incidents to police. Other typical variables that have been used in the formula include various socio-economic demographics,

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Figure 2: Precept revenues per capita (2010)
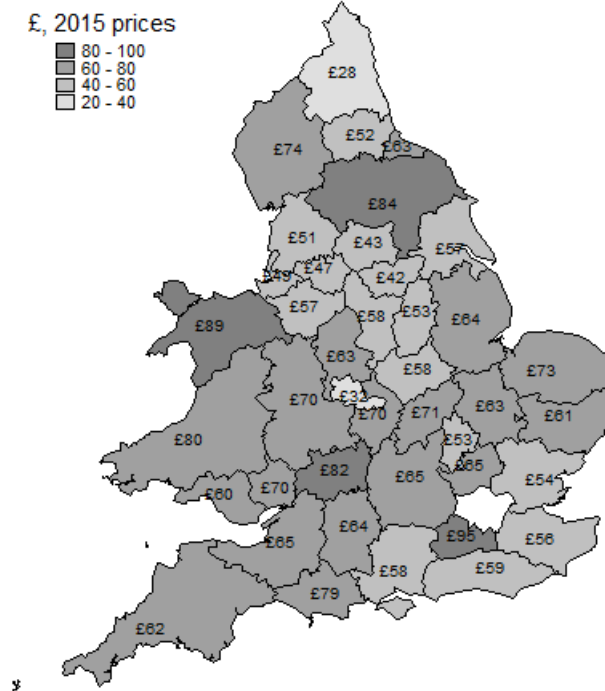
the quality and nature of the housing stock, the density of bars (since alcohol consumption is a driver of street crime), and so on.

The major difference in grant funding between the Home Office and the DCLG, other than the weights attached to various indicators, is that the latter contains an element of horizontal equalisation, as it takes into account the local tax raising ability of each police force - measured by the "number of equivalised Band D properties". What is meant by this is described more fully in the next subsection. Forces with a larger potential taxbase - which would therefore receive greater precept revenues if all forces set the same local tax rate - receive a lower grant than forces with a smaller tax base. This produces an institutional negative relationship between grant per head and potential precept per head. But the potential offset applies to less than half the central grant and is an imperfect measure of local tax capacity. Moreover, given the obvious incentive issue, no account is taken in the grant allocation of the actual tax rate that is set by the

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local police authority.

The exact formula employed to calculate relative needs has changed somewhat over time, as has the weight that the local government funding allocation formula places on relative needs versus relative tax raising capacity. However, despite the increasing complexity of the needs assessment, the formula has come under increasing criticism for being "more and more detached from the real demands of policing".[7] Furthermore, since 2002 there have been various 'damping' procedures employed to smooth the year-on-year changes in forces' grants. This has made the grant allocation process considerably more opaque, and has reduced the extent to which grants from central and local government reflect variations in policing needs or local revenue raising capacity. (More detail on the various funding regimes that have operated over the recent period is provided in Crawford *et al.* (2015) and House of Commons Library (2016)).

2.2   The police precept

The police precept is a component of council tax, a locally-levied property based tax. For the purposes of council tax, domestic residences are banded in eight categories according to an assessment of their market value in 1991 (or, in Wales since 2003, their market value in 2003). The police precept is set locally for a band D property, and then the precept for properties in other bands is determined using a ratio that is fixed across the country. For example, in all police force areas the precept on a band A property is 2/3 the precept on a band D property, and the precept on a band H property twice the precept on a band D property. The tax base can therefore be calculated as the number of Band D-equivalised properties in each area with a Band H property (the highest band) being counted as 2 x Band D and a Band A property as 0.67 x Band D. This

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[7]Statement by the Permanent Secretary to the Home Office, Mark Sedwill, at the Public Accounts Committee in 2015.

equivalised measure is used by the government in its limited extent of horizontal equalisation by DCLG. It will also be used in this paper as a component of our construction of a local tax price of policing. There are various reductions and exemptions from Council Tax for certain households, and therefore from the police precept, by virtue of low income, single occupancy and so on. This, coupled with the difference in Band D equivalised values, implies that the marginal tax price, in terms of precept, varies from area to area.

It should also be noted that there has been no re-rating of the value of properties since the initial valuations, despite the differential rise in property values across areas. For example, between April 1991 and April 2015, according to Land Registry data, house prices in Surrey rose by 335% compared to 190% in Lancashire. And house prices in Wales had doubled between 1991, when the assessment in England took place, and 2003 when the last Welsh assessment took place. Hence the tax base on which property taxes are based does not fully reflect differences in local property values, which might in turn reflect local economic indicators and amenity values. Moreover, the ratio of precept band differences across property values (from 0.67 x band D to 2 x Band D) is much less than the local variation in actual property values.

Given the value of grants received from central government, the police force budget (and hence the value of the local police precept that is set) is determined by the local police authority in the light of the policing strategy agreed with the local senior police officer (Chief Constable). Police authorities until 2012 were bodies composed of members of the elected local authority and independent members. In 2012, police authorities were replaced by elected Police and Crime Commissioners (PCCs) with the intention of making the decision-making on policing at the local level more locally accountable. However the capacity of police authorities and PCCs to plan total budgets independently of central government has been circumscribed in some periods by capping of rises in council

Figure 3: Distribution of precept rates over time
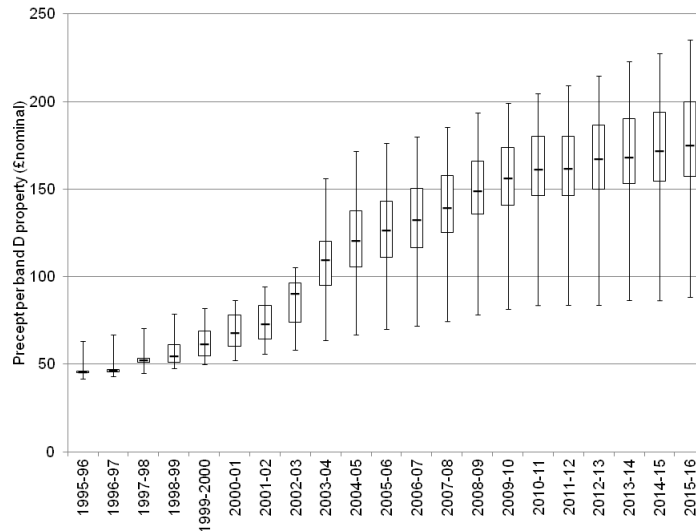
Notes: Boxes indicate the 25th to 75th percentiles, the horizontal bars indicate the median, and the tails indicate the range.

tax and police precept. These caps were universal across local authorities in the period 1995-96 to 1998-99, and from 2011-12 onwards under austerity measures. The period from 1999-2000 to 2010-11, which forms the basis of our empirical analysis, was relatively free of central government restrictions although there was some selective capping after 2004-05.

Figure 3 shows how the distribution of the precept levied per band D property has changed over time. In 1995, when the funding system described in this section was introduced, virtually all forces set the same precept level.[8] After the move to 'selective capping' in 1997 there was a striking increase in average precept levels, and a widening of the distribution over the time. Figure 4 shows the year on year growth in the band D precept. This illustrates considerable variation in changes in police precepts over the first half of the 2000s when Police Authorities had most independent discretion over their local tax rate.

In this paper we focus on the variation in police precept revenues among the 41

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[8]Prior to 1995 police services were funded via an open-ended grant based on actual expenditure.

Figure 4: Distribution of annual increase in precept rates over time

English and Welsh police forces outside London over the 11 year period 2000-01 to 2010-11 (inclusive), since this is the period when Police Authorities had the most discretion over the level of their local precept. In the next section we set out a theoretical model of public good demand and supply, to illustrate which factors would be expected to play a role and why, while our empirical strategy and data are described in section 4.

3   A model of demand for local police spending

Here we set out a theoretical model that serves to illustrate the factors that one would expect to play a role in determining local police funding, and the channels through which these factors would be expected to operate. First we consider the production of public safety, before turning to individual preferences, the grant allocation mechanism, and how individuals' preferences are represented in the choices made by local police authorities. For the moment, we assume that the production of public safety is the only activity that the police service undertakes.

3.1 Production of public safety

The output of interest for individuals is not police spending per se, but the level of public safety in the local area. We assume that locally-perceived "public safety" is generated by local police spending on visible crime prevention, such as patrols, and by police forces dealing with recorded crime activity through investigation, arrest, detention and so on. Hence, public safety is a function of local police spending per capita s_F, the local cost of police services P_F and local environmental factors D_F (for example, demographic, socio-economic or geographical characteristics that may affect the underlying propensity for crime in an area, or the ability of the police to deal with crime that occurs).

$$H_F = h(s_F, P_F, D_F) \tag{1}$$

3.2 Individuals' demand for police services

Individuals' utility is taken to depend on public safety H_i and other (composite) consumption C_i. We assume that all individuals in a given police force area enjoy the same level of public safety ($H_i = H_F$): that is, that the production of public safety is a pure public good.

$$U_i = U(H_F, C_i) \tag{2}$$

The individual faces a budget constraint, whereby their private income Y_i must cover both their private consumption C_i (with prices normalised to unity) and their contribution to the local funding of police services Π_i.

$$Y_i = C_i + \Pi_i \tag{3}$$

Local police services are funded through government grants G_F (expressed in per capita terms) and the revenue raised from local residents. Individuals' contribution to the funding of police services is therefore some proportion π_i of the difference between grant income and local spending on the police. The individual's budget constraint can therefore be rewritten as:

$$Y_i = C_i + \pi_i(s_F - G_F) \tag{4}$$

Individuals face the maximisation problem:

$$\max_{s_i} \ U(H_F, C_i) \ \text{s.t.} \ Y_i = C_i + \pi_i(s_F - G_F)$$
$$H_F = h(s_F, P_F, D_F) \tag{5}$$

The solution to this is individuals' demand for police spending per capita:

$$s_i^* = f(Y_i, \pi_i, P_F, D_F, G_F) \tag{6}$$

or in terms of locally-raised precept per capita:

$$t_i^* = f(Y_i, \pi_i, P_F, D_F, G_F) - G_F \tag{7}$$

3.3 Grant allocation

Government grants to police forces are allocated on the basis of observable relative 'needs' - that is, on an observable subset of the factors that affect the production of public safety given local police spending ($\hat{D}_F \subset D_F$) - and on local revenue raising capacity (in the case of the DCLG component of the grant) tb_F.

$$G_F = g(\hat{D}_F, tb_F) \tag{8}$$

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3.4 Aggregating local choices

In similar vein to Borcherding & Deacon (1972), to get from a model of individual preferences to a public choice over local spending we need to consider three further factors: the mechanism for aggregating individual preferences, the preferences of the local agency (here, the police authority) and the costs to the local agency of providing the public service (here the cost to the police authority of providing public safety). We therefore assume that the police authority chooses police spending with reference to a representative household in the local area, subject to the political preferences of the local police authority and the efficiency of the local police service. Efficiency, we assume, in part depends on the accountability of the local police force. Together, these factors imply police spending per capita s_m^* where m is the representative household. The level of police spending per capita in police force area F is therefore:

$$s_F = g(s_{m,F}^*, I_F, E_F) \tag{9}$$

where I_F indicates the ideology and salience of the police authority, and E_F the level of efficiency of the local police force. [9]

3.5 Summary

This simple theoretical model illustrates that locally-raised police revenues would be expected to vary across police force areas for a number of reasons. Demand for police spending varies as a result of differences in private incomes, the tax price of police spending, the price of police inputs, the factors that feature in the production function for public safety, and grant income. Furthermore, the

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[9]There will of course be feedback of the perceived ideology and activities of the police authority and the perceived effectiveness of the police force to the demand for spending by voters. These will have implications for the tax price of police services provided. We discuss what we mean by the salience of the activities of the police authority in the next section.

level of police spending may depend on the preferences of, and costs faced by, the decision making police authority.

4   Empirical estimation and data

There have been various attempts to estimate models of this kind using simultaneous equation techniques, such as Bahl *et al.* (1978), Baum (1986) and Ohls & Wales (1972), largely on cross-section data. These modelling techniques require strong functional form assumptions. This approach has tended to fall out of fashion in recent years in favour of models based on external identification (such as policy reforms). In this paper we adopt a simple reduced form approach in which locally-raised precept per capita is modelled as a log-linear function of the explanatory factors set out in equation 7. This approach does not allow us to identity all structural parameters but by using panel data methods we are able to allow for exogenous time variation in key variables such as those that determine the tax price and that underpin the local public choice mechanism.[10].

Specifically our empirical estimation takes the form:

$$Precept_{F,t} = \alpha + \beta_1 Y_{m,t} + \beta_2 \pi_{m,t} + \beta_3 P_t + \beta_4 G_F + \delta' D_{F,t} + \gamma' \text{Prefs}_{F,t} + \theta' E_F + \epsilon$$

$$(10)$$

where $Precept_{F,t}$ is real precept revenue per capita, $Y_{m,t}$ is real private income, $\pi_{m,t}$ is the local tax price of additional police spending, P_t is the real price of police services, G_F is real grant revenues per capita, D_F are indicators of 'needs', $\text{Prefs}_{F,t}$ are indicators of local preferences for public safety, and E_F are indicators of efficiency. These data, and in particular the indicators of 'needs', preferences

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[10]One approach in the literature is to limit the scope of the model to examining variations in self-reported preferences for local public goods. Data on self-reported preferences for policing are thin on the ground; data in the British Social Attitudes Survey, used by Preston & Ridge (1995) to examine local preferences for local spending, suggest that education and health (which is in fact centrally funded) are seen as local priorities while questions on preferences in the annual British Crime Survey are phrased such that they are largely endogenous to the level of local policing. See also Schokkaert (1987).

and efficiency used, are described in more detail below. In general, we assume that local decision makers fully reflect the preferences of the local population.

Police revenues   Data on precept revenues per capita and government grants per capita are available for each police force from the Chartered Institute of Public Finance and Accountancy (CIPFA).[11] In some of our empirical analysis grant revenues are disaggregated into general revenues from central and local government, and revenue from specific grants.

Private income   The measure of private income used is household gross disposable income per capita, aggregated to the police force area level from local authority level data published by the Office for National Statistics (ONS). This is a measure of mean income, as there is no data on further moments of the income distribution at a sufficiently local geographical level.

Median individuals' tax price of additional spending   We define the local tax price as the effective cost per tax paying local resident of increasing spending by £1 per capita. This is a function of the size of the taxbase relative to the adult population, and the average council tax band of the area, divided through by the average number of adults in the household. Our measure differs across areas for three reasons. First, the average number of individuals per household varies. Second, some individuals are exempt from paying council tax by reason of low income. Third, the distribution of properties by council tax band varies across areas. Across our sample the real individual tax prices ranges from 0.91 to 1.18, with a median of 1.09. In other words, to raise police spending per capita

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[11]Adjustments have been made by us such that pension contributions are treated consistently over time. (From 2006 onwards, the funding arrangements for police officer pensions (an unfunded, PAYG system) were changed from one in which all pension outgoings (net of current employee contributions) were funded explicitly in grant allocations, to a new arrangement where police forces were required to make employee contributions for current employees, and government provided a pension 'top-up' when employee and employer contributions for current employees were insufficient to meet outgoings for retired officers.)

by £1 would on average require an increase in council tax for the individual of £1.09 in a median-sized household. Data on the distribution of properties across council tax bands was provided by the Valuation Office Agency. Figures for population and the taxbase - the number of band D equivalent properties, taking into account the proportion of people entitled to reduced council tax payments - are provided by CIPFA, and the average number of adults per household by local area are interpolated between the ONS Censuses of Population.

Prices and Labour costs All financial figures are converted into real terms (2015-16 prices) using the GDP deflator - a measure of economy wide inflation. To control for geographical variation in prices we include the 'area cost adjustments' that the government uses in the grant allocation formula to reflect the fact that some areas face higher costs than others. However, it is worth pointing out that there is relatively little geographical variation in the cost of police services in England and Wales because the cost of the main input, police officer wages, is nationally regulated. Police officers of an equivalent rank are paid the same across England and Wales. We control for the change in the real price of police officer labour over time using an index of the real change in the police pay scale relative to 2000-01.

Preferences We also add controls for demographic characteristics that might be expected to be related to preferences for public safety. Emmerson *et al.* (1998) found that older individuals, and those who supported the Conservative party, had higher preferences for spending on police services. Local preferences may also be affected by the ethnic composition of the local population, and the fact that ethnic minorities are more likely to support the Labour Party, which may have other priorities for local spending. As controls for preferences we therefore include: the proportion of the local population aged 65 and over, the proportion of the population in ethnic minorities (BME), the proportion of lo-

cal authority elected seats held by members of the Conservative party, and the proportion of local authority elected seats held by members of the Labour party (with the residual number of seats being the proportion of seats held by independent individuals or members of other parties). The demographic structure of the population is estimated by the ONS, and the data on the political persuasion of local authorities is available from The Elections Centre at Plymouth University (http://www.electionscentre.co.uk/). We also include net population (im)migration: that is, transfers of population between police areas as a further variable. Net immigration into a police area might be associated negatively with the rate of police precept for two reasons: first, an area of net immigration will tend to have higher employment rates and more generally the type of demographics that will tend to raise the fiscal capacity of the area to raise precept; secondly a lower level of precept may induce net immigration whilst high rates of precept, as part of local taxation, may induce out-migration, conditional on other factors determining preferences.

Accountability   We examine two indicators of accountability of the police authority. The first is a measure of the turnout rate in local elections, using data from the Election Centre. The data are normalised for variations in the timing of local elections across England and Wales, since turnout rates are higher when local elections coincide with General Elections for the national government. We also allow for different structures of local government in different parts of the country. The sign of the effect on turnout is unclear: if voters are against high tax bills, we might expect a negative correlation between the precept and the turnout rate; a positive sign might signal a community's desire for greater spending on the police.

Our second measure is the number of local authorities which are responsible for sending out council tax bills to residents in each police force area. Whereas there

are only 43 police forces, around 400 local authorities in England and Wales send out billing notices which incorporate the police precept for the policing area covered by the police authority. This suggests that salience is an issue in interpreting policing as a local public good (Chetty, 2009). The public good provided by the police authority is less 'local' than other services provided by the local authority; local residents can perceive the direct link between the activities of their local council and the rate of council tax that it levies, but may find it more difficult to link the tax levied for policing (the police precept) to their local level of policing when the police area covers multiple local jursidictions. This might suggest a greater unwillingness to pay the police precept when the number of billing authorities covered by a police force area is large: voters do not then see the link between local service delivery by the police force and the tax-price of that service. Hence we might expect a negative correlation between number of billing authorities and the level of the precept. On the other hand, the 'add-on' of the precept to the council tax that is levied for local services may not be well understood by local voters, which allows the police authority a degree of discretion in varying the precept without voter reaction.

Efficiency Ideally, we would like to include indicators of the efficiency of the police force. A highly inefficient police force might induce local taxpayers to prefer to spend their money on other services or activities, including other measures to enhance individual safety such as private security services. However, there are no good measures over this period of the relative efficiency of different police forces that are not themselves potentially endogenous (this rules out, for example, using recorded crimes and crime clear-up rates). There has been some work on the efficiency of police forces in England using operational research methods (Drake & Simper (2003), Drake & Simper (2005)) but this results vary according to method used and are only available for a few years. A more recent and visible measure is the annual PEEL assessment introduced by HM Inspec-

torate of Police but this is only available from 2013 and tends to return the value 'good'. More evidence on efficiency is sorely needed. Given this paucity of evidence, we use one indicator, which is the workforce exit rate. This may be an indicator of relative force efficiency whereby inefficient workforce practices results in higher worker turnover, and consequently higher hiring and training costs. Higher turnover should therefore be associated with a lower precept, by the argument that voters are less willing to pay for a less efficient police service.

Needs variables The theoretical model presented in section 3 illustrated that local 'needs' characteristics, that affect how much public safety can be provided for a given level of police service inputs, underpin the basis of the grant formula. Hence the majority of these characteristics will already be captured by including the grant component in the model of the determination of the precept, as illustrated in equation (4). Nevertheless, these characteristics are weighted by the Home Office and DCLG through fixed parameters, and there may be residual variations in the production of and demand for public safety that are not covered by the central government formula. To check this, and also the determinants of the grant formula itself, we collect data on the majority of local characteristics that the government believes to be associated with the cost of producing public safety (i.e. those characteristics included in the grant allocation formula). This includes:

- The proportion of residents in routine occupations, semi-routine occupations, who have never worked or who are long-term unemployed (interpolated between the ONS Censuses of population in 2001 and 2011).

- The proportion of households that i) live in rented accommodation, ii) are occupied exclusively by students, iii) are overcrowded (by the ONS definition which adjusts for expected bedroom occupancy), iv) live in terraced accommodation, v) are lone parent families (also interpolated between the

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ONS Censuses of population).

- The proportion of the population unemployed (defined as those claiming unemployment benefits) and the proportion of the population on income-providing means-tested benefits (we calculate the 'lag' of these variables as the average proportion over the previous 3 years).

- Motorway lengths and urban B/C road lengths in km (time-varying from 2005 onwards only)

- The natural logarithm of the number of bars per hectare

- Population density (hectares per 1000 population)

The 'match' between area characteristics, the grant formula and the local precept may not be perfect for two reasons. First, since the data on many of these local area characteristics are collected only periodically (for example, in the census every 10 years), we could understate the extent to which these factors vary across police forces over the period we consider, and potentially the extent to which they explain differences in local tax raising. Second, there may be variables that are not included in the grant formula that may be pertinent to the production of public safety. The most obvious example is where there are spillovers of policing across local police areas. Grants to adjacent areas should match to relative needs in those areas, but if the match is imperfect, this may have implications for policing in the area itself. We capture this by the unweighted mean grant of neighbouring police authorities. the relation of this variable to the locally-raised precept is unclear a priori, however.

Summary statistics on the distribution of real precept revenues per capita, and the explanatory variables described above, are set out in Table 1. These distributions are described over the 451 police force-time observations - those variables

in italics are those were there is less, or no, time series variation due to data limitations.

Table 1: Summary statistics

	Mean	Median	Std. dev	Min	Max
Precept (pc)	51.50	51.30	15.65	21.77	96.12
Mean income (pc)	16.93	16.31	2.28	13.01	26.06
General grant (pc)	139.89	129.31	29.39	93.20	239.71
Special grant (pc)	15.48	14.85	8.90	0.03	61.69
Individual tax price	1.08	1.09	0.06	0.91	1.18
Pay index	102.47	102.80	0.83	100.00	102.99
Wales = 1	0.10	0.00	0.30	0.00	1.00
Proportion of ethnic minorities	5.85	4.30	5.05	0.70	28.89
Proportion of population aged 65+	17.00	16.70	1.92	13.21	22.34
Proportion of labour councillors	29.34	25.36	17.81	0.87	76.96
Proportion of conservative councillors	38.01	41.00	18.08	0.40	72.14
Proportion of net in-migrants	0.20	0.21	0.33	-0.68	1.37
Local election turnout	34.80	34.92	4.08	22.92	45.82
Num. billing authorities per police force	8.24	7.00	3.51	2.00	17.00
Force leaving rate (%)	5.53	5.35	1.30	1.80	12.73
Mean neighbour grant	144.97	139.58	17.91	115.15	192.01
Area cost adj.	1.02	1.00	0.03	1.00	1.16
Population density	418.74	271.90	404.37	34.00	2300.30
Log of bar density	-1.00	-0.99	0.74	-2.63	0.87
Low S.E. status households	27.78	27.76	4.42	14.76	39.28
Households renting	28.37	27.78	3.74	20.01	38.96
All-student households	0.40	0.35	0.25	0.02	1.17
Overcrowded households	5.35	5.13	1.27	3.31	9.01
Terraced houses	24.95	24.48	5.66	14.97	39.05
Lone-parent households	6.37	6.14	1.17	3.94	9.69
Means tested benefit recipients	8.06	7.41	2.30	3.60	15.46
Unemployment benefit recipients	1.50	1.34	0.63	0.44	4.14
Motorway lengths	75.14	68.20	58.76	0.00	231.20
Urban road lengths	344.33	308.00	162.46	90.70	752.70
Support staff ratio (lag)	0.54	0.53	0.11	0.34	0.97
Other local spend (lag)	32.79	31.47	9.81	13.31	68.81

5 Results

5.1 The government's grant formula

Our attempt to capture the formula for allocating government grants used by the Home Office and the DCLG is presented in Table 2. The various socio-economic indicators are those used by these government departments to measure 'relative needs'. In addition, DCLG, unlike the Home Office, include a measure of the taxbase in their grant calculation. The Table shows that our linear regression of the various indicators that are used to explain 'relative needs' at various points of time, coupled with the measure of the taxbase in the case of the DCLG, can explain 80-90% of the variation in general grants per capita. The variation which is unexplained arises from two factors: first, the specific functional form used in each year by each government department to incorporate these factors, and second, the influence of non-needs factors on grant allocations (for example the introduction of 'dampening' to smooth year-on-year fluctuations in grant allocations). The latter is likely to have become more important over time. It is also useful to note from these regressions that the taxbase of a local area is not significant when considering the allocation of Home Office grants, but is significant and negative for DCLG grants, which should be the case given the different administrative procedures in the two cases.

5.2 Real precept per capita

Our main results are in Table 3, where we estimate variations in real per capita area precepts for the period 2000-01 to 2010-11. These regressions are based on implementing text equation (10), but we use log-linear formulations for ease of interpretation, with the caveat that the resulting reduced form 'elasticities' cannot be interpreted in all cases as the structural parameters of a theoretical

Table 2: Explaining per capita grant allocations

	(1) HO grant	(2) DCLG grant
Taxbase (pc)	-44.23	-94.42**
	(-1.47)	(-3.09)
Area cost adj.	44.02	31.88
	(1.83)	(0.99)
Households renting	0.72**	1.16***
	(2.79)	(3.93)
Overcrowded households	0.10	-1.23
	(0.18)	(-1.37)
All-student households	0.52	4.03
	(0.18)	(1.32)
Terraced houses	0.52***	0.76**
	(4.27)	(3.38)
Lone-parent households	1.61	-1.82
	(1.85)	(-0.82)
Low S.E. status households	0.13	0.00
	(0.38)	(0.01)
Means tested benefit recipients	2.90***	3.91***
	(4.74)	(4.36)
Unemployment benefit recipients	-4.98**	-4.98
	(-3.26)	(-1.97)
Young male JSA claimants	-83.59*	7.75
	(-2.02)	(0.18)
Long term JSA claimaints	72.80***	64.57**
	(5.30)	(2.74)
Log of bar density	6.13**	6.93
	(3.09)	(1.92)
Population density	0.01***	0.00
	(4.37)	(0.88)
Number of staff in 1995	-0.00	-0.00
	(-0.64)	(-0.16)
Motorway lengths	0.03	0.02
	(1.75)	(1.20)
Urban road lengths	0.00	-0.00
	(0.11)	(-0.26)
Constant	-6.23	-5.54
	(-0.21)	(-0.14)
Number of observations	451	451
Adjusted R-Squared	0.77	0.89

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

model. We discuss this issue further as the results are evaluated. All standard errors are clustered at the police area level.

Column 1 of Table 3 provides a pooled time x area OLS regression of per capita precept levels for our baseline variables. As expected, precept per capita is negatively and significantly related to real grant per capita from central government. This negative coefficient derives in part from the partial incorporation of local tax capacity into the grant formula model, as discussed previously, but also reflects the straightforward proposition that those police areas which obtain greater central funding relative to the local implicit demand for policing do not need to raise so much local finance. However, as we shall see, this coefficient not only implies significantly less than full offset, but is reduced in magnitude in more comprehensive specifications. Conversely, specific discretionary grants are significantly positively related to precept levels. This may in part illustrate a 'flypaper' effect by which additional funding generates additional local spending (Hamilton (1983)), but also the more prosaic fact that discretionary grants may require a degree of matched local funding.

Real precept per capita is positively and significantly associated with real precept levels. This coefficient however does not have a structural interpretation. It may reflect a positive income elasticity of demand for the production of public safety (in line with the results on local spending in Britain in Preston & Ridge (1995)) but may also illustrate that the productivity of policing varies with local income levels, since higher income levels are typically negatively correlated with some indicators of higher potential crime incidence and also therefore with the some of the indicators used in the central grant formula. The sensitivity of this coefficient to specification is illustrated in the regressions in subsequent columns of Table 3.

We predict that the real tax price of raising local funding will have a negative impact on local area precept. This is borne out by the first and indeed all

Table 3: Estimation results - main specification

	(1)	(2)	(3)	(4)
ln Real grant per capita	-0.65***	-0.36*	-0.08	0.13
	(-4.74)	(-2.42)	(-0.66)	(1.21)
ln Specific grants per capita	0.13***	0.12***	0.05***	0.02
	(5.23)	(9.41)	(4.17)	(1.45)
ln Mean income (pc)	0.61***	2.56***	0.73*	-0.44
	(3.88)	(8.15)	(2.34)	(-1.44)
ln Real tax price	-0.87*	-0.61*	-0.48*	-0.43*
	(-2.09)	(-2.51)	(-2.49)	(-2.29)
ln Real cost index	8.20**	4.38***	7.02***	2.37*
	(3.47)	(3.37)	(6.44)	(2.08)
Wales = 1	0.25***			
	(6.51)			
Proportion of ethnic minorities			0.03***	-0.02
			(4.13)	(-1.45)
Proportion of population aged 65+			0.04*	0.07*
			(2.16)	(2.47)
Proportion of labour councillors			-0.01***	-0.01***
			(-5.60)	(-4.23)
Proportion of conservative councillors			0.00	-0.00
			(0.11)	(-1.32)
Proportion of net in-migrants			-0.09*	0.01
			(-2.41)	(0.17)
Local election turnout			0.01**	-0.00
			(3.26)	(-0.19)
Num. billing authorities per police force			-0.01	-0.01
			(-0.85)	(-1.57)
Force leaving rate (%)			0.00	0.00
			(0.85)	(0.30)
ln Average grant, neighbouring forces				0.44*
				(2.26)
Area cost adj.				1.09*
				(2.34)
Support staff ratio (lag)				0.44***
				(4.43)
ln Homelessness spend (lag)				0.00
				(0.39)
ln Mental health spend (lag)				0.07*
				(2.19)
ln Youth service spend (lag)				-0.00
				(-0.16)
Obs	451	451	451	451
R-Squared	0.71	0.74	0.84	0.89
Control for formula needs?	No	No	No	Yes
Fixed Effects?	No	Yes	Yes	Yes

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

further columns of Table 3. The range of this variable is limited across areas: see Table 1 for example, the range from highest to lowest value in 2010-11 is +26%. Across the various specifications in Table 3, this would suggest that. comparing the police area with the highest tax price relative to the lowest, the precept would be from 12-22% lower in the former. This is not a trivial effect and seems robust across specifications. The implicit elasticity of local tax raising to local tax pricing, is higher but not significantly so than the estimates in the United States of Bergstrom & Goodman (1973) who find tax price elasticities of between -0.13 and -0.36 across selected US states (albeit with varying levels of significance).

The other two variables in Column 1 need less discussion. Real precept levels are positively associated with the real cost index, which we measure as time variation in police wages (which are centrally determined and hence have only time variation). Since central grant allocations do not necessarily incorporate negotiated wage settlements, there is a 'gearing' effect whereby the impact of higher or lower negotiated settlements are borne by local police areas. This, in part, explains the magnitude of the coefficient. However experimentation in alternative specifications suggests that the trended nature of this variable (and indeed, of real income per capita) render this coefficient (and also that on mean income per capita) sensitive to estimation method and inclusion of a time trend. Variations in local costs are hard to measure and indeed should partly be reflected through a notional area cost adjustment in the grant formula. Finally, then positive coefficient on Wales reflects in part the higher assessed council tax values in Wales arising from the later date of the valuation discussed previously; this effectively reduces the real tax price of higher precept in Wales.

Column 2 of Table 3 controls for unobserved area heterogeneity via a fixed effect estimator. As mentioned in the introduction to this paper, we are able to improve on existing (mostly US-based) studies that rely on cross-sectional variation across

states or localities where there may be unobserved correlations between local tax rates and area characteristics. Hence we are here identifying coefficients off time variation across local areas. Using this estimator weakens the negative effect of grant per capita on local precept, reflecting the high degree of inertia in central grant allocations which typically do not reflect temporal variations in the local determinants of 'relative need'. This in turn affects the coefficient on local income by removing some of the correlation of income and policing indicators in the funding formula, but with the caveats as to the nature of the estimated coefficient noted earlier. The 'real tax price effect' remains robust. The coefficient on the real cost index is reduced because we are now measuring year-on-year differences in the rise in the cost index.

Column (3) of Table 3, retaining the fixed effects framework, incorporates some additional indicators that we described as imperfect measures of local preferences, efficiency and accountability. These have mixed results. The level of in-migration, which we argued reflected the buoyancy of local economic conditions, is associated with a lower precept rate; such areas are arguably easier to police than areas with worsening economic conditions and indeed there may be a feedback effect of local taxes on economic conditions. Areas with a greater number of older people and higher election turnout (these are likely to be correlated) have a marginally higher precept rate, ceteris paribus; in similar vein areas with higher proportions of Labour councillors have lower precept rates. Ethnic minorities are associated with higher precept rates, perhaps reflecting preferences or the nature of local policing; note that this variable is not included in our attempt to replicate the grant formula (Table 2). The 'force leaving rate' appears to be a poor measure of police efficiency. The number of billing local authorities per police area, which we took to be a measure of 'salience' of policing as a local public good, also appears to be insignificant, at least in these specifications. It should also be noted that the inclusion of these additional variables renders the

'real grant per capita' variable insignificant and significantly reduces the coefficient on income per capita. The coefficient on real tax price, though slightly lower than Column 2, is not significantly different from that specification.

5.3 Extending the policing model

So far, we have assumed that police officers are wholly engaged in providing a local public good: public safety. However, in reality police officers undertake a range of activities other than patrolling, crime detection and involvement in the processing of criminal activity. Many of these other activities can be considered as private goods with fairly limited social externalities. These including dealing with family disputes, mental health problems, child protection etc. Such issues are also dealt with by other government agencies, private bodies and NGOs such as social care and mental health services, the NHS and so on. The extent of police activity in these areas of family provision etc. is in part determined by budget allocations to other agencies: when real budgets are reduced for other agencies, the police service has to pick up some of their case load, thereby reducing time that can be spent on measures relating to public safety. In addition, the police service is a body subject to reporting and other institutional requirements. Police activity also includes a degree of form-filling such as charge sheets, crime reports, preparation for court appearances and many other administrative duties. The police service also employs staff to deal with some of these activities but of course a greater part of the burden of 'paperwork' falls on officers when fewer police staff are employed.

In the present context, we can think of deployment of police officers to these other activities as reducing the time available for providing public safety which thereby raises the real tax price of public safety. Since there is not enough publicly-available data with which to implement a fully augmented model of the production of both public safety and private goods by individual police forces, we

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utilise some indicators which we interpret as exogenous drivers of time spent by police officers in local area of non-public safety activities to augment the public good model of policing. Among these variables are changes in the resourcing of social services other than police forces in local areas: the argument being that, where such services have slower real growth in resources (or even real reductions), a greater burden of dealing with these issues falls on the police, thereby reducing the time available for dealing with public safety and hence raising the real tax price of policing public safety. In similar vein, if a local police force employs a higher number of police staff, less time is spent by officers on paper processing, with a consequent fall in the real tax price of providing public safety.

In the final column of Table 3, we augment the precept equation with several variables derived from CIPFA data to capture these indirect tax price effects. The first indicator is the (one period lagged) ratio of police support staff to police officers. We expect a positive sign on this variable, since a higher ratio frees up police officers from paperwork and other activities to focus on increasing public safety and thereby lowers the tax price of public safety, ceteris paribus. We also utilise measures of (one period lagged) spending on protective services by other agencies: specifically on mental health, homelessness and youth services. Again, the presumption is of a positive effect: higher spending by other agencies on these activities reduces the time spent by police officers on these activities and lowers the real tax price of public safety.

The use of spending on protective services by other agencies as a valid instrument for the allocation of police resources to raising public safety would be valid if the incidence of the need for protective services was completely random across areas or spending by other agencies was wholly unrelated to need. But while a case can be made that spending by other agencies is dependent in part on local budgetary pressures and thereby contains some exogenous variation, the need for such services is unlikely to be random. Indeed the evidence suggests that

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area-based relative need for protective services such as mental health treatment, homelessness and family-related protection issues are not only non-random but correlated with precisely the factors that enter into the central grant calculations for police allocations. For example Weich & Lewis (1998) argues that the cross-section incidence of mental health issues correlates strongly with the incidence of unemployment and low income; a result confirmed by Fryers *et al.* (2003). Walby & Allen (2004) argues that episodes of domestic violence, sexual assault and stalking, which take up an increasing amount of police time, are correlated with very similar area socio-economic characteristics to other forms of crime. If we were to ignore these facts, we would get a spurious correlation between spending by the police and by other agencies.

We resolve this problem by incorporating into the final column of Table 3 not just the indicators of staffing and social service spending but the original 'risk factors' that underpin police grant allocations. We argue that these additional variables control for inter-area differences in need for these social services, so that the estimates of the effect of other agency spending are thereby independent of relative needs. By doing so, of course, we render the coefficient on 'real police grant per capita' insignificant since the relative need factors that now determine the grant (in part at least) are now independently entered in the precept equation.

Table 3 column 4 now includes all the factors described in Table 2 as measures of 'relative needs in policing framework as additional explanatory variables as well as our indicators of police activities other than public safety provision, in a fixed effects framework. Unsurprisingly, the 'relative needs' variables are strongly jointly significant (results are available on request). In relation to the 'core variables' in the other columns of Table 3, the inclusion of these extra variables removes the significance on grants per capita and real income per capita. The coefficient is reduced on real costs; the real tax coefficient is unchanged. Once we

include these 'relative need' variables, the indicators of the allocation of police time between public and private goods, namely the staff ratio and other agency spending changes, are jointly significant with the correct sign [F test$(4, 379)$ = 6.57]. However, this significance is largely driven by the variable 'lagged support staff'; the three indicators of spending by other agencies, once we control for incidence of need, are jointly insignificant [F test$(3, 379)$ = 1.69].

6 Summary and conclusions

This is the first paper, to our knowledge, since Preston & Ridge (1995) to examine the demand for local public spending in Britain. We exploit a change in the funding regime in England and Wales that permitted local police forces to raise funds additional to central grants in order to fund their activities, via the introduction of a precept as a supplement of local taxation of property values. Since the willingness of police authorities to raise precept varies over time as well as spatially, we are able to investigate a number of hypotheses concerning local spending in the context of a simple model of the demand for police services and the costs of providing those services.

Our log-linear model including prices, incomes and some other indicators of local preferences can explain three-quarters of the variation in the level of police precept per capita. The major sources of variation in precept per head over police areas over time are government grants, median real incomes, the real tax price of raising local precept, police costs (albeit these are largely driven by time variation) and a vector of socio-economic controls. We find some evidence that local political preferences and election turnout also have explanatory power.

Unlike existing studies of local funding that exploit cross-section variation in area characteristics, and which are exposed to the issue of unobserved heterogeneity, we also have time variation in the extent of local spending - indeed it is in

explaining the differential rise in local spending on the police that our paper has the most immediate policy implications. We exploit this time variation by re-testing the model using panel data methods. We also extend the model to consider police activities that could be considered as private rather than public goods, and investigate whether exogenous variations in budgets of other local agencies dealing with these problems (such as care of children, homelessness and mental health issues)affect local police spending by affecting the time devoted by the police to public good activities.

The policy implication of the paper is that variations in precept spending are driven by real economic variables and are not driven simply by, say, the relative efficiency or otherwise of local police forces. Since central government often tries to limit the capacity of local police forces to raise additional revenues, these economic determinants of revenue-raising should be taken into account. On the other hand, one of the weaknesses of data and measurement of variables in the police context is the lack of adequate indicators of the efficiency of local police forces. To fully understand the extent to which local police funding requirements are driven by area characteristics rather than by local efficiency, further research is needed.

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