Measuring Attitudes towards Public Spending using a Multivariate Tax Summary Experiment [*]

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It is difficult to measure public views on tradeoffs between spending priorities because public understanding of existing government spending is limited and the budgetary problem is complicated. We present a new measurement strategy using a continuous treatment, multivariate choice experiment. The experiment proposes deficit-neutral bundles of changes in spending and taxation, allowing us to investigate attitudes towards modifications to the existing budget. We then use a structural choice model to estimate public preferences over spending categories and the taxation level, on average and as a function of respondent attributes. In our application, we find that the UK public favours paying more in tax to finance large spending increases across major budget categories; that spending preferences are multidimensional; and that younger people prefer lower levels of taxation and spending than older people.

Introduction

How much money should the government collect in taxes and how should it spend these resources across different policy areas? These two questions about the public budget are among the most important choices that governments make: they both change the material positions of citizens and enact political and social priorities. With this in mind, pollsters and political scientists have long sought to measure public attitudes regarding how much the government should tax and spend overall, and how much citizens want spent on different things. But despite the importance of taxation and spending itself, and of public opinion about taxation and spending to democratic governance, we lack good strategies for measuring these basic political preferences.

The fundamental tension in understanding and measuring public opinion on government

budget choices is the collision of the intrinsic complexity of budgeting with the well-known limitations of citizens' understanding and engagement with public policy. How much information can we reasonably expect to extract about the public's views regarding taxation and government spending, when very few members of the public have previously considered what their ideal budget might look like, let alone tried to articulate it? Existing studies tend either to ask simple questions, which make life easy for respondents, but avoid the complex realities of budgeting; or to maintain a high degree of fidelity to the budget process at the cost of very demanding response tasks for respondents. In either case, we may lack confidence that these articulated preferences are what will be relevant to public responses to the policies that governments in fact enact.

This paper proposes a strategy for inferring a distribution of coherent public budget preferences from accessible questions about tradeoffs over subsets of budget categories. We demonstrate this approach using a new survey experiment of UK citizens.[1] Every UK taxpayer receives a tax summary at the end of the financial year which indicates how individuals' income tax and national insurance contributions are proportionally allocated across a variety of public spending categories. Using these as the baseline for status quo levels of taxation and spending, respondents to our experiment are asked whether they prefer the status quo spending, or randomly generated deficit-neutral proposed bundles of changes in tax levels and spending categories. Our experimental design ensures that survey respondents have only to consider the relative merits of the status quo versus a proposal that is identical to the status quo on all but three potential spending areas and, possibly, the tax level. This simplifies the choice task faced by respondents (versus a full budget allocation), but still maintains the essential quantitative budget constraint that spending changes and tax changes add up.[2]

The limited data we collect from each individual does not contain sufficient information to estimate preferences at the individual level. Instead, we use a structural choice model to translate the choices from our survey into estimates of the distribution of preferences across the UK

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[1]A separate criticism of using stated preferences to elicit preferences is that surveys ask inherently hypothetical questions of respondents. Our approach does nothing to improve on this limitation, but given the ubiquity of survey-based approaches and the different problems associated with behavioral measurements of budget preferences in public opinion, improvements within the survey method are valuable.

[2]Government spending can also be financed through increased borrowing, but here we focus respondents' attention on the key tradeoffs between tax and spending. Our approach easily permits changing deficit levels.

public. We also estimate how average preferences vary as a function of demographic and political attributes of citizens. Our general strategy is to provide citizens with a set of questions that they could answer if they had well-formed budget preferences, observe the choices they make, and translate these choices back into the distribution of well-formed preferences across citizens that would have generated those responses. We acknowledge that most respondents may not in fact have well-formed budget preferences. One motivation for our design is that if citizens were asked to articulate such a budget, starting from the status quo and contemplating the tradeoffs involved in changing it is a plausible strategy. Another motivation is that real budgets must add up, and so it is worth knowing the coherent budget that is most consistent with the spending and tax tradeoffs that citizens are willing to endorse, even if individual citizens could not articulate a full budget themselves.

We identify three major substantive findings. First, on average, UK citizens express a willingness to support higher taxes in return for increased expenditure across a range of spending categories which aggregate to an overall increase of 7% of current levels. Second, preferences over spending areas are multidimensional: it is not simply the case that some people want more spending and others want less or that there are "left-wing" budget areas and "right-wing" budget areas. Third, 18-34 year-olds want lower tax and spending levels than those older than 55, both unconditionally and holding constant their voting preferences, degree status and income. This is notable given the very large age gradient in voting in recent elections, which have seen much higher support for the Labour party among young people than old people. In contrast to much political commentary, young people in the UK are not left-wing in the sense of wanting a substantially larger government.

We report both an internal validation, using our model to predict responses to held-out survey responses from our experiment, and an external validation, using our model to predict responses to novel budgetary proposals in a new pre-registered survey.

Our study contributes to several literatures in political science. First, knowing what policies people support is necessary for answering questions about elite responsiveness to public preferences (Lax and Phillips, 2009*b*). Much of this literature does not consider the responsiveness of government spending, focusing instead on issues where spending is a second-order concern:

gay rights (Lax and Phillips, 2009*a*), abortion (Arceneaux, 2002) and support for judicial nominees (Kastellec, Lax and Phillips, 2010). While it is straightforward to measure levels of government spending across different policy areas, we address a key limiting factor for this literature: the absence of reliable measures of public preferences for levels of spending across policy domains.

Second, public opinion on economic issues in many countries is often treated as though it varies primarily according to a single ideological dimension which captures the classic left-right divide over the size of government (Meltzer and Richard, 1981, Caughey, O'Grady and Warshaw (2017)). We show that voters do not simply favour more or less government spending (or taxation) overall, but rather favour higher spending in some areas and lower spending in other areas. This claim is distinct from the fact that politics in many countries features a multidimensional mix of economic and social issues: even when focusing solely on fiscal policy, improved measurement reveals that voters' preferences are not closely approximated by a unidimensional structure. These results speak to recent work on coalitions of support for the reorientation of welfare spending from traditional categories to new ones (Häusermann, 2010). However, our UK respondents do not divide in a budgetary competition between social investment (education spending) and consumption (pensions) (Busemeyer et al., 2018). Instead, our respondents prefer to increase both at the expense of higher taxes and spending reductions elsewhere.

Finally, scholars in comparative political economy are increasingly attentive to budget tradeoffs in social and fiscal policy-making at times of austerity. An important body of work asks about voter preferences on the tradeoff between spending cuts and tax increases, if borrowing is off the table so that the government budget constraint is hard (Bremer and Bürgisser, 2019; Hübscher, Sattler and Wagner, 2018). Our approach provides an additional point of evidence that tax increases may be supported over spending cuts.

What Do We Know About Budget Attitudes and How to Measure Them?

Public preferences over government spending have long been an object of research due to their centrality to a number of important substantive questions. How voters want government allocate funds is critical in understanding the functioning of democratic systems – for example in the literature on policy responsiveness; and in questions the political economy of government

spending more broadly. All of these substantive inquiries, when using data on public opinion on spending, make choices about the measurement of these preferences. These choices (implicitly) propose some solution to the tradeoff between simplicity for the gauging of opinion, and realism in the budget preferences that are revealed. Leaving these measurement questions unexamined has led, in part, to inconsistencies in the kinds of preferences attributed to voters, who have then in turn been characterised as inconsistent. Examining these debates highlights the need for our contribution here, echoing other recent attempts to generate explicit and absolute public positions on government spending allocations to different areas of the budget (Bonica, 2015; Branham and Jessee, 2017).

First, understanding public opinion on government spending has been a central concern of scholars interested in the degree of government intervention in the economy, in particular in its actions to offset inequality. In this tradition, the centrally important preferences are those over the level of government spending overall, or aggregated across a large set of policies (Kelly and Enns, 2010; Svallfors, 2012), spending on particular social policies with important distributive implications, such as unemployment insurance (Rehm, 2011), and on the broader question of support for redistribution (McCall and Kenworthy, 2009; Cavaillé and Trump, 2015; Rueda and Stegmueller, 2019). The core themes of this work center on the role of material self interest in shaping these preferences, and overall levels of support for egalitarian spending. In the latter case, results indicating generally high levels of support for public spending and redistribution raise questions as to why policy has not followed along these lines, with some pointing to the failure of these questions to capture the tax costs of such budget changes.[3]

The second area of attention compares budget allocations to public opinion as an indicator of policy responsiveness to preferences, and of opinion responsiveness to spending (Wlezien, 1995; Soroka and Wlezien, 2005, 2009). These studies typically measure spending preferences in relative terms; for example, "Are we spending too much, too little, or about the right amount on the military, armaments, and defense?" These questions are simple for respondents to evaluate,

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[3]Much of this work also considers public preferences over the revenue-raising side of the budget, as well as the spending side, but usually taken separately rather than linked via a budget constraint (Gilens, 2012; Bartels, 2005). We consider only the overall tax burden implications of different allocations on the spending side, but an analogous exercise in examining how the public would prefer government revenues be raised is a natural application of the same underlying measurement strategy that we introduce here.

but do not translate directly into specific preference positions over a full budget. Importantly, this kind of measure makes no explicit allowance for tradeoffs in the budget process (a cost of higher spending in one area is reductions in another, or increased taxation). Nor does this allow for any prescription as to the size of any preferred change: a large majority of people in favor of an increase is not equivalent to a majority in favor of a large increase.

These approaches have led to a body of public opinion data which reflects more nuance than simple pro-spending versus anti-spending views (Page and Jacobs, 2009), but which equally may reflect variation in the salience of the tradeoffs that must be made in budget-making in the real world, and the perceived feasibility of viable changes when voters may be misinformed about the status quo.[4] When taken together, the cumulation of these simplified questions across different areas of the government budget – including implications for overall rates of taxation – tends not to provide a clear and coherent view of budget preferences.

Indeed, the results of these strategies of measurement have been divergent enough to suggest that voters want something for nothing, and are not equipped to deal sensibly with tradeoffs, although the evidence for such inconsistent preferences 'is mixed' (Citrin, 1979, 128). Voters may have beliefs that provide good reason for denying a tight tradeoff exists – in particular the perception of waste (Citrin, 1979; Williamson, 2017). If there is waste to be trimmed, a desire to increase spending without increasing taxes is not inconsistent. In other cases voters may not accurately perceive the costs and benefits on each side of the tradeoff. Scholars have explained a lack of willingness to pay taxes by the inadequate visibility of the spending they support (Downs, 1960; Mettler, 2011), and support for spending programmes by the inadequate visibility of the taxes required to support them (Winter and Mouritzen, 2001). Alternatively, patterns of public opinion that appear inconsistent at the aggregate level can arise from preferences that are rational at the individual level, where taxpayers prefer higher levels of spending financed by increases in the taxes paid by other people (Edlund and Sevä, 2013).

When survey prompts make budget tradeoffs more explicit, respondents provide more consistent profiles of responses. The most complete existing study of budget preferences under tradeoffs was fielded in the pilot to the 1996 American National Election Study, presenting re-

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[4]For example, Page and Jacobs (2009) discuss voter 'confusion' about the extent of foreign aid spending, and thus the implications for the impact of cuts to aid on the overall budget.

spondents with choices on exhaustive and mutually exclusive categories (taxation, deficits and domestic and defense spending) that incorporated the relevant tradeoff, asking about the level of support for policy packages which combined increases in one area with offsetting decreases elsewhere. Hansen (1998) finds that these data reveal a high degree of consistency in budget preferences.

Thus it is easy to demonstrate that people do not give responses that obey budget constraints when given questions that neither enforce nor encourage obeying such constraints. It is not inconsistent or irrational to prefer both high spending and low taxes in a situation where there is no reason you cannot want both. Most people want both, all else equal. The point of the budget constraint is that all else cannot be equal. But if you are answering a survey that only mentions one at a time, or if you are left free to implicitly externalise tax costs to other people, the budget constraints do not obviously bind. This is not a failure of the respondents, but a failure of the survey instrument. If our goal is to elicit public preferences over feasible budgets, it makes sense to ask respondents about feasible tradeoffs.

State-of-the-art measurement in this area has thus recently moved in the direction of richer survey prompts and spatial modelling, in order to better elicit information about tradeoffs. First, the logic leads very naturally to the idea of simply asking each respondent to set spending levels across all budget categories. This approach is taken by Bonica (2015), who uses an online budgeting task that allows respondents to re-allocate the US federal budget from its existing baseline (holding tax and deficit constant) across 21 spending areas. This approach has been adopted in number of recent studies (D'Attoma, Tuxhorn and Steinmo, 2018; Hübscher, Sattler and Truchlewski, 2020). However, solving the full budget allocation represents a highly challenging task for respondents, motivating the search for a more accessible survey instrument. Second, Branham and Jessee (2017) use US General Social Survey data on "too much", "about right", "too little" assessments of spending across 18 spending areas, and use a spatial model to map responses onto a distribution of public preferences in a unidimensional space. This makes maximal use of this kind of (relatively accessible) survey question, but does not provide quantitative estimates of the size of preferred changes, and (as the authors note) does not make respondents face tradeoffs directly (though the spatial dimension implicitly describes a range of different preferred

tradeoffs).

We build on Bonica (2015) by targeting an absolute and quantitative preference for spending change, with full attention to the multidimensional tradeoffs involved. But our concerns about the difficulty for respondents in constructing a full budget suggest our intermediate solution in which we ask about narrower tradeoffs involving a few spending categories at a time. By exploring the space of possible tradeoffs, we can use a spatial modelling approach like that of Branham and Jessee (2017) to reassemble responses into a budget.

Finally, our approach builds on recent empirical developments in the analysis of tradeoffs in general. These have come increasingly under investigation with the use of conjoint experiments. Conjoint choice analyses have been used to ascertain preferences over various multidimensional policy areas, including: tax progressivity (Ballard-Rosa, Martin and Scheve, 2017), climate change agreements (Bechtel, Genovese and Scheve, 2017) and immigration (Hainmueller and Hopkins, 2015), to name but a few.

There have already been attempts to use forced choice designs to investigate budget preferences. In Bremer and Bürgisser (2019) and Hübscher, Sattler and Wagner (2018), respondents are asked to choose a package of fiscal proposals which differ in terms of spending, taxation and government debt. In each of these approaches the direction of the changes are specified – increases or decreases in taxes and spending of different types, which may be 'small' or 'large'. Thus preferences over tax levels and spending within this directionally-balanced budget are elicited. These studies show little (if any) differentiation across spending types in terms of the effect of cuts on support for the package (cutting healthcare is equally unpopular as cutting pensions, for example), but this is a hard task for this empirical design as there is no obvious metric by which to convert 'small' cuts in one spending area to 'small' cuts in another. Our approach makes these tradeoffs more concrete by requiring not just directionally but arithmetically balanced budgets.

Our approach draws on the intuition that a multivariate, forced choice experiment like a conjoint experiment is useful for understanding preferences over multidimensional objects like budgets. But the standard conjoint design with independent treatments is ill-suited to the quantitative tradeoffs involved in budgets; budget tradeoffs are, by their nature, not independent. Increasing one spending area requires changing other spending areas or tax to maintain balance.

These changes are perfectly multicollinear: knowing the changes made in $K-1$ categories of tax and spending determines the remaining category exactly. This makes the resulting data not only incompatible with the standard linear regression analysis of conjoint experiments, but also with the theoretical logic of calculating Average Marginal Component Effects (Hainmueller, Hopkins and Yamamoto, 2014). In order to explore these budget tradeoffs, we need a different sort of multivariate forced choice experiment, and a new strategy to analyse the resulting data.

Experimental Design and Data Collection

We fielded an experiment in October 2018 where we presented respondents with information mirroring the taxpayer summaries distributed by the UK government. These summaries, which are distributed to every UK taxpayer at the end of the financial year, indicate how individuals' income tax and national insurance contributions are allocated across a variety of public spending categories. The summaries therefore provide itemized accounts of government spending over the previous year, and are personalised for each recipient by scaling them to that individual's total tax level. Further detail on these summaries is provided in the supplemental information.

We used the tax summary spending allocation from fiscal year 2016/17 as a baseline and then – for each respondent – randomly altered the amount of spending in three spending categories and (in some cases) the overall tax level. Respondents were first presented with an introduction screen which outlined the basic idea of the task, and provided information on how government spending is currently allocated across the fifteen spending categories. We expressed all information about tax and spending levels with reference to the income level of an individual who earned £23200 each year, approximately the median income of a UK taxpayer in 2016.

Respondents were then asked to consider a series of comparisons between randomly generated proposed tax and spend levels and the status quo allocation. All proposed changes involved maintaining deficit neutrality: proposed changes in spending and tax always exactly offset. In 1/3 of proposals, there was no change in tax, only shifts between spending categories. The prompt used in the experiment is given in figure 1 below. We provided respondents with current and proposed spending levels on each selected category in pounds, and also provided information on the implied change in spending and tax in both pounds and percentage terms. In addition,

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Consider the current tax and spend levels and the proposed tax and spend levels given below, for an individual with a yearly income of £23200.

	Current level (£)	Proposed level (£)	Change (£)	Change (%)
Welfare	991	981	-£10	-1%
Health	828	864	+£36	+4.3%
Overseas Aid	45	19	-£26	-57%
Total tax	4078	4078	£0	0%

Under the proposed tax plan, compared with current tax and spending levels:
- The total tax paid would **stay the same**.
- Spending on Welfare would **decrease**
- Spending on Health would **increase**
- Spending on Overseas Aid would **decrease**
- Spending on all other categories would **stay the same**.

Which tax and spending levels do you prefer?

○ I prefer the current levels

○ I prefer the proposed changes

○ I am not sure

[**>**]

Figure 1: Experiment prompt

we provided text to clarify which spending areas would see increased or decreased spending under the proposed plan relative to the status quo, and which areas would see no change in spending. Respondents were then asked to indicate whether they preferred the current levels of spending, the proposed changes, or whether they were not sure. Each respondent faced five different choice tasks, each time comparing a randomly selected spending proposal to the status quo. Details of how we generated the distribution of proposed changes are provided in the supplemental information.

We suggested above that part of the logic of this approach is accessibility to respondents compared to a full allocation task. The simplest test of respondent engagement with our prompt is to assess how many people give "I am not sure" responses, and in particular how many give this response to all five proposed sets of changes that they saw. Of 3533 respondents overall,

52% gave 0 "not sure" responses, 16% gave 1, 9% gave 2, 4% gave 3, 4% gave 4, and 16% gave 5. We would expect that even fully engaged respondents would give this responses to some fraction of the prompts, but the relatively large number of respondents giving this response to 5 items (versus 3 or 4) confirms that some respondents did not engage with the questions. Respondents who gave 5 "not sure" responses spent, on average, 56% less time on the survey than respondents who provided 0 "not sure" responses. Those with lower levels of education were more likely to not express preferences on any comparison: among those with university degrees, 11% versus 19% among those without. These are moderate levels of differential non-response that are typical of those seen in political survey data (Berinsky, 2008).

Overall, this experiment gives us rich information about how citizens make tradeoffs between different spending areas and tax, but it is not straightforward to analyze. It is not a traditional conjoint experiment, because the experimental treatments are not merely non-independent, but perfectly multicollinear. We cannot fit regressions for the responses as a function of the treatments, because of this multicollinearity: the "all-else-equal" logic of regression modelling is ill-suited to data where all-else is never equal by design. Instead, we use a structural model that assumes respondents have spatial preferences over spending and tax levels and make choices accordingly. Given these assumptions and the observed responses, we can infer the underlying distributions of preferences most likely to have generated the data.

A Model for Respondent Choice

To build a model for respondents' choices, we need to make some assumptions regarding how they will tradeoff changes in spending and taxation. We adopt an additive quadratic loss model for deviations from respondents' preferred spending level in each spending area, which is con- sistent with typical approaches in the spatial preference modelling literature (Clinton, Jackman and Rivers, 2004) and which proves mathematically convenient for defining our estimator below. Each respondent i makes a choice between the proposed alternative (A) and the status quo (S), with an option to say they are not sure (NS) which they prefer. We assume that they do so as a function of the latent utility of the two alternatives, with "not sure" corresponding to cases

where their utility difference is small.[5]

- Y_i = proposed alternative if $u_{iA} - u_{iS} > \gamma_A$
- Y_i = not sure if $\gamma_S \leq u_{iA} - u_{iS} < \gamma_A$
- Y_i = status quo if $u_{iA} - u_{iS} \leq \gamma_S$

We assume that respondents i have quadratic loss in deviations of the status quo $S = (S_1, \ldots, S_M)$ and the proposed alternative $A_i = (A_{i1}, \ldots, A_{iM})$ from their preferred point $\Psi = (\psi_{i1}, \ldots, \psi_{iM})$, and that this is weighted per dimension $j \in 1, \ldots, M$ by a factor λ_j. Further discussion of these choice model assumptions is provided in the supplemental information.

$$u_{iA} = -\sum_j \lambda_j \left(A_{ij} - \psi_{ij}\right)^2$$

$$u_S = -\sum_j \lambda_j \left(S_j - \psi_{ij}\right)^2$$

$$u_{iA} - u_{iS} = \sum_j \lambda_j(S_j^2 - A_{ij}^2) + 2\lambda_j(A_{ij} - S_j)\psi_{ij}$$

The λ_j weights mean that the model allows for respondents putting similar weights on £ deviations in all categories, or similar weights on percentage changes from baseline spending, or some other weighting of categories. The values of S_j and A_{ij} are data and we have plenty of data with which to estimate λ_j for each of the dimensions. The thing we neither know, nor can estimate with useful precision, is a single respondent i's preferred allocation in each spending area j, their ideal point ψ_{ij}.

Estimating the Distribution of Preferences

While we do not have enough data to measure ψ_{ij} at the individual level, we can estimate the distribution of these individual-level ideal points in the population. We assume that ψ_i follows a multivariate normal distribution:

$$\psi_i \sim N(\mu, \Sigma)$$

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[5] In order to identify the latent utility scale relative to the response, we assume that the thresholds that respondents apply for selecting either the proposed alternative or the status quo, as opposed to "not sure", are symmetric around 0 and set to $\gamma_A = +1$ and $\gamma_S = -1$.

where μ is a vector of length M giving the average preferred allocation in each spending area. Σ is the covariance matrix of individual respondents' preferred allocations around that average with elements $\Sigma_{jj'} = \rho_{jj'}\sigma_j\sigma_{j'}$. The utility difference $u_{iA} - u_{iS}$ above then defines an affine transformation on this multivariate normal distribution, and thus implies a univariate normal distribution for the utility difference between the two alternatives faced by a given respondent:

$$u_{iA} - u_{iS} \sim N\left(\nu_i, \omega_i^2\right)$$

$$\nu_i = \sum_j \lambda_j(S_j^2 - A_{ij}^2) + 2\lambda_j(A_{ij} - S_j)\mu_j$$

$$\omega_i^2 = \sum_j \sum_{j'} \rho_{jj'}\sigma_j\sigma_{j'} \left(2\lambda_j(A_{ij} - S_j)\right)\left(2\lambda_{j'}(A_{ij'} - S_{j'})\right)$$

Given our definition of the response at the outset this yields the following response distribution, conditional on parameters, for the three responses:

$$p(\text{status quo}) = \Phi\left(\frac{\gamma_S - \nu_i}{\omega_i}\right)$$

$$p(\text{not sure}) = \Phi\left(\frac{\gamma_A - \nu_i}{\omega_i}\right) - \Phi\left(\frac{\gamma_S - \nu_i}{\omega_i}\right)$$

$$p(\text{proposed alternative}) = 1 - \Phi\left(\frac{\gamma_A - \nu_i}{\omega_i}\right)$$

This model has a moderate number of free parameters—13 μ_j, 13 λ_j, 13 σ_j, 78 ρ_j = 117 total—but we have 17665 responses with which to estimate those parameters (about 150 per parameter). Because our experiment can most meaningfully test spending levels that are included in the distribution of provided treatments, and that distribution reflected our ex ante expectations, we put a prior on our estimated average preferred spending levels that corresponds to that treatment distribution. This prior is $\mu_j \sim N(S_j, sd_j)$, where S_j is the status quo / baseline spending in each area as described above, and sd_j is the standard deviation of the non-zero treatments provided on each spending area. Replacing this informative prior with a flat prior has little effect on the estimates of μ_j.

It is straightforward to extend the model above to enable the description of variation in in-

dividual preferences as a function of covariates. Instead of estimating a single vector of average preferred spending levels μ, we instead model individual preferences by modelling the mean vector of the multivariate normal distribution as

$$\psi_i \sim N\left(\alpha + \beta X_i, \Sigma\right)$$

for some $1 \times K$ vector of covariates X_i describing each respondent i and estimate a $M \times 1$ vector of intercepts α and a $M \times K$ matrix of coefficients β that describe variation in preferences as a function of each of the K covariates on each of the M spending dimensions. For these models, we impose the same prior on α that we put on μ in the model without covariates, and a common shrinkage prior on all β parameters proportional to the category size $\beta \sim N\left(0, S_j \sigma_\beta\right)$ to avoid overfitting small subgroups.

We estimate the models with and without covariates using Hamiltonian Monte Carlo as implemented in Stan (Carpenter et al., 2016). Our presented results consist of mean posterior point estimates and central 95% intervals based on five parallel simulation chains of 1000 iterations (after 250 iteration warmup) for each model. In order to maximise the degree of representativeness with respect to the UK population, we use demographic survey weights provided by YouGov via a quasi-likelihood approach. The estimates are very similar without using the weights.

Results

Average Preferences

Figure 2 presents the average preferred change in spending for each of the spending categories in our experiment, expressed in percentage terms (where current levels are the baseline). UK respondents, on average, endorse spending increases of greater than 10% in education, pensions, health, the environment and housing; we also see smaller increases in transport, welfare and criminal justice. By contrast, UK respondents favour budget cuts in only relatively few spending areas: business and industry, culture, overseas aid, and UK contributions to the EU budget. People want more spending in the four categories with the largest baseline levels: education, pensions, health, and welfare. Likewise, the largest preferred spending cuts – to overseas aid
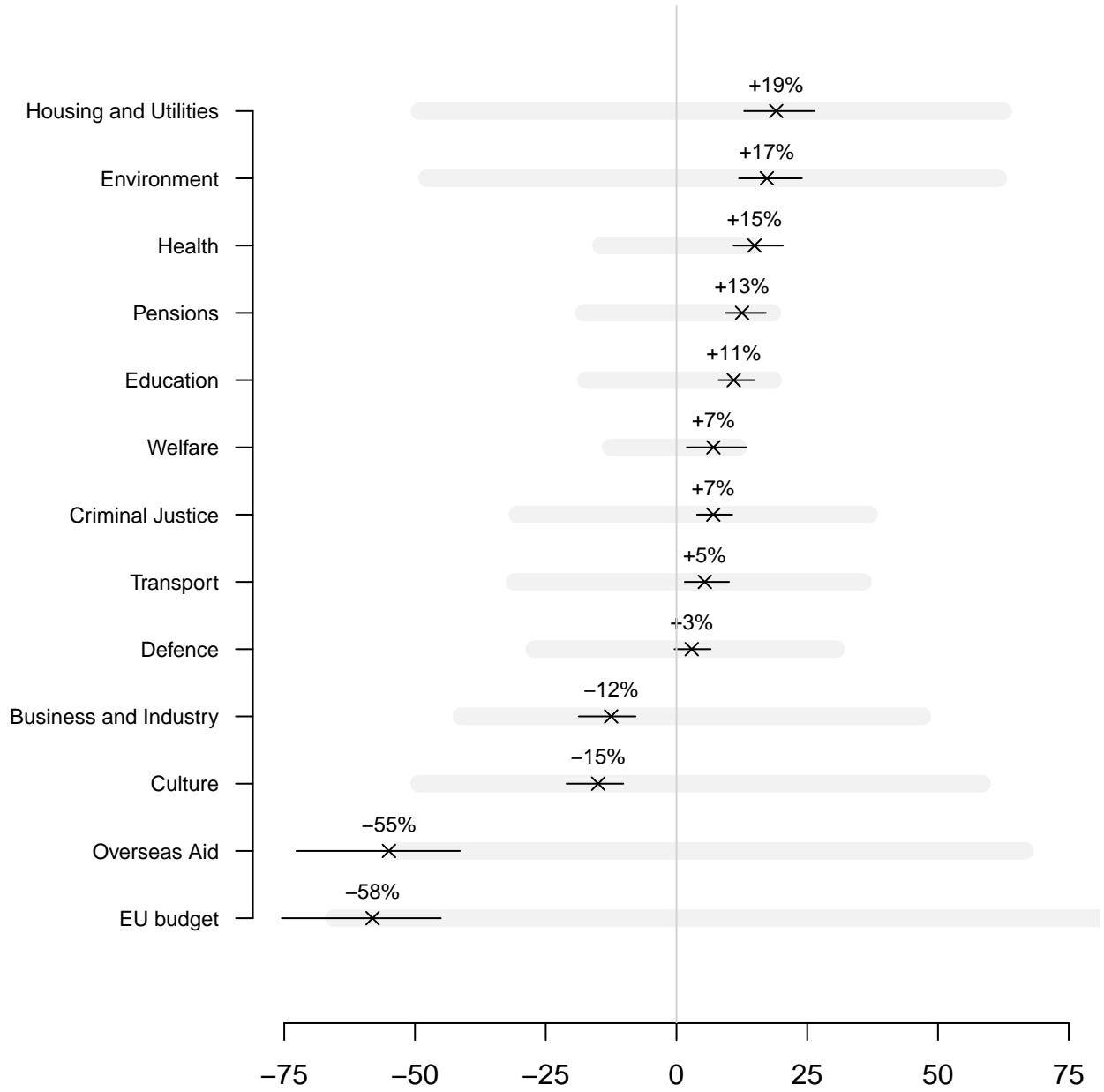
Figure 2: Average Preferred Change in Spending (% of Current Level) with 95% posterior intervals. The light grey bands show the central 95% range of the treatment distribution for that spending area.

and EU budget contributions – are in the two smallest categories we included in the experiment. One consequence of this is that the average preferred overall spending levels are 1.08 times the current spending levels in the categories where we proposed changes. Once we take into account the two budget categories in which we did not test changes—payments on the national debt and government administration—this implies that respondents would be willing to accept an overall tax increase of 7% to pay for these increases in spending.[6]

Model checks

In the supplemental information, we look in detail at the values of the auxiliary parameters λ, σ and ρ, as well as examining the several alternative specifications of the model. We briefly summarise some key findings here. The dimensional weights λ_j are very close to inversely proportional to the baseline spending levels: the correlation coefficient of the λ_j parameters with $1/S_j$ is $r = 0.985$. This indicates that respondents tend to penalise alternatives in terms of percentages, not pounds (recall that we present both in the experiment). The ρ_j indicate that preferences across spending areas are correlated in expected ways, given how UK politics is organised, but not very strongly. The most positively correlated preferences are those for the core social welfare categories of welfare, education and health.

In the supplemental information we also report the estimates of μ from our main model compared to (1) the same model with a flat prior on the μ_j, (2) a model where we assume quadratic loss in log spending rather than spending, (3) a model where we drop respondents who gave "I am not sure" responses to all five proposed changes, (4) a model where we estimate responses separately for each of those five rounds of responses, and (5) a model where we use only responses to proposals that involve no tax change. Overall, the estimates are robust to these model and data variations, telling a consistent story about respondents' relative preferences for spending in different areas.

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[6]While the estimated average preferred changes are within the range of treatments we tested for every spending category, their cumulative effect on the tax level is not. This occurs because our data tells us that respondents prefer spending increases in many areas when they are considered three at a time, but not whether they would be willing to increase taxes to fund all of those increase at once. The quadratic loss preferences we specify imply that they would be willing to pay for several increases, and our model estimates that the size of those increase would require a tax hike that is outside of the tax changes that we proposed in the experiment.

Cross-Sectional Preference Variation

As we described earlier, the average preferences of the public can be further disaggregated in terms of covariates. We present a series of simple models (figure 3) with single categorical variables for age (18-34, 35-54, 55+), university degree (no, yes), household income (below £30,000, above £30,000, refused), and combinations of votes in the 2016 EU referendum the 2017 UK general election (Conservative-Leave, Conservative-Remain, Labour-Leave, Labour-Remain, other). In addition, we fit a multivariate model with age, degree, income, 2016 vote and 2017 vote, in order to check whether the univariate patterns that we find for some of these variables might reflect the correlations between the covariates. We present the results from the multivariate model in figure 4.

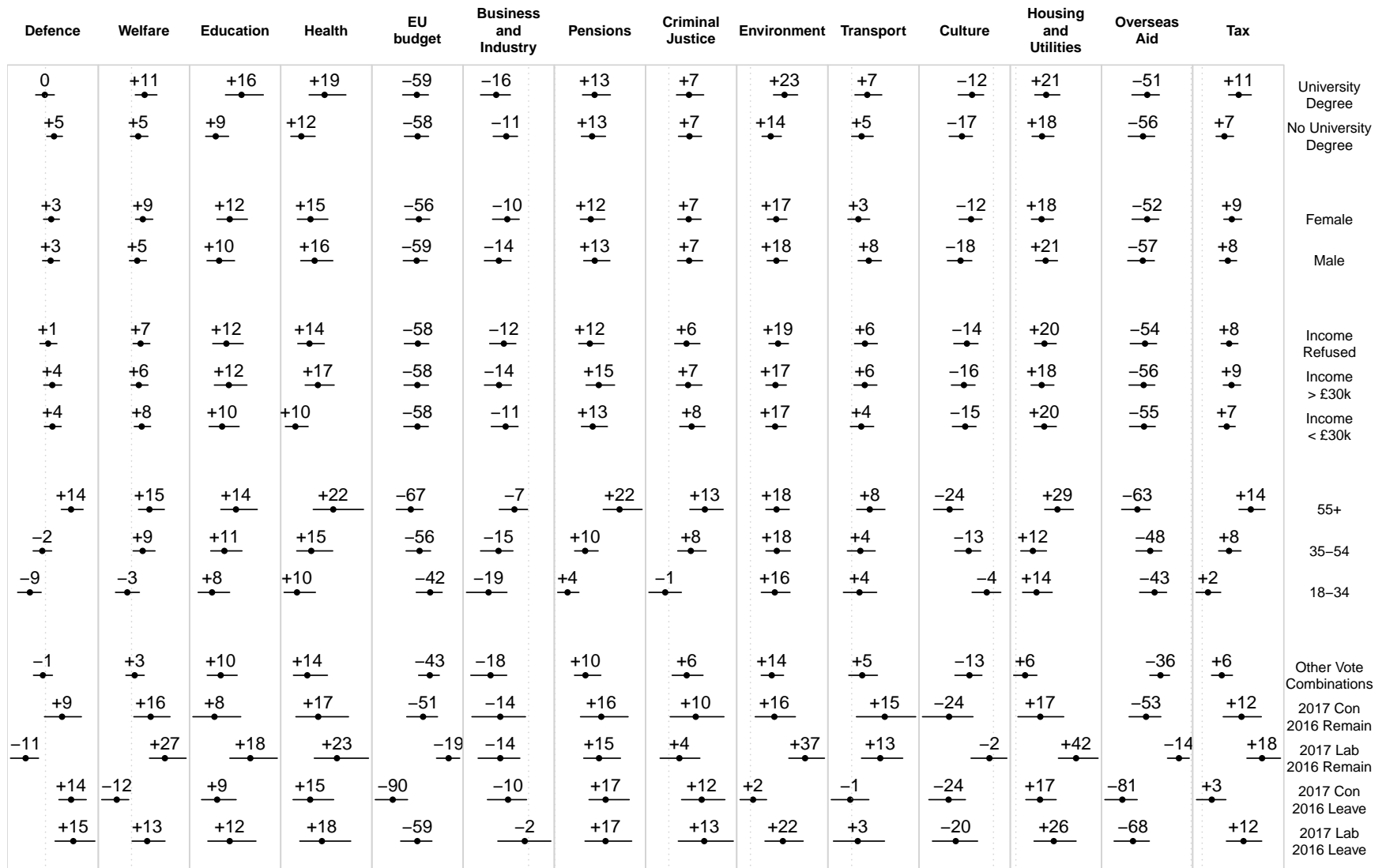|	Defence	Welfare	Education	Health	EU budget	Business and Industry	Pensions	Criminal Justice	Environment	Transport	Culture	Housing and Utilities	Overseas Aid	Tax
University Degree	0	+11	+16	+19	−59	−16	+13	+7	+23	+7	−12	+21	−51	+11
No University Degree	+5	+5	+9	+12	−58	−11	+13	+7	+14	+5	−17	+18	−56	+7
Female	+3	+9	+12	+15	−56	−10	+12	+7	+17	+3	−12	+18	−52	+9
Male	+3	+5	+10	+16	−59	−14	+13	+7	+18	+8	−18	+21	−57	+8
Income Refused	+1	+7	+12	+14	−58	−12	+12	+6	+19	+6	−14	+20	−54	+8
Income > £30k	+4	+6	+12	+17	−58	−14	+15	+7	+17	+6	−16	+18	−56	+9
Income < £30k	+4	+8	+10	+10	−58	−11	+13	+8	+17	+4	−15	+20	−55	+7
55+	+14	+15	+14	+22	−67	−7	+22	+13	+18	+8	−24	+29	−63	+14
35–54	−2	+9	+11	+15	−56	−15	+10	+8	+18	+4	−13	+12	−48	+8
18–34	−9	−3	+8	+10	−42	−19	+4	−1	+16	+4	−4	+14	−43	+2
Other Vote Combinations	−1	+3	+10	+14	−43	−18	+10	+6	+14	+5	−13	+6	−36	+6
2017 Con 2016 Remain	+9	+16	+8	+17	−51	−14	+16	+10	+16	+15	−24	+17	−53	+12
2017 Lab 2016 Remain	−11	+27	+18	+23	−19	−14	+15	+4	+37	+13	−2	+42	−14	+18
2017 Con 2016 Leave	+14	−12	+9	+15	−90	−10	+17	+12	+2	−1	−24	+17	−81	+3
2017 Lab 2016 Leave	+15	+13	+12	+18	−59	−2	+17	+13	+22	+3	−20	+26	−68	+12

Figure 3: Average preferred changes in each spending area and overall tax (columns), for various subgroups (rows)
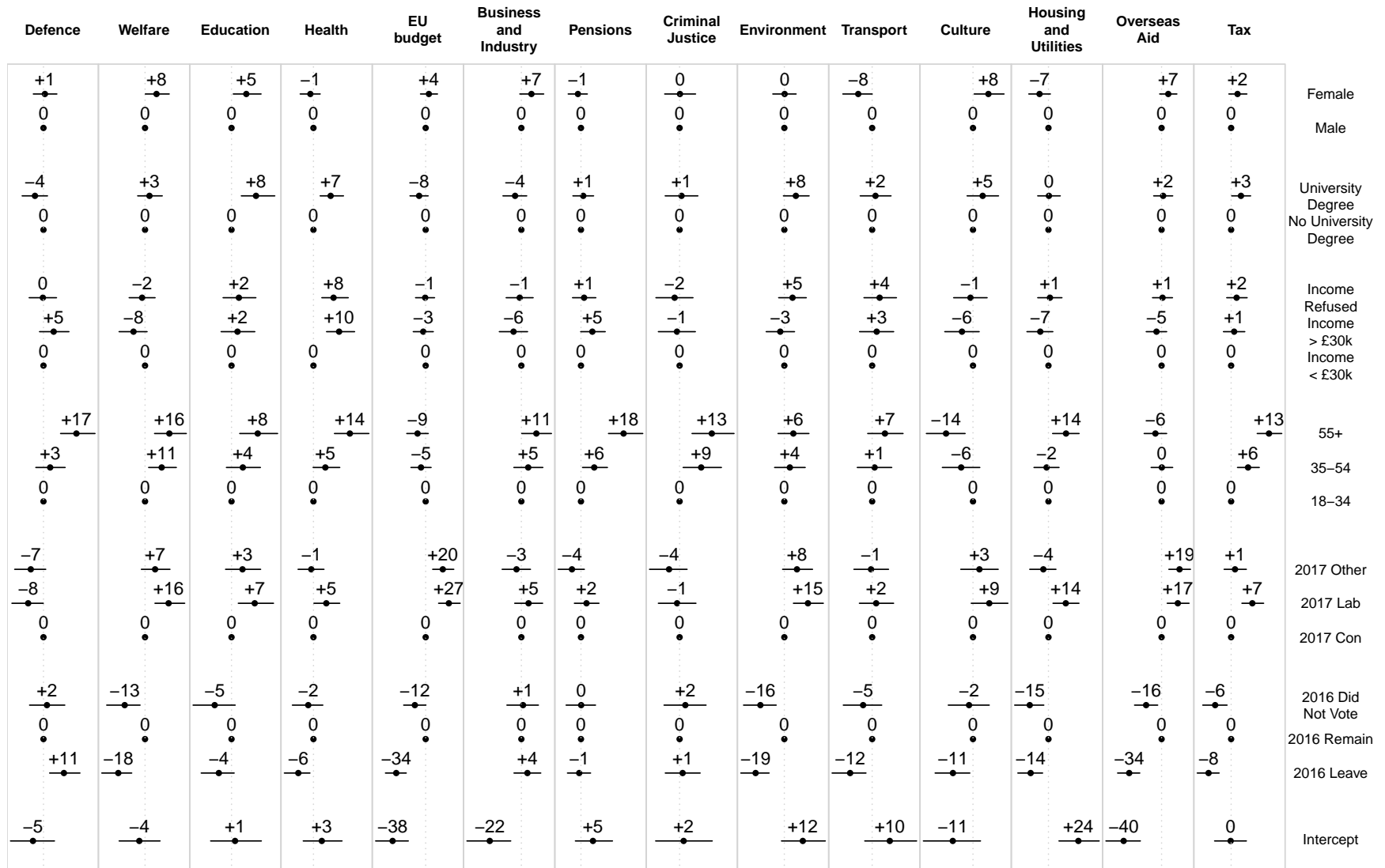
Figure 4: Multivariate model coefficient estimates as a function of covariates (rows) for average preferred spending in % of current baseline for each spending area and for overall tax (columns).

	Defence	Welfare	Education	Health	EU budget	Business and Industry	Pensions	Criminal Justice	Environment	Transport	Culture	Housing and Utilities	Overseas Aid	Tax
Female	+1	+8	+5	−1	+4	+7	−1	0	0	−8	+8	−7	+7	+2
Male	0	0	0	0	0	0	0	0	0	0	0	0	0	0
University Degree	−4	+3	+8	+7	−8	−4	+1	+1	+8	+2	+5	0	+2	+3
No University Degree	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Income Refused	0	−2	+2	+8	−1	−1	+1	−2	+5	+4	−1	+1	+1	+2
Income > £30k	+5	−8	+2	+10	−3	−6	+5	−1	−3	+3	−6	−7	−5	+1
Income < £30k	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55+	+17	+16	+8	+14	−9	+11	+18	+13	+6	+7	−14	+14	−6	+13
35–54	+3	+11	+4	+5	−5	+5	+6	+9	+4	+1	−6	−2	0	+6
18–34	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017 Other	−7	+7	+3	−1	+20	−3	−4	−4	+8	−1	+3	−4	+19	+1
2017 Lab	−8	+16	+7	+5	+27	+5	+2	−1	+15	+2	+9	+14	+17	+7
2017 Con	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016 Did Not Vote	+2	−13	−5	−2	−12	+1	0	+2	−16	−5	−2	−15	−16	−6
2016 Remain	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016 Leave	+11	−18	−4	−6	−34	+4	−1	+1	−19	−12	−11	−14	−34	−8
Intercept	−5	−4	+1	+3	−38	−22	+5	+2	+12	+10	−11	+24	−40	0

Figure 3 (simple models) and figure 4 (the multivariate model) both provide results that both confirm the face validity of the estimates and reveal some interesting patterns that would not be obvious given commonly held stereotypes about contemporary British politics. Regarding face validity, we see the basic strong political relationships that we would expect. 2017 Conservative voters want less spending and lower tax overall than 2017 Labour voters. Labour voters want more spending than Conservative voters on most categories of spending, especially welfare, education, health, the environment, and housing. Conservative voters want more defence spending than Labour voters. Leave voters want far lower spending on the EU (and overseas aid) than Remain voters, but also less on the environment, welfare, transport, culture and housing. None of these relationships are surprising – for many we would have reason to worry about the validity of the method if it had found otherwise.

What might be more surprising to observers of British politics are the associations of respondents' tax and spend preferences with age. Age-related differences in party choice are not new features of UK politics, but the 2017 UK general election saw a historically remarkable age gradient in voting in the UK, with Labour winning those aged 18-34 by a 60% to 27% margin and the Conservatives winning those aged 55 and older by 54% to 31%. This gap emerged in the context of an election where the Labour Party campaigned on a manifesto which pledged to significantly increase spending in several areas of the government budget and to increase both income and corporation taxes. Several commentators took the increase in support for Labour among the young to emphasise the new importance of age cleavages in UK politics[7] and young supporters of the Labour Party have been described recently as "millenial socialists".[8]

However, in our survey, younger respondents prefer substantially *lower* levels of taxation and spending overall. This is true both holding constant 2017 vote (figure 4) but also unconditionally (figure 3). In the simple group comparison (figure 3), the average increase in overall spending and tax preferred by 55 year-olds is 14%, versus just 2% for those under 35 years-old. Young people endorse lower spending levels than older people in every spending category except the contribution to the EU budget, culture, and overseas aid, which are all among the smallest budget areas. This pattern is in stark contrast to the widely held understanding in UK politics that younger co-

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[7]See "The Biggest Political Divide in Britain is Age", *Economist*, June 2017
[8]See "Millenial socialism", *Economist*, February 2019

horts are more amenable to greater public expenditure and taxation than older voters,[9] though is consistent with recent cross-national evidence on generational fiscal preferences (O'Grady, 2020). Unless there is some very large age-associated bias in our measurement strategy, which we think is unlikely, it is the older voters who want to substantially increase government spending not the younger voters.

Overall, a key finding of this analysis is that citizens' spending preferences are multidimensional rather than tightly structured by a single preference dimension. In the supplemental information, we report details of principal components analysis on the estimated distribution of preferences from the model. The first dimension is oriented from Conservative-Leave to Labour-Remain, associated with wanting more spending on everything except Defence, Business, Pensions and Criminal Justice. The second dimension is oriented from Conservative-Remain to Labour-Leave, associated with wanting more spending on everything except the EU budget, culture and overseas aid.

We do not see a strong first dimension, followed by a rapid decline in preference variation explained. The Conservative-Leave to Labour-Remain dimension is more predictive of spending preferences across areas than any other dimension, but not much more predictive. Thus we find that preferences over spending in different categories vary in a complex way across individuals and demographic groups that does not reduce to some groups simply being in favour or more or less spending, or more left-wing versus right-wing spending priorities. That preferences are not simply unidimensional should not surprising given what we know about the high level of individual-level idiosyncrasy in citizens' political preferences in other domains (Broockman, 2016; Lauderdale, Hanretty and Vivyan, 2018), even though the idea of a dominant left-right economic dimension is widespread in the political science literature.

Validation

Ideally a model that infers a distribution of preferences of individual voters based on their survey responses would be able to predict survey responses to similar budget tradeoff questions out-of-sample. We evaluate the out-of-sample predictive performance of our modelling approach in

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[9] Grasso et al. (2017) has some suggestion of this finding, but the measures used in that research are less precisely focused on spending.

two ways. First, we conduct an *internal* validation, where we evaluate the ability of the model estimates to predict responses to the experimental prompt which are held out from estimation of the model. Second, we conduct an *external* validation, where we evaluate the ability of the model estimates to predict responses to a novel budgetary proposal in a new survey.

Internal Validation

Our internal validation is a five-fold cross-validation. We fit our baseline model and our full covariate model five times, each time holding out one round of responses to the experiment. We then construct predicted probabilities for responses to the held-out round from the model fit that excluded that round, generating predictions for all responses to the experiment, none of which were fit on the predicted responses. Both the baseline and covariate models predict variation in the probabilities of each response across proposals because some changes (e.g. reducing health spending) tend to decrease support for proposals while others tend to increase it across all respondents. The covariate model is additionally able to predict variation across respondents holding the proposal fixed.

Figure 5 shows that while the model predicts the probabilities of respondents endorsing the proposal reasonably well, with or without respondent-level predictors, it does less well at predicting endorsement of the status quo spending levels and does quite poorly at predicting the "I am not sure" response. By implication, the model is not doing well at distinguishing between endorsing the status quo and the not sure response. This is not a problem related to overfitting: these plots are indistinguishable from when we examine in-sample fit. The functional form of our model cannot fully describe the patterns of responses that we see as a function of the proposals.

The primary reason for the lack of predictive fit is that our model does not capture all "not sure" mechanisms well. This has limited consequence for the estimates of the model: when we construct estimates excluding respondents who gave "I am not sure" responses to all five proposals there is negligible change in the estimates, even though this drops about half of the not sure responses in the data set (see supplemental information). The fact that there are a substantial number of such respondents, however, highlights that our model can only make sense
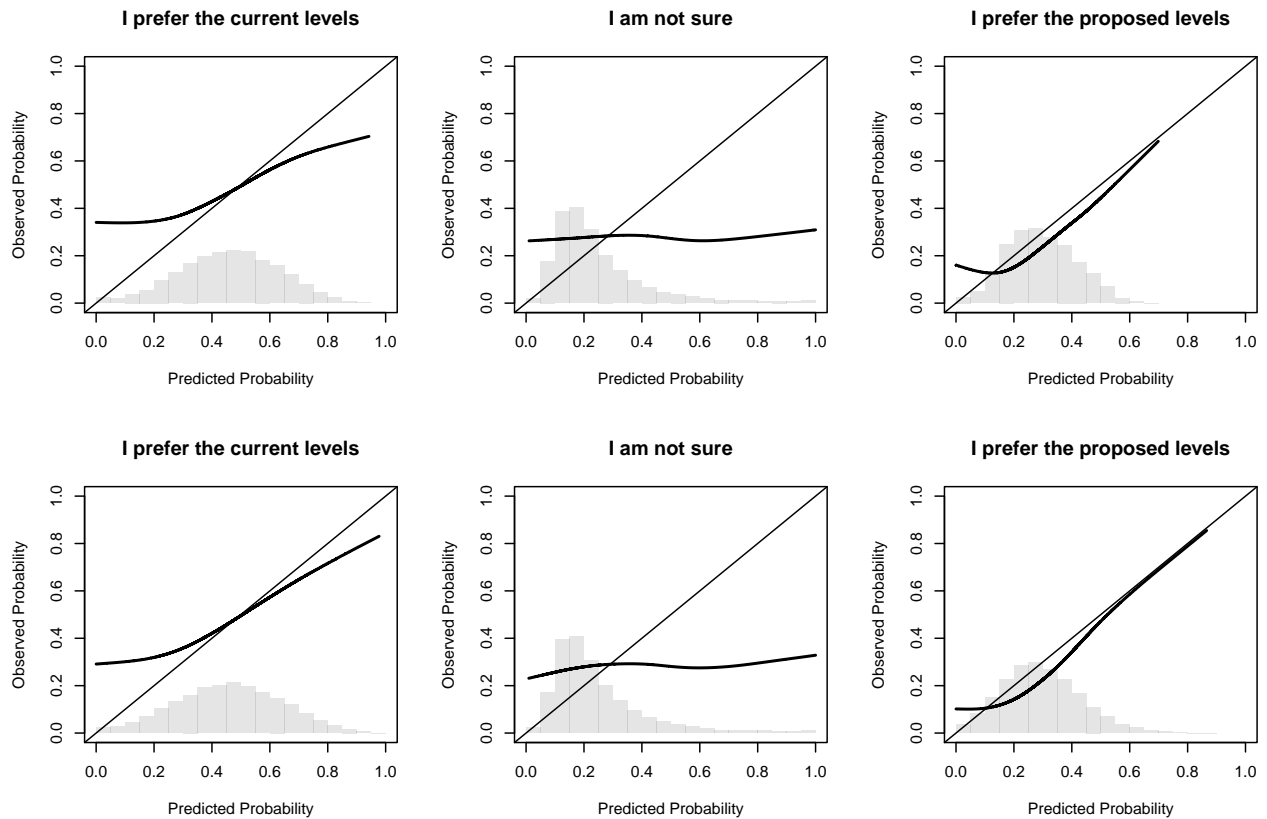
Figure 5: Cross-validation predictive performance by response-level, using the model without (top row) and with (bottom row) respondent-level predictors. Each plot shows a spline fit for the observed response on the prediction overlaid on the distribution of predicted probabilities.

of non-response as the result of narrow indifference between the status quo and proposal. In reality, "I am not sure" responses are likely to arise from several mechanisms, including this sort of narrow indifference, but also including strong cross-pressure (a strongly liked change combined with a strongly disliked change) that respondents find difficult to weigh, or general disengagement (respondents who always say they are not sure). Future research could leverage this experimental design to examine the relative extent, and among which groups of respondents, not sure responses arise from these different mechanisms.

External Validation

Because we estimate not only the average preferences of UK citizens (via the μ parameters), but also their distribution and relative weight (via the σ, ρ and λ parameters), we can estimate what proportion of respondents we would expect to support a proposal to change all spending and tax levels to the average preferred level, versus the status quo. According to our structural model, we calculate that 72.7% of respondents should prefer the proposal to the status quo (SE: 0.028; 95% interval: 0.681-0.792), and 27.3% should prefer the status quo, according to whether they have positive or negative latent utility differences $u_{iA} - u_{iS}$. In the original experiment, status quos were preferred nearly twice as often as the proposed changes. Have we in fact found a set of changes that is substantially preferred to the status quo, even when most proposed changes were not preferred in the original experiment?

Our external validation study was also conducted by YouGov, using the same sampling methods from their UK panel, and we asked a single question of 3,000 respondents. We presented respondents with the status quo figures for each spending category and the overall tax rate from the baseline tax summary, and then asked them to compare that with a proposal that involved changing all spending categories to the average preferences estimated from our model. The entire prompt, as delivered, is provided in supplemental information. We pre-registered this validation study and our standards for a successful validation before data collection.[10]

The results of the validation were as follows. Of the population-weighted respondents, 39% indicated that they supported the proposed changes, versus 25% who indicated that they pre-

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[10]Our pre-registration documents (Barnes, Blumenau and Lauderdale, 2019) can be found at (http://egap.org/registration/5550).

ferred the current spending levels. 36% indicated that they were not sure. Using the estimator that we pre-registered to maximise comparability, we calculate that this response distribution corresponds to 58.3% of respondents preferring the proposed changes to the status quo versus our structural model prediction of 72.7%.

According to our pre-registered assessment criteria, this counts as a "moderate success". We were able to use the experiment to identify a profile of changes that was supported by substantially more respondents than opposed it, even though the level of support was not as high as the structural model implied. In the pre-registration, we identified several reasons to expect that fewer respondents would endorse this proposal than our structural model implied, including status quo bias that did not reflect the actual content of proposals, the larger tax hike involved in this proposal, and the greater difficulty of the task of contemplating changes to thirteen spending categories rather than three (Barnes, Blumenau and Lauderdale, 2019).

Moving beyond the basic evaluation set out in the pre-registration, we post-stratify the structural model estimates onto the validation survey respondents, and then characterize the relationship between predicted support levels and actual support for the proposal among those respondents. Figure 6 shows the results of this analysis. While the observed levels of support for the proposal are consistently lower than the predicted levels, they are strongly associated with those predictions, with a slope close to one and only minor non-linearity in the relationship (left panel). When the individual respondents are aggregated into the same categorical groupings used previously (right panel), we see that the demographic groups which the structural model indicated should be more favourable towards the proposal are in fact more favourable towards that proposal.

Validation Summary

Do these internal and external validation results undermine the estimates we produced of the average preferred spending (and thus tax) levels? To the extent that these results indicate that respondents do not exactly approximate the choice logic underlying our structural model, that does imply lesser confidence in the overall spending *level* of the estimates as the true "ideal" for the UK population. Nonetheless, we are able to make valid out-of-sample predictions for which
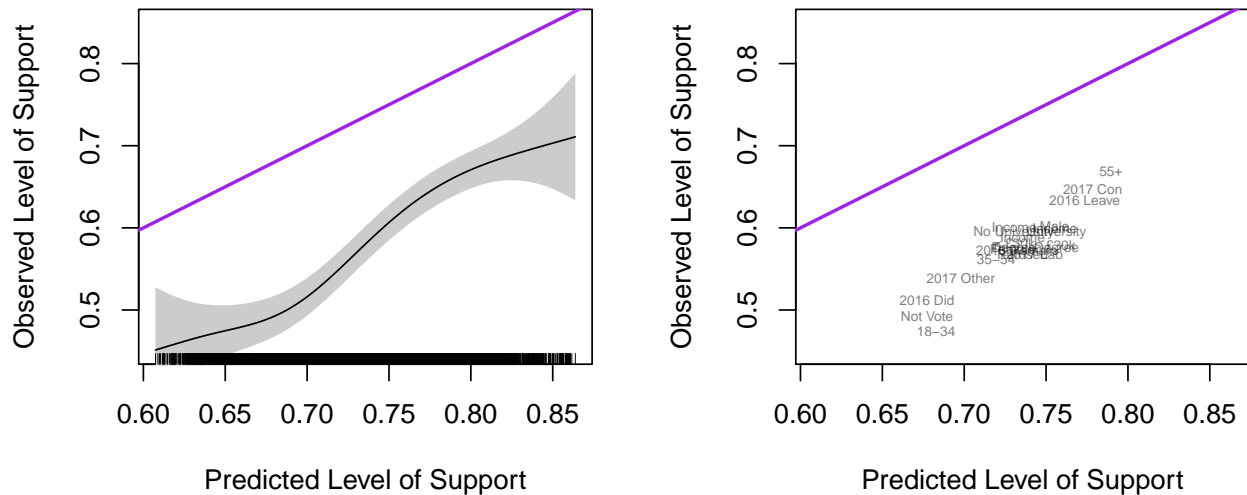
Figure 6: Left: Observed level of support for proposal in validation study as a function of predicted level of support given the set of explanatory variables in the multivariate model. Perfect agreement between the predictions and the validation would correspond to the purple line; the black line is a spline fit to the validation data. Right: Observed level of support as a function of predicted level of support for different groups.

three-category change proposals would be more or less favoured by respondents. We are also able to identify a full alternative budget that received substantially more support than opposition, despite high survey item complexity, potential for loss aversion, status quo bias, and other factors. Further, we are able to identify and validate variation across demographic subgroups. In the supplemental information, we provide a further discussion of the lessons we draw for future experimental design, including discussion of tradeoffs associated with providing more complicated sets of changes to respondents, varying presentation of tax costs by respondent income level, and specification of the change proposal distribution.

Applications

Our approach translates readily to applications other than the British national budget, with appropriate 'domestication' of the categories. In the United States a parallel implementation might use categories from the President's published budget, as in Bonica (2015). There is no general *right* answer regarding which categories to use, but the choice ought to be as accessible as possible to a typical citizen. The measurement strategy outlined here could be usefully incorporated into existing large-scale survey projects in order to measure these preferences in a quantitatively

meaningful way over time and across space. Building this strategy into national election studies would provide a consistent way to track relative spending priorities, and the relative priority of tax reductions, within countries over time. One natural cross-national application would be to use the budget categories of the European Union, and to use our design to measure average preferences across these areas in different EU member states. Our approach can also provide a way to gauge preferences over spending tradeoffs *within* policy areas. For example, within the area of education, voters may prefer allocating more resources to early-years intervention, at the cost of lower K-12 spending.

Second, researchers can use this strategy to measure spending preference outcomes in bespoke experiments, including – and perhaps especially – in the context of studies focused on one area of social policy spending. One problem that such studies face when asking about budgetary preferences is that questions about spending in that area typically follow a series of other questions about that spending area, creating potential for both framing and demand effects. Our approach has similar advantages to the use of conjoint experiments as a way to minimise social desirability bias.

Third, we have not exhausted the kinds of analysis that can be done with the data we have collected already. For example, because our estimation strategy enables estimation of a linear model for preferences in terms of covariates, the derived preferences could be used to generate descriptions of how spending preferences are geographically distributed via post-stratification. This would generate geographic estimates of public budget preferences which might be useful for assessing campaigns, intra-party variation in budget preferences of representatives, and other research questions.

Fourth, estimating the public preference distribution enables a range of welfare and social choice analyses. The first kind of welfare analysis that we might do would assess the aggregate social welfare deriving from different budgets. A second kind of welfare analysis, facilitated by our covariate model, might assess which population groups are more or less satisfied with the status quo or particular proposals. In addition to welfare questions, we can also ask social choice questions about the estimated preference distribution. A first type of social choice analysis would be to assess whether particular spending profiles would defeat the status quo

spending profile. Such analyses can be extended to characterise relevant regions of the win-set: all proposals that would defeat the status quo by majority rule. A second type of social choice analysis involves identifying extreme budgets subject to popularity constraints, such as the biggest overall tax/spending cut or increase that defeats the status quo. A third type of social choice analysis involves identifying popularity maximizing budgets subject to total spending constraints. In the supplemental information we discuss each of these welfare and social choice analyses in more detail, and provide examples of two of them.

Conclusions

We have demonstrated a new strategy to measure spending preferences multidimensionally and quantitatively. We elicit quantitative preferences on narrow spending tradeoffs from a sample of respondents who are representative of the broader public on measurable characteristics, and translate those into estimates of a distribution of public spending preferences. Doing this involves assuming coherent preferences, but we have argued this is a sensible approach because it enables us to find a distribution of coherent budget preferences that is consistent with the choices that citizens make when faced with accessible tradeoffs between spending categories and taxation. Whether or not individual members of the public in fact hold or can articulate consistent budgetary preferences, it is worth knowing which feasible budgets are likely to best match citizens' assessments of the relevant tax and spending tradeoffs.

Our approach to the study of spending preferences serves as an example of three broader methodological principles which are widely applicable. First, and most narrowly, our approach highlights the utility of using continuous treatments within multivariate choice experiments, of which conjoint experiments are one prominent example. Since the central tool for analysing the data generated in conjoint experiments is regression analysis, and regression analysis is suited for the analyses of continuous variables, the focus on qualitative attribute levels in conjoint approaches often represents a missed opportunity to generate more precisely quantifiable effects. Second, structural models are a useful tool for estimating aggregate quantities of interest in contexts where we have insufficient data to generate complete descriptions of the distributions at the individual level and where regression-based approaches are either inapplicable or gen-

erate relatively uninteresting causal estimands. Third, this paper emphasises the importance of validation. In any approach based on a parametric model, we should be concerned about the degree to which the assumptions made about functional forms drive the results. The validation exercise not only provides greater confidence in the results obtained, but also highlights specific areas for further development.

Substantively, we find that current levels of government spending in the UK are lower than the average preferences of the UK public, and that this is true across many different spending categories. Crucially, as the set-up of our experiment forces respondents to take government budget constraints seriously, the public expresses these preferences for increased spending even when taking into account increases in taxation required to fund them. We showed that a public budget including an implied tax hike of approximately 7% received majority support amongst those expressing an opinion. We are also able to identify demographic variation in preferences for more spending that operates in different directions in different spending areas. Our finding that it is older voters, not younger voters, who want to substantially increase UK government spending is clear in the results of both the original experiment and the validation study and is at odds with the conventional wisdom regarding age and political preferences in the UK. The fact that this age pattern is present both unconditionally and also conditional on gender, education, income, EU referendum vote and general election vote suggests this is likely to be a real and important feature of contemporary British politics that merits further investigation.

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