AGRICULTURAL AND FOOD SCIENCE

Agricultural and Food Science (2022) 31: 198–219

https://doi.org/10.23986/afsci.115415

Contingent allocation of the agri-food budget: comparison of farmer and non-farmer preferences

Eija Pouta, Eero Liski, Annika Tienhaara, Tuija Lankia and Jyrki Niemi

Natural Resources Institute Finland (Luke), Latokartanonkaari 9, 00790 Helsinki, Finland

e-mail: eija.pouta@luke.fi

Agricultural production faces diverse and often conflicting expectations, such as considerations related to environmental protection, food security and risk management, as well as strengthening the profitability and competitiveness of domestic production. In this study, we applied the contingent allocation method to a national agricultural budget to analyse the preferences of farmers and other citizens for allocating budget funds. Survey data collected from 2014 citizens and 518 farmers were used in compositional data analysis where it is considered that each spending decision bears an opportunity cost, and the decision maker faces trade-offs across budget priorities. The allocations of farmers and non-farmers were found to differ considerably. Farmers emphasized agricultural income and the economic resilience of farms as well as the self-sufficiency in food production and soil conditions. Non-farmers emphasized environmental public goods. The allocations were used to form compositional respondent clusters. The first cluster emphasised multiple objectives for agricultural policy, whereas the second cluster was clearly production oriented and the third cluster environmentally oriented. The results highlight the differences between farmers and non-farmers challenging the planning of legitimate agricultural policy.

Key words: agricultural policy, budget allocation, compositional data analysis, budget size

Introduction

Agricultural production faces versatile and often conflicting expectations. Achieving national self-sufficiency in food production and defending the incomes of farmers traditionally appear to be the most important goals of agricultural policy in many countries. However, current expectations regarding agricultural policy are not limited to ensuring an adequate and safe food supply or securing farm incomes. Agriculture is also expected to contribute to combating climate change, preserving biodiversity and the cultural landscape, and promoting animal welfare, as well as preventing water pollution, soil erosion and waste of natural resources (Renting et al. 2009, Huang et al. 2015, Song et al. 2020). These public goods, produced as externalities of food, have no market price, but they are important in political decision making, and their value is recognized in society's support for agriculture.

Policymakers should be able to integrate the different expectations into an acceptable agri-food policy within the existing budgetary constraints. It is difficult, however, to link agricultural sector decisions with such broad expectations, especially given the multidimensional attributes of agricultural policies. There are many questions regarding the current and future direction of support for the sector: Is retaining the income of farmers a legitimate policy objective, and how much should be spent to guarantee domestic food production? Should the environment and public goods be emphasised? This study provides information on the preferences and values of citizens and farmers in Finland related to allocating the agricultural budget among versatile goals. Measuring people's values related to the agri-food sector facilitates the directing of agricultural policy to objectives that are strongly preferred by citizens. The results of this study could support the design of legitimate and acceptable agri-food policies that correspond with citizen preferences.

This study was carried out in response to the call for public involvement in policy design. According to a previous meta-analysis on the importance of agricultural objectives among stakeholders, the general public emphasizes social values, whereas farmers and stakeholders in the food chain place more weight on economic objectives (Ahtiainen et al. 2015). If citizens' voices are heard in policy settings, the information obtained is typically in the form of the general importance of different objectives without connection to budgetary constraints, i.e., the expenses faced by taxpayers. Decision makers and other stakeholders recognize the need to examine citizen perceptions regarding a wider range of policy options to increase the legitimacy of public policies and more generally improve the public's understanding and acceptance of policies (Bombard et al. 2011, Costa-Font et al. 2015, 2017, Røsten Mærøe et al. 2021). This implies that a tool is needed for mapping the perceived importance of agri-food policy objectives to citizens and consumers to increase the legitimacy of agricultural and food policies.

Received 16 March 2022 / Accepted 6 September 2022

The Scientific Agricultural Society of Finland

Previous studies on budget allocation have either been general, focusing on budget allocation between different sectors (Koford 2009, Soguel et al. 2020), or when sector specific, they have in most cases focused on health care or education (Bombard et al. 2011, Skedgel et al. 2013, Costa-Font et al. 2015, 2017). Applications related to the environment or natural resources have been rare (Evans et al. 2017) and few studies have focused on budget allocation in the agricultural sector (Gómez-Limón and Atance 2004, Rocamora-Montiel et al. 2014, Mittenzwei et al. 2016). The knowledge gap is not only in measuring preferences, which would be interesting from a policy planning perspective, but also, as Ozdemir et al. (2016) argue, in the collection and analysis of respondent socioeconomic characteristics, which could provide policy makers with useful information about supporters and opponents among different budget alternatives. By collecting socioeconomic information in a survey and using regression analysis, it is possible to provide policy makers with a better understanding of how different population groups will react to allocating a budget across programmes or budgetary classes. In previous studies applying the contingent allocation method CAM (Evans et al. 2017, Soguel et al. 2020), the compositional nature of the data has seldom been considered (Adolph et al. 2020). Compositional data originate from the essence of the budget decision. Each spending decision bears an opportunity cost, and the decision maker faces trade-offs across budget priorities. If one category is provided more funding, funding needs to be decreased in other categories if the total budget is not to increase.

In Finland, the objectives of the national agricultural policy are recorded in government programmes, and the Ministry of Agriculture and Forestry is responsible for the practical implementation of the agricultural budget. The practical implementation of budget is negotiated with the agricultural producer organizations, but its execution does not require a common agreement. Citizens do not have direct influence over the budget, but only indirectly through the political parties they support. There have been practically no discordances between the political parties regarding the main lines of the agricultural budget during EU membership since 1995 (Laurila and Niemi 2017). During the EU membership Finland has been granted the right to pay national support to agriculture on top of subsidies paid in full or co-financed by the EU. Over the years from 2013 to 2020, agriculture's share of government expenditure remained stable at around 3.7 percent (or €2 billion) on average (Ministry of Finance 2022). From this € 2 billion annual total support for agriculture about 60 % is paid nationally and 40 % comes from the EU budget.

Most of the agricultural support (50%) in Finland has been allocated to ensuring the preconditions and competitiveness of domestic production and the strengthening of profitability. In addition, a quarter of the budget support has been used for natural constraint payments, which are intended to ensure the continuity of agriculture in less favoured areas and to keep rural areas populated. In order to be eligible for these support payments, farmers have had to comply with certain environmental conditions. About 13% of the funding during 2013–2020 was used for specific agri-environmental support measures to compensate farmers who had committed to undertaking measures aimed at reducing environmental loading or providing ecosystem services. Only 3% of the support was used to improve animal welfare (Latvala et al. 2021).

In the present study, we applied CAM that facilitates the integration of citizen preferences in budgetary decisions. Our assumption was that integrating citizen values as well as farmer values in policy design will increase its legitimacy, transparency and acceptability. We compared the agricultural and rural policy preferences of farmers and non-farming citizens to identify those citizens who benefit most from different budget allocations and possible value conflicts. The preferences were elicited using an Internet survey involving a representative sample of Finnish citizens, i.e., non-farmers as well as farmers. Based on the data, we sought to explain budget allocations with citizen characteristics and identify citizen clusters with similar allocations. We developed the contingent budget allocation method by recognizing the compositional nature of the data in the statistical analysis. Furthermore, we also explained budget size evaluations and analysed the association between budget allocation preferences and budget size preferences.

Literature review

There is a growing demand for citizen involvement in policy development to ensure that decisions are legitimate and broadly reflect social values (Bombard et al. 2011, Costa-Font et al. 2015, 2017). This entails including the general public in decision making to ensure that all decisions are informed, transparent and legitimate (Abelson et al. 2003). Involving citizens in budgetary decisions is suggested to increase the legitimacy of policies (e.g., Røsten Mærøe et al. 2021). The process of public involvement may itself increase perceived legitimacy (Tyler 2006). Tyler (2006) suggested that information about fair procedures can in fact influence people's judgments of outcomes with which they may not initially agree. The final policy and associated budget are seen as more legitimate if markets without a policy are perceived to produce an unfair solution (Tyler 2006). This is the case for agricultural products, with farmers typically being perceived as receiving too small a share of the food price.

In agricultural policy design, typical approaches to increase public involvement in the budgeting process include focus groups, advisory boards, informational discussions and traditional public meetings in policy planning processes (Simonsen and Robbins 2000). The primary problems with these deliberative methods of citizen involvement are that they fail to obtain a representative sample. They also often fail to include a budget constraint in discussion. Including a budget constraint when obtaining citizens' input in budgetary decisions has at least two advantages (Koford 2009): first, it imposes the condition that citizens cannot have more of everything, and second, it adds a degree of realism for citizens participating in the budget process.

To measure citizen preferences in a budgetary setting, previous studies have implemented several approaches. The basic idea in these preference elicitations is that respondents allocate public funds as citizens, not their own funds as "consumers".

The contingent allocation method (Evans et al. 2017, Soguel et al. 2020) confronts individuals with a hypothetical situation in which they have full power to allocate budgetary resources, for example 100 units in total. Thus, the aim is not, as in the contingent valuation method (CVM), to measure the trade-off between a given amenity to be valued and other goods and services under an individual budget constraint (i.e., a marginal rate of substitution). The aim of the CAM is to identify the trade-off between the defined budget classes within a defined volume of budget resources. Therefore, respondents are explicitly required to allocate the budget according to the perceived relative utility of the various functions. Blomquist et al. (2004) and Koford (2009) applied a similar method, although they referred to it with a different name, i.e., contingent budget choice.

Several alternative approaches to the CAM have been reported in the literature. In constant-sum paired comparisons (CSPCs) (Skedgel et al. 2013), respondents are asked to allocate a fixed budget between two alternatives. In contingent ranking (Costa-Font and Rovira 2005), budget classes are ranked based on their importance. Some studies have considered a hypothetical budgetary increase and asked about willingness to assign it to different purposes (Costa-Font and Rovira 2005). This can be based on an open-ended valuation question, where respondents are asked to assign from a fixed remaining budget of public resources to each function or programme in question.

Another similar method to the CAM is the budget pie experiment (Costa-Font et al. 2015), which focuses on soliciting responses to allocate a fixed budget between a set of potential alternatives (programmes). It can be implemented with pairs of programmes or a limited number of programs. In addition, choice experiments between programmes have been implemented in the budget allocation context (Kerr et al. 2010, Skedgel et al. 2013, Ozdemir et al. 2016).

Elicitation of the preferred budget allocation with various methods has particularly been applied in health care sector decisions (Costa-Font and Rovira 2005, Skedgel et al. 2013, Costa-Font et al. 2015, 2017), but also in decisions between main budget classes (Blomquist et al. 2004, Koford 2009, Kerr et al. 2010) or specific programmes in several sectors (Ozdemir et al. 2016). In environmental or natural resource decisions, budget allocation experiments have been rare. Evans et al. (2017) asked citizens to allocate funds for coastal zone management efforts and suggested that respondents preferred funding for natural resource management. Meinard et al. (2017) used a ranking approach to define the importance of biodiversity in public policy.

Previous examples from the agricultural and food sector have partly been summarized in a meta-analysis by Ahtiainen et al. (2015) that focused on the perceived importance of agricultural objectives among various respondent groups. However, in several of the studies included in this meta-analysis, budget allocation was not in focus. For example, Gómez-Limón and Atance (2004) examined the relative importance of CAP objectives in policy evaluation and design. They also provided information on distinct citizen clusters differing in their emphasis on the objectives. Rocamora-Montiel et al. (2014) directly focused on budgetary allocation in the CAP with a choice experiment to improve the CAP's equity and social legitimacy. Their results revealed that the post-2013 CAP reform was more in line with public preferences than the previous programme. Mittenzwei et al. (2016) applied a budget allocation approach by asking Norwegian respondents to allocate 100 points between seven agricultural policies issues. The results demonstrated that respondents gave most attention to food prices, followed by food self-sufficiency, farm income, rural settlement and the diversification of food products. The cultural landscape and soil conservation ranked lowest. Mittenzwei et al. (2016) did not, however, provide a statistical model to explain the allocations.

By collecting socioeconomic information in a survey and using regression analysis, we provide policy makers with a better understanding of how different population groups will react to allocating a budget across programmes or budgetary classes (Ozdemir et al. 2016), which could provide policy makers with useful information regarding the winners and losers among different budget alternatives. In the data analysis and in modelling budget choices, we utilized methods that take into account the compositional nature of budget allocation data (Adolph et al. 2020).

Methods and data

Data collection

To collect representative data on the budget allocation preferences of Finnish citizen, we implemented an Internet survey. The citizen sample was drawn from the Internet panel of the private survey company Taloustutkimus. This panel comprises a large number of respondents (approximately 30 000) representing the adult population, who were recruited using random sampling. The farmer sample was drawn from the register of the Finnish Food Authority and the data were collected by Taloustutkimus.

A pilot survey (n = 202) was conducted in August 2020. After the pilot, two online focus groups were implemented to discuss the topic of future agriculture and to test the measures of the survey. The focus groups examined, for example, how the participants perceived the questions in general and how understandable the survey instructions and information sections were. The questionnaire was subsequently modified and further tested in a second pilot study (n = 205) in November 2020.

The final survey data were collected during January and February of 2021. For citizens, a random sample of 10 362 respondents was selected and 2014 completed the survey (response rate 19.4%). Regarding farmers, an invitation e-mail was sent to 4827 farmers and 518 responses were received (response rate 10.7%). The combined data represented the population rather well regarding the age and regional distribution, but the proportion of females and higher income respondents was lower than in population, as summarised in Table 1.

The data sets of farmers and citizens were combined into one data set in the analysis to be able to test the differences between farmers and non-farmers. This led to higher share of farmers in the combined data set (25%) than in the population. The farmers from the citizen sample were coded as farmers in the combined data set.

Table 1. Some key sociodemographic variables in the data set and the Finnish population

	In the combined data set	In the population[a]
Proportion of females, %	43	51
Age group:		
18–34 years, %	20	26
35–65 years, %	60	48
over 65 years, %	20	26
Average monthly income, €	2745	3434
Proportion of people living in Southern Finland, %	53	52
Proportion of farmers from adult population	25%	1%
	In the farmers data	In the farmers population
Proportion of plant producers	72%	70%
Average field area, ha	35	51

a) Source: Stat.fi

Survey measures

In the survey (Supplementary material), the contingent budget allocation question had the following form: "Agriculture is subsidized by tax funds. How tax funds should be directed is a matter of opinion. How important are the following themes to you personally when allocating funding to Finnish agriculture? Think of your total valuation as 100 points and divide your points between the following themes according to your own valuations. Not every theme needs to be given points. That is, if you do not care about a particular theme, you can allocate it 0 points. The combined score should be 100." The themes presented in the question were:

- Agricultural income and farm economic resilience (Aginc)
- Competitiveness of Finnish agriculture compared to other countries (Competit)
- Self-sufficiency in food production (Self-suff)
- Climate change mitigation and adaptation (Climate)
- Condition of soil (Soil)
- Quality of surface waters (Waters)
- Biodiversity and landscape (Biod. landscape)
- Entrepreneurship, livelihoods and services in rural areas (Rural)
- Production of healthy nutrition (Nutrition)
- Farm animal welfare (Anim. welfare)
- Other aspects not mentioned (Other)

After the allocation question, respondents were given the following information about the size of the current budget for agricultural support to farms. "Agriculture is supported by a sum of approximately EUR 2 billion from the Finnish State budget. The support is directed towards safeguarding the viability of farms, the quality of the environment and the welfare of farm animals. This equates to about 4% of the state budget. This is more than, for example, the shares allocated to culture, development cooperation or the police and rescue services in the state budget, but less than, for example, the cost of land defence or education."

After the information, each respondent was asked to "Assess whether you think agriculture's share of the state budget is currently too small, adequate or too large." The range of response options was as follows: far too large, somewhat too large, a little too large, adequate, a little too small, somewhat too small, far too small, and can't say. In the survey, the direction of the scale, from large to small or from small to large, was randomized between the respondents. For the analysis, the scale was converted to a three-step scale by combining the first three options as "too large", keeping the option "adequate" as it was measured, and by combining the last three options as "too small".

The general background variables and their distribution or the mean and standard deviation are presented in Table 2. Beyond the socio-demographic variables, we also used perceptions of the funding for agriculture to explain the allocations and evaluations of the budget size. To construct the final variables, the eight measures of preferences for funding alternatives were included in factor analysis applying the principal component method (Hair et al. 2006) (Appendix 1). The analysis transformed a larger set of correlated variables into a smaller set of uncorrelated variables, i.e., orthogonal principal component scores, without losing much information. The components with eigenvalues less than 1 were not considered in further analysis. As a result of the analysis, we obtained three factors for the perceptions of funding for agriculture: Factor 1, Support for subsidies; Factor 2, Investments for funding; and Factor 3, Markets and prices.

We measured the individual human–nature relationship with the New Environmental Paradigm (NEP) (Dunlap et al. 2000). This measure, with a five-point scale (from 5 totally agreed to 1 totally disagree), encompasses six statements with the following facets: the balance of nature, limited resources, anthropocentrism, the risk of an eco-crisis, limits to growth and humans' ability to control nature. Based on the acceptable Cronbach's alpha (0.754), the final NEP measure was the sum of these statements.

Table 2. Socio-demographic and attitudinal variables

	Share of respondents (%)	
Gender, male	57.4	
Age 18–24	5.53	
25–34	12.8	
35–44	16.2	
45–54	22.7	
55–64	25.3	
65–70	11.9	
71–74	5.65	
Farmer	25.0	
Vegetarian	6.87	
Member of a farmers' association	15.2	
Member of a hunting club	17.6	
Countryside vacation home owner	30.0	
Countryside residence	34.8	
Employed	67.3	
Occupation:		
Forest or agricultural entrepreneur	14.0	
Other entrepreneur	7.15	
Blue-collar worker	24.5	
White-collar worker	18.6	
Professional or managerial employee	22.2	
Student	8.93	
Other	4.54	
Occupational field: primary production, %	16.4	
Gross monthly income:		
under €500	2.76	
€500–999	7.58	
€1000–1499	10.9	
€1500–1999	10.6	
€2000–2999	25.2	
€3000–3999	17.4	
€4000–4999	10.6	
€5000–6999	7.39	
over €7000	3.24	
	Mean	Sd
FAC1 Support for subsidies	0	1
FAC2 Investments for funding	0	1
FAC3 Markets and prices	0	1
NEP–nature relationship	3.84	0.73

Statistical analyses

First, we conducted a descriptive analysis of the budget allocation and budget size variables. Second, we applied three models to explain the variation in budget allocation and budget size. For budget allocation, we first applied the compositional regression model with a set of best predictors and, second, hierarchical cluster analysis with respect to the compositional budget allocation variable. For budget size, we applied a cumulative logit model with a set of best predictors.

Budget allocation has a statistically special structure. Its components consist of weights that are zero or positive, sum up to a constant and carry only relative information. Therefore, budget allocation is a composition. Compositions cannot be analysed using standard statistical methods (for a detailed reasoning, see Aitchison 1986), but, instead, specialized methods applicable to compositions are needed (Appendix 2). We applied compositional regression analysis.

In compositional regression analysis, the interest lies in the relative proportions of the budget allocation categories. Compositional results for the chosen predictor levels (categorical predictor) and values (continuous predictor) were presented as estimated compositions. The model intercept is interpreted as the expected composition at the baseline level of the predictor. We used MANOVA to test the statistical significance of the predictor overall, as well as the differences between predictor classes. The uncertainty in the compositional regression model was examined via bootstrapping. For each bootstrap sample, a model was fitted and estimated compositions were calculated for given predictor values. For each composition element, 0.025 and 0.975 quantiles were calculated from the 500 samples to describe the uncertainty. Furthermore, median was calculated by choosing the 0.5 quantile. Median was chosen because it is the most natural measure of central tendency when quantiles are used for measure of spread.

For compositional analysis, there can be no zero values. There were 8995 zero values for the initial compositions before imputation. For each composition, we imputed each zero with a small nonzero value randomly from the range 10^{-6}–10^{-4} to avoid the choices of fixed values affecting the results, after which the closure operation was performed (Appendix 2). Thus, the final dataset did not contain any strict zero values.

In addition to the compositional regression model for budget allocation, we constructed allocation clusters based on the compositional analysis using the Euclidean distance in the centered log ratio scale and the Ward method (Appendix 2). Chi-squared tests were performed with respect to several variables to infer differences between cluster groups.

The second dependent variable, evaluation of the *budget size*, was ordinal with three levels (too small, adequate, too large). Therefore, evaluation of the budget size was modelled using a cumulative logit model.

Model selection in both regression models was performed using a machine learning approach. The data were divided into two sets, training and validation, using an 80/20 split. A set of potential predictors was defined as follows: gender, age group, region, perceptions of funding for agriculture (Factor 1, Factor 2, Factor 3), vegetarian, membership of relevant organizations, living in an agricultural environment, occupation, employment status, occupation in primary production, income and voter for the Centre Party (Table 2). For each predictor combination, a model was fitted. To estimate the final compositional linear regression model, the model was fitted and the validation R^2 value was calculated. To estimate the cumulative logit model, the model was fitted and the validation accuracy was calculated. Finally, the set of predictors corresponding to the maximum validation R^2 value and validation accuracy were chosen as the best models, respectively, for the compositional linear regression and cumulative logit model. The prediction performance of the final models was evaluated using bootstrapping: 500 bootstrap samples were drawn and the validation R^2 value and validation accuracy were calculated for the out-of-bag sample. To evaluate the prediction performance and variability, 2.5%, 50% and 97.5% quantiles were recorded from the calculations.

The statistical analyses were performed using R software (R core team 2020) and the packages *compositions* (Boogart et al. 2021), *MASS* (Venables and Ripley 2002), *rms* (Harrell 2021) and *tidyverse* (Wickham et al. 2019).

Results

Descriptive results

The compositional means (Fig. 1) indicate the budget categories with largest allocation for all respondents: self-sufficiency in food production, farm animal welfare and water quality of water bodies. The allocations differed considerably between farmers and non-farmers. In their allocation, farmers emphasized agricultural income and farm economic resilience (33% of the allocated 100 points), as well as self-sufficiency in food production (26% of points). Furthermore, for soil conditions, the allocation of farmers was higher than that of non-farmers. Compared to farmers, non-farmers particularly emphasized environmental public goods. They allocated more than average to water quality, farm animal welfare, climate change mitigation and adaptation, as well as biodiversity and landscape. When environmental goods are compared in their allocations, water quality received a somewhat higher share of the allocation than other environmental goods, i.e., biodiversity and climate.

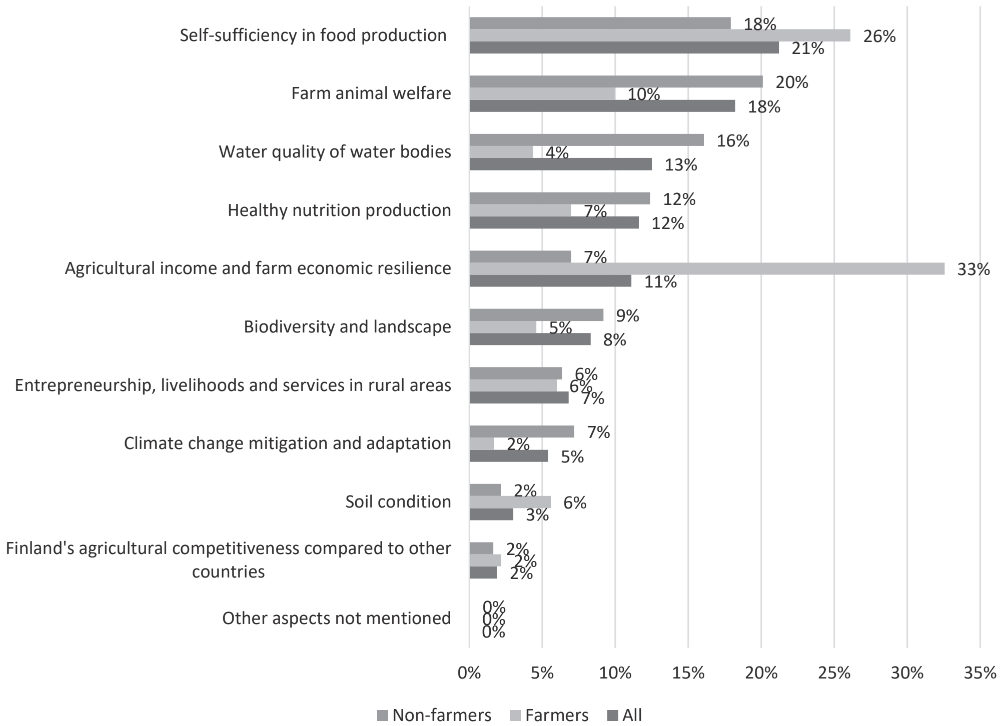

Fig. 1. The compositional means of the budget allocation

Figure 2 displays the distribution of evaluations regarding the budget size. Out of all respondents, 35% considered the budget as adequate. As expected, the majority of farmers (67%) considered the allocation too small, but even among non-farming respondents, over one-third considered the size of the budget to be too small. In the non-farming group, one-fourth perceived the agricultural budget too large, whereas only 5% of farmers viewed it as too large.

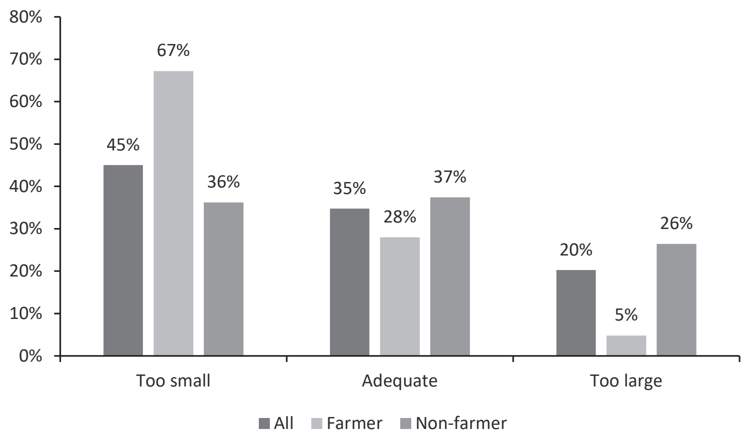

Fig. 2. Budget size evaluations by farmers, non-farmers and all respondents

The model for budget allocation

The compositional regression model results for budget allocation are presented in Table 3. These predictors were found to maximize the prediction performance, although the validation R^2 value was rather low, being 3.7% (with 95% bootstrap quantiles of 2.5% and 4.7% based on 500 bootstrap out-of-bag sampling). Table 4 provides the MANOVA test statistics for the significance of each model variable. The model also includes variables with a non-significant effect, because the model was built with machine learning and not based on variable significances. To avoid multicollinearities, we examined the variance inflation factor (VIF) for a linear model between variables for farmers and members of farmers association showing value of 1.6 that demonstrates low multicollinearity.

Table 3 first presents the median compositions for the baseline. The median (0.5 quantile) was calculated from the 500 bootstrap samples for each component element (286 elements, based on 11 columns and 26 rows in Table 3). The baseline was selected to be internally logical but with an allocation as close as possible to the median composition. The baseline respondents were non-farmers who were non-vegetarian females with an age in the class 35–44 years, were not members of relevant organizations and had no vacation home in the countryside, were employed, belonged to the income class €2000–2999, and for whom funding perception Factors 1–3 were 0. The rows for each model variable present the median budget allocation if the variable in question changes from the baseline. By comparing these allocations on each row of independent variables to baseline the effect of each independent variable on budget allocation can be observed.

The median compositions in Table 3 and test statistics in Table 4 indicate that male gender had a significant effect on allocations compared to the baseline. This means that male and female compositions differ significantly, i.e. all the 11 composition elements differ significantly simultaneously. Male gender associated with a higher allocation especially to agricultural income and farm economic resilience (Aginc), agricultural competitiveness compared to other countries (Competit) and self-sufficiency in food production (Self-suff). This happened at the cost of climate change mitigation and adaptation (Climate) and farm animal welfare (Anim. welfare). The effect of age was also highly significant. Middle-aged and older respondents especially emphasized self-sufficiency in food production and healthy nutrition production (Nutrition).

Funding-related Factors 1 and 2 had a significant effect on allocations. In particular, Factor 1 (Support for subsidies) shifted the allocation of funding and was associated with a greater emphasis on agricultural income and self-sufficiency, but a lower emphasis on environmental public goods.

Farmers differed significantly from the median baseline allocation, with a greater emphasis on agricultural income and competitiveness, but also on soil conditions and healthy nutrition, with all other allocations on a lower level compared to the baseline. If a respondent was a member of a farmers' association, the allocation closely resembled that of farmers, but the emphasis shifted slightly towards self-sufficiency and animal welfare.

The vegetarian variable also had an effect: it shifted the allocation towards climate change mitigation and adaptation, but also towards biodiversity and landscape. We found some differences between income classes, but no clear tendency.

The relative differences between upper and lower quantiles for the compositions are reported in Appendix 3. The differences in quantiles allow the observation of uncertainty in median compositions. Appendix 3 indicates that divergence between quantiles is high in the low and high age classes, as well as in the low and high income classes, reflecting the high level of heterogeneity among these respondents. We observed allocations to vary in some of the budget categories, especially in self-sufficiency and animal welfare. However, in these categories, the allocations were on a high level and the relative variance reported in Appendix 3 was therefore minor. When the difference between upper and lower quantiles was related to median allocations, variances were especially high in competitiveness, the condition of soil, and entrepreneurship, livelihoods and services in rural areas.

Table 3. Median compositions according to model variables predicted with the compositional regression model. The baseline row represents female respondents in the age class 35–44 years who are non-vegetarian, non-farmers, are not members of relevant organizations and own no vacation home in the countryside, are employed and in the income class €2000–2999, and for whom Factors 1–3 are 0. R^2 = 0.037. Each row presents median budget allocation based on 500 bootstrap samples if the variable in question changes from the baseline.

	Aginc	Competit	Self-suff	Climate	Soil	Waters	Biod. landscape	Rural	Healthy nutr.	Animal welfare	Other
Baseline	0.048	0.011	0.166	0.07	0.032	0.103	0.083	0.054	0.061	0.361	0
Male gender	0.099	0.027	0.291	0.037	0.034	0.113	0.075	0.074	0.061	0.176	0
Age 18–24	0.077	0.012	0.053	0.237	0.023	0.088	0.092	0.089	0.052	0.245	0
25–34	0.06	0.015	0.11	0.13	0.04	0.114	0.103	0.065	0.064	0.285	0
45–54	0.058	0.01	0.19	0.055	0.02	0.099	0.067	0.071	0.079	0.342	0
55–64	0.063	0.008	0.18	0.062	0.016	0.111	0.088	0.079	0.109	0.271	0
65–70	0.045	0.013	0.181	0.093	0.016	0.115	0.076	0.066	0.169	0.205	0
71–74	0.065	0.019	0.207	0.06	0.017	0.065	0.055	0.086	0.242	0.153	0
FAC1: Subsidies	0.095	0.013	0.256	0.048	0.033	0.065	0.064	0.058	0.055	0.302	0
FAC2: Investments	0.05	0.015	0.138	0.085	0.029	0.108	0.083	0.058	0.066	0.358	0
FAC3: Prices	0.046	0.012	0.182	0.069	0.034	0.102	0.085	0.054	0.059	0.344	0
Farmer	0.15	0.016	0.141	0.052	0.076	0.054	0.065	0.053	0.066	0.305	0
Vegetarian	0.008	0.002	0.034	0.257	0.015	0.107	0.182	0.008	0.03	0.34	0
Member of a farmers' association	0.046	0.01	0.177	0.066	0.048	0.088	0.071	0.039	0.038	0.397	0
Member of a hunting club	0.043	0.01	0.243	0.041	0.03	0.092	0.08	0.076	0.059	0.309	0
Countryside vacation home owner	0.049	0.01	0.152	0.061	0.026	0.115	0.098	0.055	0.06	0.359	0
Not employed	0.04	0.012	0.185	0.073	0.021	0.12	0.062	0.044	0.068	0.355	0
Monthly income €0	0.056	0.012	0.149	0.035	0.044	0.106	0.046	0.052	0.084	0.375	0
under €500	0.047	0.012	0.133	0.076	0.047	0.097	0.143	0.032	0.076	0.286	0.001
€500–999	0.06	0.008	0.119	0.046	0.05	0.106	0.097	0.057	0.087	0.346	0
€1000–1499	0.05	0.009	0.147	0.056	0.046	0.091	0.108	0.057	0.062	0.357	0
€1500–1999	0.043	0.006	0.192	0.056	0.026	0.107	0.078	0.031	0.063	0.383	0
€3000–3999	0.044	0.012	0.143	0.096	0.029	0.148	0.081	0.039	0.097	0.297	0
€4000–4999	0.042	0.01	0.094	0.081	0.029	0.151	0.088	0.048	0.103	0.338	0
€5000–6999	0.053	0.013	0.207	0.084	0.042	0.134	0.087	0.03	0.069	0.254	0
over €7000	0.097	0.011	0.14	0.106	0.061	0.118	0.115	0.057	0.045	0.196	0

Table 4. Type 3 MANOVA showing the *p*-values for independent variables in the compositional regression model

	Test stat	Pr(>F)	
(Intercept)	0.126659	2.20E-16	***
Gender	0.043565	2.20E-16	***
Age class	0.060804	4.27E-10	***
FAC1: Subsidies	0.105821	2.20E-16	***
FAC2: Investments	0.019496	3.68E-07	***
FAC3: Prices	0.005242	0.21563	
Farmer	0.028298	1.99E-11	***
Vegetarian	0.044467	2.20E-16	***
Member of a farmers' association	0.006347	0.10185	
Member of a hunting club	0.00733	0.04859	*
Countryside vacation home owner	0.00414	0.40817	
Not employed	0.006242	0.1098	
Income, personal	0.049295	0.01008	*

Clusters based on budget allocation

Budget allocations were also used to cluster respondents based on similarities in their allocation decisions. Interest in the interpretation of clusters led us to select three clusters from the alternative solutions of two and three clusters. Table 5 presents the three-cluster solution based on the closeness of respondents' perceptions of the budget allocations. The characteristics of clusters based on socio-demographic and attitudinal variables are presented in Table 6 and Appendix 4.

Table 5. Mean composition of budget allocation in the clusters

	Cluster 1	Cluster 2	Cluster 3	All
	Multifunction	Production	Environment	
Cluster size N/ %	1559/ 62%	691/27%	282/11%	2532/100%
		Mean composition		
Agricultural income and farm economic resilience	0.139	0.1444	0.000	0.111
Finland's agricultural competitiveness compared to other countries	0.014	0.029	0.000	0.019
Self-sufficiency in food production	0.099	0.660	0.010	0.212
Climate change mitigation and adaptation	0.108	0.001	0.478	0.054
Condition of soil	0.038	0.008	0.002	0.03
Quality of surface waters	0.113	0.019	0.254	0.125
Biodiversity and landscape	0.103	0.006	0.182	0.083
Entrepreneurship, livelihoods and services in rural areas	0.061	0.062	0.002	0.068
Healthy nutrition production	0.127	0.031	0.019	0.116
Farm animal welfare	0.198	0.040	0.053	0.182
Other aspects not mentioned	0	0	0	0

The first cluster, comprising 62% of respondents, emphasised budget categories quite equally, indicating support for the multiple objectives of agricultural policy. This cluster particularly emphasised climate issues, animal welfare and healthy nutrition production, but also agricultural income. From among the clusters, the first cluster most closely resembles the average respondent Table 6 showing no overrepresentation regarding any of the variables.

The second cluster, comprising 27% of respondents, was clearly production oriented. Their budget allocation particularly exceeded the mean of all respondents for self-sufficiency of food production, but also for agricultural income of farms and competitiveness of Finnish agriculture compared to other countries. Membership in cluster

2 was more typical among farmers, male respondents and those who lived in an agricultural environment and voted for the Centre Party. In cluster 2 memberships in hunting clubs or in farmers association were more typical than among respondents in average.

The third cluster (11% of respondents) was environmentally oriented. Respondents in this cluster strongly emphasised climate change mitigation and adaptation, the quality of surface waters, and biodiversity and landscape. Their allocations to agricultural income, competitiveness and self-sufficiency were close to zero. Membership of cluster 3 was most typical in the capital region among young respondents. In particular, members of nature conservation organizations and vegetarians were clearly overrepresented in this cluster.

Table 6. The over-represented variable groups for each cluster. The full documentation of the comparison between clusters in Appendix 4.

	Cluster 1	Cluster 2	Cluster 3
		Overrepresented variable groups*	
Farmer (yes/no)	-	Farmer	Non-farmer
Gender	-	Male	Female
Age	-	-	25–34
Region	-	-	Helsinki-Uusimaa
Diet	-	Mixed	Vegetarian
Associations	-	Farmers' assoc Yes	Farmers' assoc No
		Nature Conser No	Nature conser Yes
		Hunting club Yes	Hunting club No
Income	-	-	3000–3999 euroa
Agricultural environment	-	Permant residence (yes)	Permanent residence (no)
			Vacation home (no)
		Childhood environment (yes)	Childhood env No
Occupation	-	Forest or agri entrep	Professional employee
			Student
			Other (occup)
Primary production		Yes	
Political party	-	Centre	

* Over-representation was fulfilled when the cluster group proportion was above the corresponding confidence intervals' upper limit. Since the number of observations was large, to construct confidence intervals for the probability of each variable class a normal approximation was used for each confidence interval (see for example Hogg and Tanis 2015). A z-score of 4 was chosen for each confidence interval, since it served as a sufficient separator.

The model for budget size

The cumulative logit model presented in Table 7 predicts preferences for the size of the agricultural budget. The farmer variable associated significantly and negatively with the continuum of responses from too small to adequate and further too large, implying that farmers have a higher probability of belonging to the "too small" group and a smaller probability of belonging to the "too large" group compared to non-farmers. A similar direction of the association was found in the case of members of a farmers' association or a nature conservation association and ownership of a countryside residence and countryside vacation home. From among the separate occupations, the blue-collar worker group, with a significant negative coefficient, indicated support for increasing the budget compared to the reference group of white-collar workers. High income classes supported evaluation of the current budget, which they viewed as too large. The attitudinal variable, an environmental orientation measured with the NEP, associated positively with a shift in responses concerning the agricultural budget from too small to adequate and further too large. From the perceptions of funding for agriculture, Factors 1 and 2 associated negatively with the continuum of the response groups. Factor 3, Markets and prices, associated positively with the response continuum from too small to too large. An increasing in the value of Factor 3 indicates a stronger evaluation of the budget as being too large.

The perceptions of budget size differed significantly between budget allocation clusters. Respondents with a multifunctional allocation were close to the average distribution of budget size evaluations. Perceptions of the budget being too small associated positively with a production-oriented allocation (Cluster 2). Of them 56% considered the budget too small, while the sharewas 45% for all the respondents. Interestingly, almost half (49%) of the respondents from the cluster with an environmentally oriented allocation perceived the budget for agriculture as too large. For all the respondents, the share was 20%.

Table 7. Cumulative logit model for budget size (three classes: too small, adequate, too large)

	Coef.	S.E.	Wald Z	Pr(>|Z|)	Variable significance (from deviance)
Constant (small|adequate)	-0.659	0.434	-1.52	0.129	
Constant (adequate|too large)	-2.906	0.440	-6.6	<0.001	
NEP	0.401	0.069	5.79	<0.001	5.22E-09
FAC1: Subsidies	-1.175	0.060	-19.64	<0.001	<2.20E-16
FAC2: Investments	-0.122	0.048	-2.56	0.012	0.010
FAC3: Prices	0.275	0.049	5.63	<0.001	1.43E-08
Farmer	-0.597	0.175	-3.41	0.001	0.001
Vegetarian	0.478	0.204	2.35	0.019	0.018
Member of a farmers' association	-0.462	0.178	-2.59	0.010	0.009
Member of a nature conservation association	-0.059	0.143	-0.41	0.682	0.682
Countryside residence	-0.348	0.131	-2.66	0.008	0.008
Countryside vacation home	-0.162	0.102	-1.59	0.112	0.112
Occupation (ref: white-collar worker)					0.001
Forest or agricultural entrepreneur	-0.201	0.242	-0.83	0.406	
Other entrepreneur	0.210	0.198	1.06	0.290	
Blue-collar worker	-0.448	0.141	-3.19	0.001	
Professional or managerial employee	0.095	0.145	0.65	0.514	
Student	-0.370	0.231	-1.6	0.109	
Other	-0.398	0.264	-1.51	0.131	
Not employed	-0.132	0.184	-0.72	0.474	0.474
Monthly gross income (ref. €0)					0.167
under €500	0.394	0.406	0.97	0.331	
€500–999	0.030	0.303	0.1	0.920	
€1000–1499	0.160	0.286	0.56	0.575	
€1500–1999	0.276	0.293	0.94	0.347	
€2000–2999	0.166	0.274	0.6	0.545	
€3000–3999	0.346	0.279	1.24	0.215	
€4000–4999	0.440	0.296	1.49	0.137	
€5000–6999	0.535	0.309	1.73	0.083	
over €7000	0.907	0.362	2.5	0.012	
Voter for the Centre Party	-0.053	0.138	-0.38	0.703	0.703
N	2062				
Likelihood ratio test *p*-value: Pr(> chi^2) < 0.0001					
R^2	0.407				
No information rate	0.447				
Model prediction accuracy					
2.50%	0.557				
50%	0.588				
97.50%	0.617				

Discussion and conclusion

This study demonstrated how the preferred budget allocations of citizens can be measured to improve the legitimacy of agricultural policy. We were also able to explain the allocation with citizen characteristics to provide information on which population groups might benefit or suffer from the shifts in agricultural budget allocation. We found expected differences in preferred budget allocations between farmers and non-farming citizens, but other sociodemographic variables were also found to have a significant impact on the results concerning the preferred budget allocations. These results demonstrate the importance of wide participation in the design of agricultural policies.

The mean budget allocation by all respondents revealed the importance of supporting the self-sufficiency of food production, animal welfare and the quality of surface waters threatened by agriculture. Farmers emphasized, in addition to self-sufficiency, the importance of agricultural income and farm economic resilience. The importance of self-sufficiency has also been found by Mittenzwei et al (2016). In this study, the respondents did not emphasize rural development, contrary to a Spanish study by Rocamora-Montiel et al. (2014). Compared to their results concerning the importance of environmental objectives in general, our study used a more detailed classification of environmental objectives, showing the lower emphasis on climate change mitigation and biodiversity compared to water quality issues that is understandable if reflected with the long running discussion about the impact of agriculture on the surface water quality.

Our results also identified a small group of citizens, typically vegetarians, whose preferences for allocations differed most from the median allocation in an environmentally oriented direction. It appears that if citizens have taken environmental concerns into account in their own behaviour, they are also consistent in demanding a change towards an environmentally oriented direction in agricultural policy. Among the other socio-demographic variables, the difference between genders was surprisingly clear. The results indicated a strong production orientation among male respondents compared to the multi-objective and environmental emphasis among female respondents.

The contingent allocation task used in this study resembles a budget decision: if some of the objectives are allocated more funds, less funding can be given to other objectives. Unlike several previous budget allocation studies, our analysis took into account this compositional nature of allocation. Although the modelling approach provides reliable estimates, the results may be perceived as complicated to interpret when the entire allocation is modelled simultaneously. In our analysis, the baseline class was selected to be as close as possible to the median allocation, and the reported class medians indicated the discrepancies from the baseline. Selecting an alternative baseline class might have emphasized different aspects of allocation behaviour. A deficiency of our modelling approach was that the rather complex compositional analysis did not allow us to combine the budget size evaluation in the simultaneous modelling framework together with the allocation decision.

The compositional regression model for the budget allocation and compositional clustering analysis demonstrated the significant but expected difference between farmers and non-farming citizens. These results highlighted the stronger production orientation and weaker environmental orientation of farmers compared to non-farmers. However, interestingly the largest cluster of respondents emphasizing multiple objectives was equally represented among farming and non-farming citizens. The results from the compositional regression model also showed that members of farmers associations, typically representing farmers in policy processes, had a slightly more diverse budget allocation than the entire group of farmers, which was more production oriented.

The results also demonstrate that the current allocation of agricultural budget support (Latvala et al. 2021) is broadly in line with farmers' preferences. Farmers are prepared to spend even slightly more than currently on securing food production, farm incomes and competitiveness, but roughly the current amount on environmental and climate measures. It is also worth noting that farmers are prepared to allocate clearly more budget resources to promote animal welfare: as much as 10% of the agricultural budget instead of the current 3%.

Putting the mean budget allocation preferred by citizens into a practical agricultural policy in Finland would, however, mean a rather significant change in the allocation of budget support, of which about half is currently used to secure food production, farm incomes and international competitiveness, and a quarter to ensure the continuity of agriculture in less favoured areas. According to the survey results, about a third of the agricultural budget support could still be used to secure production and farm incomes. In contrast, more than 30% of the budget support, instead of the current 13%, should be directed to measures to promote environmental and climate-related objectives. Citizens are also willing to allocate significantly more to promoting animal welfare: as much as 18% of the agricultural budget instead of the current 3% share.

Although previous budget allocation studies on samples of citizens have not provided information on the weight placed on animal welfare, the studies identified in the meta-analysis by Ahtiainen et al. (2015) reported a lower importance of animal welfare than the 20% allocation observed here. The relative importance has typically varied from 7% to 17%. The meta-analysis of Ahtiainen et al. (2015) also included Finnish studies. One reason for the observed increase in the importance of animal welfare may be an actual change in preferences over time, even though the state of animal welfare has continuously improved along with changes in the regulations. This high allocation may indicate interest among citizens in maintaining the relatively good present state of animal welfare.

Our results also revealed the views of citizens regarding the size of the agricultural budget. The results indicated a clear difference in the share of respondents who rated the current budget as “too low”. Two-thirds of farmers and one-third of non-farmers considered the agricultural budget to be too small. Furthermore, the results showed that an environmental orientation, measured with the New Environmental Paradigm, and a vegetarian diet are associated with the perception of an oversized budget for agriculture. This observation most probably relates to the expectation that an increased budget will lead to emphasis on production objectives in budget allocation and would not be directed to environmental purposes. This implies a possible deficit of legitimacy towards agricultural policy among those with a clear environmental orientation.

Although the results seem to offer information basis for developing the budget allocation to follow more closely citizen preferences, we need to recognize the limitations of the survey measures. Simplified survey setting can be criticised, because it is focusing on the separate budget for agriculture. There might be several associated objectives in society such as biodiversity, a fair income distribution and food security, that link to the budget of agricultural sector but cannot be fully covered in this kind of study focusing on one sector. Future research question might be to reveal the linkages between different but associated policies and related citizen preferences.

In the case of agriculture, one essential complication in measuring citizen preferences for budget allocation is how to present the EU part of the funding and the national funding. The commitment to the Common Agricultural Policy (CAP) of the EU naturally limits the scope for national agricultural policy and thus for the agricultural budget. However, as part of the CAP, Finland has significant national room for maneuver, 60% of the total support for agriculture. The significant national share of support is also well known by citizens and provides feasible basis for national survey and policy relevant results.

Other challenge of the survey measure used here is that some of the objects of agricultural policy are implemented separately of budget allocation categories with other types of policy measures. For example, food safety is regulated by law and farmers have to comply with food safety regulations without being given particular subsidies to achieve food safety standards. Similarly, the condition of soil or of animal welfare may not be perceived as budget related topics. Soil conditions received a very low score by citizen, but that does not necessarily mean that citizens regard soil conditions less important, but that they are satisfied with the current soil conditions and do not prioritize to spend more public funds on soil improvement. One reason may also be that soil issues have not been raised in the public debate in the same way as, for example, animal welfare issues. In other words, citizens may not be particularly aware of the current state of soil management.

It is also worth noting that citizen preferences for different budget allocations are always time dependent. Our data were collected during the COVID-19 pandemic, which most probably affected the allocations. We can assume that food self-sufficiency, in particular, may have been emphasized by respondents during the pandemic. This type of possible variation in preferred budget allocations does stress the importance of continuously measuring citizen preferences to support legitimate policy making in agriculture.

Acknowledgement

We thank Academy of Finland for the financial support (310205).

References

Abelson, J., Forest, P.G., Eyles, J., Smith, P., Martin, E. & Gauvin, F.P. 2003. Deliberations about deliberative methods: issues in the design and evaluation of public participation processes. Social Science & Medicine 57: 239–251. https://doi.org/10.1016/S0277-9536(02)00343-X

Adolph, C., Breuning, C. & Koski, C. 2020. The political economy of budget trade-offs. Journal of Public Policy 40: 25–50. https://doi.org/10.1017/S0143814X18000326

Ahtiainen, H., Pouta, E., Liski, E., Myyrä, S. & Assmuth, A. 2015. Importance of economic, social, and environmental objectives of agriculture for stakeholders-A meta-Analysis. Agroecology and Sustainable Food Systems 39: 1047–1068. https://doi.org/10.1080/21683565.2015.1073207

Aitchison, J. 1986. The statistical analysis of compositional data. Monographs on statistics and applied probability. London: Chapman & Hall.

Blomquist, G.C., Newsome, M.A. & Stone, D.B. 2004. Public preferences for program tradeoffs: Community values for budget priorities. Public Budgeting & Finance 24: 50–71. https://doi.org/10.1111/j.0275-1100.2004.02401003.x

Bombard, Y., Abelson, J., Simeonov, D. & Gauvin, F.P. 2011. Eliciting ethical and social values in health technology assessment: a participatory approach. Social Science & Medicine 73: 135–144. https://doi.org/10.1016/j.socscimed.2011.04.017

Costa-Font, J. & Rovira, J. 2005. Eliciting preferences for collectively financed health programmes: the 'willingness to assign' approach. Applied Economics 37: 1571–1583. https://doi.org/10.1080/00036840500181695

Costa-Font, J., Rovira Forns, J. & Sato, A. 2015. Participatory health system priority setting: Evidence from a budget experiment. Social Science & Medicine 146: 182–190. https://doi.org/10.1016/j.socscimed.2015.10.042

Costa-Font, J., Rovira Forns, J. & Sato, A. 2017. Identifying health system value dimensions: more than health gain? Health Economics, Policy and Law 12: 387–400. https://doi.org/10.1017/S1744133117000032

Dunlap, R.E., Van Liere, K., Mertig, A. & Jones, R.E. 2000. Measuring endorsement of the New Ecological Paradigm: A revised NEP scale. Journal of Social Issues 56: 425–442. https://doi.org/10.1111/0022-4537.00176

Egozcue, J.J., Pawlowsky-Glahn, V., Mateu-Figueras, G. & Barceló-Vidal, C. 2003. Isometric logratio transformations for compositional data analysis. Mathematical Geology 35: 279–300. https://doi.org/10.1023/A:1023818214614

Evans, K., Noblet, C., Fox, E., Bell, K. & Kaminski, A. 2017. Public acceptance of coastal zone management efferts: The role of citizen preferences in the allocation of funds. Agricultural and Resource Economics Review 46: 268–295. https://doi.org/10.1017/age.2017.9

Gómez-Limón, J.-A. & Atance, I. 2004. Identification of public objectives related to agricultural sector support. Journal of Policy Modeling 26: 1045–1071. https://doi.org/10.1016/j.jpolmod.2004.07.005

Hair, J.F.J., Black, W.C., Babin, B.J., Anderson, R.E. & Tatham, R.L. 2006. Multivariate data analysis 6th edition. Prentice-Hall International, New Jersey, USA.

Harrell, F.E. Jr. 2021. rms: Regression Modeling Strategies. R package version 6.2-0. https//CRAN.R-project.org/package=rms

Hogg, R.V. & Tanis, E.A. 2015. Probability and statistical inference. Pearson Education Inc. New Jersey.

Huang, J., Tichit, M., Poulot, M., Darly, S., Li, S., Petit, C. & Aubry, C. 2015. Comparative review of multifunctionality and ecosystem services in sustainable agriculture. Journal of Environmental Management 149: 138–147. https://doi.org/10.1016/j.jenvman.2014.10.020

Kerr, G.N., Cullen, R. & Hughey, K.F.D. 2010. Choice experiment assessment of public expenditure preferences. New Zealand Economic Papers 44: 259–268. https://doi.org/10.1080/00779954.2010.522163

Koford, B.C. 2009. Citizens' Budget Choices for the State of Kentucky. Kentucky Annual Economic Report 2009: 17–23.

Laurila, I. & Niemi, J. 2017. Kansallista konsensusta: Suomen maatalouden selviytyminen EU-aikana. (Abstract: National consensus has supported the survival of Finnish agriculture in the EU). In: Raunio, T. & Saari, J. (eds). Reunalla vai ytimessä? Suomen EU-politiikan muutos ja jatkuvuus. Gaudeamus. p. 149–169. (in Finnish)

Latvala, T., Väre, M. & Niemi, J. 2021. Finnish agri-food sector outlook 2021. Natural resources and bioeconomy studies 72/2021. Natural Resources Institute Finland. 71 p. http://urn.fi/URN:ISBN:978-952-380-292-6

Meinard, Y., Remy, A. & Schmid, B. 2017. Measuring Impartial Preference for Biodiversity. Ecological Economics 132: 45–54. https://doi.org/10.1016/j.ecolecon.2016.10.007

Ministry of Finance 2022. Draft Budgetary Plans from 2013 to 2020. Publications by the Ministry of Finance in Finland. https://vm.fi/en/publications

Mittenzwei, K., Mann, S., Refsgaard, K. & Kvakkestad, V. 2016. Hot cognition in agricultural policy preferences in Norway? Agriculture and Human Values 33: 61–71. https://doi.org/10.1007/s10460-015-9597-8

Ozdemir, S., Johnson, F.R. & Whittington, D. 2016. Ideology, public goods and welfare valuation: An experiment on allocating government budgets. Journal of Choice Modelling 20: 61–72. https://doi.org/10.1016/j.jocm.2016.07.003

Renting, H., Rossing, W.A.H., Groot, J.C.J., Van der Ploeg, J.D., Laurent, C., Perraud, D., Stobbelaar, D.J. & Van Ittersum, M.K. 2009. Exploring multifunctional agriculture. A review of conceptual approaches and prospects for an integrative transitional framework. Journal of Environmental Management 90: S112–S123. https://doi.org/10.1016/j.jenvman.2008.11.014

Rocamora-Montiel, B., Colombo, S. & Salazar-Ordóñez, M. 2014. Social attitudes in southern Spain to shape EU agricultural policy. Journal of Policy Modeling 36: 156–171. https://doi.org/10.1016/j.jpolmod.2013.08.004

Røsten Mærøe, A., Norta, A., Tsap, V. & Pappel, I. 2021. Increasing citizen participation in e-participatory budgeting processes. Journal of Information Technology & Politics 18: 125–147. https://doi.org/10.1080/19331681.2020.1821421

Skedgel, C.D., Wailoo, A.J. & Akehurst, R.L. 2013. Choosing vs. allocating: discrete choice experiments and constant-sum paired comparisons for the elicitation of societal preferences. Health Expectations 18: 1227–1240. https://doi.org/10.1111/hex.12098

Simonsen, W. & Robbins, M.D. 2000. Citizen participation in resource allocation. Boulder, CO: Westview. 200 p. https://doi.org/10.4324/9780429501630

Soguel, N., Caperchione, E. & Cohen, S. 2020. Allocating government budgets according to citizen preferences: a cross-national survey. Journal of Public Budgeting, Accounting & Financial Management 32: 487504. https://doi.org/10.1108/JPBAFM-08-2019-0123

Song, B., Robinson, G.M. & Bardsley, D.K. 2020. Measuring Multifunctional Agricultural Landscapes. Land 9: 260. https://doi.org/10.3390/land9080260

Stat.fi 2021. Statistics Finland. Statistical databases. https://www.stat.fi/tup/tilastotietokannat/index_en.html

Tyler, T.R. 2006. Psychological perspectives on legitimacy and legitimation. Annual Review of Psychology 57: 375–400. https://doi.org/10.1146/annurev.psych.57.102904.190038

Venables, W.N. & Ripley, B.D. 2002. Modern applied statistics with S. 4th edition. Springer, New York. https://doi.org/10.1007/978-0-387-21706-2

Wickham, H., Averick, M., Bryan, J., Chang, W., D'Agostino McGowan, L., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Lin Pedersen, T., Miller, E., Milton Bache, S., Müller, K., Oooms, J., Robinson, D., Seidel, D.P., Spinu, V., Takahashi, K., Vaughan, D., Wilke, C., Woo, K. & Yutani, H. 2019. Welcome to the Tidyverse. Journal of Open Source Software 4: 1686. https://doi.org/10.21105/joss.01686

Appendix 1. Factor analysis: perceptions of funding for agriculture

	Mean	Standard deviation	Component loading	Eigenvalue	% of variance	Cumulative %
Support for subsidies				2.491	31.132	31.132
Agriculture must be supported by tax funds.	3.769	1.030	0.783			
The whole food chain should be financially responsible for the future of agriculture.	4.128	0.872	0.557			
Farmers should receive a higher share of the price of food.	4.360	0.767	0.673			
Agriculture should not be supported, even if it leads to a decrease in Finnish food production.	1.739	1.007	-0.803			
Investments for funding				1.356	16.953	48.085
Citizens could participate in supporting agriculture on a voluntary basis, for example by buying shares in farms.	3.355	1.021	0.768			
International private equity investors could invest in Finnish agriculture.	2.803	1.236	0.755			
Markets and prices				1.169	14.611	62.696
Agricultural support is not needed, as all costs could be included in the prices of domestic agricultural products.	2.328	1.072	0.649			
Support for Finnish agriculture should be in line with support in other countries so that Finnish products are competitive.	3.636	0.996	0.394			

Appendix 2. Compositional data analysis

A composition is a vector, where the elements are denoted as components. Because components carry only relative information, standard statistical analyses are not suitable for compositional data (Aitchison 1986). Compositional data can be analysed by choosing an appropriate multivariate scale. An important operation for compositions is perturbation, which for a D-part composition y and a D-vector x is defined as $y \oplus x = \mathcal{C}(y_1 x_1, \ldots, y_D x_D)$, where $\mathcal{C}$ is the closure operation defined as $\mathcal{C}(y) = \frac{y}{1^T y}$. Another important compositional operation is the power transformation: $\lambda \odot x = \mathcal{C}(x_1^{\lambda}, \ldots, x_D^{\lambda})$. Perturbation and power transformation relate to the sum and product operations, respectively, in traditional linear regression.

Because absolute size is irrelevant for compositional data, as interest lies in the relative proportions of the weights, data transformation must be performed. We used the popular isometric logratio (ilr) transformation (Egozcue 2003), which allows the compositions to be presented in an orthogonal coordinate system, along with the use of classical statistical analysis such as explanatory data analysis and linear regression.

Let Y denote the compositional response matrix. That is, Y is an $N \times D$ matrix, where for each composition (row) $y_i, \sum_{j=1}^{D} y_{ij} = 1$ and $y_{ij} \in \mathbb{R}^{+} (i = 1, \ldots, N; j = 1, \ldots, D)$.

As a measure of the central tendency of Y, we use the compositional mean defined as

$$\overline{y} = \mathcal{C}\left[\exp\left(\frac{1}{N}\sum_{i=1}^{N} \ln(y_i)\right)\right].$$

The variation of the components can be examined using the variation matrix (Aitchison 1986), whose elements are defined as $\tau_{ij} = var\left(ln\frac{y_i}{y_j}\right)$ $(i = 1, \ldots, D-1; j = i+1, \ldots, D)$. To help in the interpretation of the variation matrix, Aitchison (1997) suggested considering the transformation $\rho_{ij} = \exp\left(-\frac{\tau_{ij}^2}{2}\right)$, which can interpreted as a correlation coefficient.

By applying appropriate data transformation, one may apply the linear regression model. We write the model as

$$ilr(y_i) = ilr(a) + \sum_{j=1}^{k} X_{ij} ilr(b_j) + ilr(\varepsilon_i) \ (i = 1, \ldots, N),$$

where j denotes the variable index, i denotes the composition, X is the predictor, N is the number of observations, ilr denotes the ilr transformation and ε is a compositional random variable with null compositional expectation (neutral element) $\mathbb{I} = \frac{1,\ldots,1}{D}$ and a centered log-ratio covariance matrix Σ. We assume that $\varepsilon_i \sim N_S^D(1, \Sigma)$ (see Aitchison 1986 for details).

For the cluster analysis, we used the popular centered log ratio (clr) transformation, which is defined as $clr(x) = \ln\left(\frac{x}{g(x)}\right)$, where $g(x) = \sqrt[D]{x_1 \cdot x_2 \cdots x_D}$. The inverse clr transformation can be obtained in the following way: if $x^* = clr(x)$, then $x = \mathcal{C}[\exp(x^*)]$.

Appendix 3. Prediction variability: The difference between upper and lower quantiles (2.5% and 97.5%) in relation to medians (Table 3).

	Aginc	Competit	Self-suff	Climate	Soil	Waters	Biod. landscape	Rural	Healthy nutr.	Animal welfare	Other
Baseline	0.81	0.91	0.71	0.81	0.81	0.67	0.73	0.85	0.79	0.49	
Male gender	0.78	0.93	0.59	0.97	0.88	0.73	0.79	0.81	0.85	0.69	
Age 18–24	1.29	1.58	1.55	1.03	1.43	1.10	1.16	1.43	1.31	0.89	
25–34	0.87	1.00	0.85	0.88	0.90	0.70	0.77	0.92	0.86	0.59	
45–54	0.74	0.90	0.63	0.80	0.80	0.69	0.72	0.79	0.72	0.46	
55–64	0.75	1.00	0.67	0.79	0.81	0.69	0.70	0.80	0.71	0.53	
65–70	1.00	1.15	0.86	1.09	1.13	0.89	0.99	1.06	0.86	0.80	
71–74	1.28	1.53	1.02	1.42	1.47	1.29	1.42	1.33	0.93	1.16	
FAC1: Subsidies	0.77	0.92	0.63	0.92	0.88	0.74	0.81	0.84	0.84	0.57	
FAC2: Investments	0.86	1.00	0.75	0.84	0.86	0.69	0.77	0.88	0.82	0.51	
FAC3: Prices	0.87	1.00	0.74	0.87	0.88	0.74	0.78	0.89	0.85	0.54	
Farmer	0.95	1.19	0.93	1.17	1.00	0.98	1.05	1.08	1.02	0.71	
Vegetarian	1.38	1.00	1.38	0.85	1.33	0.93	0.86	1.25	1.40	0.77	
Member of a farmers' association	1.20	1.40	1.01	1.24	1.17	1.06	1.04	1.26	1.24	0.62	
Member of a hunting club	1.07	1.30	0.81	1.20	1.10	0.98	1.03	1.11	1.05	0.72	
Countryside vacation home owner	0.90	1.10	0.81	0.97	0.96	0.81	0.82	0.95	0.92	0.56	
Not employed	1.08	1.25	0.91	1.10	1.05	0.88	0.97	1.14	1.09	0.65	
Monthly income €0	1.38	1.92	1.56	1.77	1.57	1.34	1.41	1.50	1.56	0.93	
under €500	1.81	2.00	1.80	1.59	1.66	1.35	1.34	1.78	1.74	1.13	
€500–999	1.15	1.38	1.13	1.33	1.16	0.99	1.05	1.18	1.13	0.75	
€1000–1499	0.98	1.22	0.90	1.07	1.02	0.89	0.90	1.04	1.03	0.63	
€1500–1999	1.09	1.33	0.85	1.11	1.08	0.90	0.97	1.16	1.02	0.56	
€3000–3999	0.93	1.08	0.85	0.93	0.93	0.70	0.83	0.97	0.86	0.60	
€4000–4999	1.02	1.20	0.98	0.99	1.10	0.79	0.86	1.04	0.89	0.62	
€5000–6999	1.28	1.46	0.95	1.21	1.24	1.00	1.10	1.37	1.16	0.81	
Over €7000	1.46	2.00	1.51	1.50	1.77	1.39	1.37	1.82	1.71	1.20	

Appendix 4. Socio-demographic and attitudinal variables in budget allocation clusters

		Cluster 1	Cluster 2	Cluster 3	Chi 2	*p*-value
			%			
Farmer	Farmer	64	33	3	59.515	0.000
	Non-farmer	61	25	14		
Gender	Female	67	19	14	72.635	0.000
	Male	57	34	9		
Age	18–24	77	9	14	38.414	0.000
	25–34	63	23	15		
	35–44	60	28	12		
	45–54	60	30	10		
	55–64	61	30	9		
	65–70	60	27	12		
	71–74	60	29	10		
Area	Helsinki-Uusimaa	62	22	17	47.234	0.000
	Southern Finland	61	30	9		
	Western Finland	62	29	8		
	Northern and Eastern Finland	61	31	8		
Diet	Vegetarian	63	2	34	134.27	0.000
	Mixed	61	29	9		
Farmers’ association	Yes	63	34	2	39.935	0.000
	No	61	26	13		
Nature conservation	Yes	67	12	21	62.451	0.000
	No	61	29	10		
Hunting club	Yes	59	36	5	35.775	0.000
	No	62	25	12		
Monthly income	€0	67	24	9	32.762	0.013
	€1–500	77	10	13		
	€500–999	66	23	11		
	€1000–1499	68	23	8		
	€1500–1999	61	29	10		
	€2000–2999	57	31	12		
	€3000–3999	60	26	13		
	€4000–4999	63	27	10		
	€5000–6999	55	34	12		
	over €7000	60	30	10		
Agricultural environment	Permanent residence yes	62	34	4	79.17	0.000
	No	62	24	15		
	Vacation home, yes	60	30	10	6.096	0.050
	No	62	26	12		
	Childhood environment, yes	61	31	8	42.793	0.000
	No	62	23	15		
Occupation	Forest or agriculture entrepreneur	62	35	3	94.128	0.000
	Other entrepreneur<	60	34	7		
	Blue-collar worker	62	28	10		
	White-collar worker	60	25	14		
	Professional or managerial employee	59	28	14		
	Student	76	9	15		
	Other	52	30	17		

Employed	Yes	61	28	10	4.761	0.093
	No	62	25	13		
Occupational field:	Yes	64	34	2	41.916	0.000
primary production	No	61	26	13		
Centre Party voter	Yes	65	33	2	46.581	0.000
	no	60	27	13		
		Means			F-test stat.	*p*-value
Perception of funding for agriculture	FAC1: Subsidies	0.023	0.200	-0.616	36.93	0.000
	FAC2: Investments	0.029	-0.070	0.013	1.42	0.234
	FAC3: Prices	-0.039	0.102	-0.037	2.09	0.148
Environmental orientation	NEP	3.94	3.43	4.31	0.53	0.470