Public preferences for post 2020 agri-environmental policy in the Czech Republic: a choice experiment approach

Ioanna Grammatikopoulou[a,b,*], Tomas Badura[a,c], Davina Vačkařova[a]

* *Corresponding author*

[a] *Global Change Research Institute of the Czech Academy of Sciences, Bělidla 986/4a, 603 00 Brno, Czech Republic*

[b] *Natural Resources Institute Finland (LUKE), Helsinki, Finland*

[c] *Centre for Social and Economic Research on the Global Environment (CSERGE), School of Environmental Sciences, University of East Anglia, Norwich Research Park, NR4 Norwich, England, United Kingdom*

Abstract

In November 2017 European Union commission presented a communication report summarizing the reform proposal of the post 2020 Common Agriculture Policy (CAP). The reform aims to address the environmental degradation associated with agricultural production as well as change in the structure of CAP payments. To this end, the Ministry of Agriculture in Czech Republic is preparing to set its priorities towards CAP's reform. In this study we applied a choice experiment to investigate the public preferences for a set of environmental goods and services delivered by agri-environment-climatic voluntary measures (AECMs). A mixed logit model is employed to elicit preferences and explore their heterogeneity. We find that respondents oppose strongly funding removal. Among environmental attributes, water and food quality are the ones with the highest implicit marginal willingness-to-pay values. Preferences for no funding option are heterogeneous with socio-demographic and attitudinal variables explaining some sources of this heterogeneity. A continuation of national funding for the AECMs is expected to lead to a better state of environment with an anticipated positive welfare change of 669 to 932 mil EUR as opposed to funding removal. The change reflects the estimated welfare change resulting from moving from a low to a medium or to a high preservation state of agri-environmental attributes. We also project the budget change for AECMs considering the level of national funding and given the transfer share between Pillar I and II. Based on our results, we suggest that national funding can be informed by the welfare change scenarios and transfer shares are projected accordingly.

Keywords

Common Agricultural Policy, agri-environmental measures, ecosystem services, choice experiment, mixed logit

1. Introduction

The intensification of agricultural production in the European Union (EU) has led to a substantial increase in food production, but caused significant loss of biodiversity and ecosystem degradation (Zhang et al., 2007; Huang et al., 2005; Pretty 2018). This degradation is largely associated with the way farmers have been financially incentivised to produce the food - what is also known as the EU's Common Agricultural Policy (CAP) – which in many cases led to water quality and soil deterioration, increased carbon emissions and biodiversity loss (Pe'er et al., 2014). Despite previous policy reforms, agriculture remains dominant driver of biodiversity and ecosystem services loss (Pe'er et al., 2014). In the Czech Republic, for example, the entering in the EU's CAP has been associated with a significant loss of bird diversity (Reif and Vermouzek, 2018) which is used as a major indicator of EU's Biodiversity Strategy (Gregory, 2006). Transitioning towards more sustainable agricultural practice is therefore the key factor for not only maintaining valuable species and habitats (Power 2010) and securing EU's food supply, but also to provide a range of agriculture-related public goods including climate adaptation, recreation, amenity value or cultural identity and employment.

It is widely viewed that the environmental degradation associated with agriculture in the EU can be addressed by a change in the structure of payments that farmers receive from the national governments (Bateman and Balmford, 2018). EU commission has consequently proposed the post 2020 CAP reform aiming to simplify and modernize CAP by incentivising generation of environmental public goods and allowing more flexibility for the Member States (MS) to structure the funding at the national level. The communication report that summarises this reform proposal, titled 'The future of food and farming' (European Commission, 2017), was presented in November 2017.

The current green architecture of CAP includes the cross compliance and green measures which are under Pillar I direct payments program and the voluntary agri-environment and climate measures (AECMs) which are part of Pillar II rural development program. On the 1st of June 2018, the EU Commission presented a legislative proposal on CAP beyond 2020 (EC, 2017). The future structure of CAP is planning to embrace more flexible, result-oriented and locally targeted measures (Burton and Schwarz, 2013; Hart et al., 2018). The proposed architecture introduces the enhanced conditionality and the eco-schemes under Pillar I and climate/environmental schemes under Pillar II. MS can combine mandatory and voluntary measures in Pillar I and Pillar II in order to meet the nine general objectives of CAP relating to the economic, environmental and social importance of the policy, defined at the EU level (EC, 2018 pp.11). Environment and climate are among the underlined objectives of CAP reform. MS are expected to make a greater contribution (than they currently do) to overall environmental-and-climatic related EU objectives that include climate action, environmental care, landscape and biodiversity concerns (EC, 2018-Article 92).

In line with these recent developments the Ministry of Agriculture in Czech Republic is interested to evaluate the impacts of current agricultural policy on the environment in the context of the preparation of the country's priorities towards the next planning period. This should be in accordance with the environmental and climate objectives of the EU which will also aim to reflect the citizens' concerns regarding sustainable and environmentally-friendly agricultural production, including biodiversity, climate, ecosystem services and health and nutrition concerns (Recanati et al., 2019). An important information that can support these aims is the investigation of citizens' preferences for agriculture-related ecosystem services, biodiversity and climate change mitigation and adaptation under different funding schemes within CAP, that this study aims to examine.

This study evaluates public preferences towards provision of public goods and ecosystem services by AECMs in the Czech Republic. In order to inform the decision-makers in their preparation of strategic plans for the next period of CAP, we employed a choice experiment, a stated preference method that can help to estimate the welfare changes related to environmental policies and associated changes in public good provision. Our study objectives are the following. First to understand citizens' preferences for the way in which the future strategy addresses the major agri-environmental climatic objectives of CAP. To this end, we explore the variability in the elicited preferences for these objectives across the sample population and assess the relative importance that the public puts on the different environmental objectives that the new CAP proposal sets to achieve. The last objective is to evaluate the potential aggregated public welfare generated from three policy options that the Czech government might consider in forming its future CAP strategy and to explore the potential structure of funding (and potential transfers) between the two CAP pillars. The study closes with discussion of the policy implications of the results.

2. Choice experiment methods in agri-environmental policy assessment

The choice experiment (CE) is a questionnaire-based method often used to elicit individual preferences for hypothetical environmental changes with impacts on the provision of ecosystem goods and services. This method provides certain advantages when evaluating public goods for which there is no direct market price indicator, and when both use and non-use values of public goods are involved (Bateman et al., 2002). In CE, choices are described in terms of their attributes and the levels these attributes can take. Respondents are usually presented with a repeated set of choice situations in which they are asked to select between number of alternatives. Each alternative is described by different levels of preselected attributes, and the respondents are asked to choose the one they most prefer. A monetary attribute representing the cost of the choice is often included in the list of attributes for each choice in the choice set. A *status quo* alternative may also be part of the choice sets, reflecting the baseline or 'no change' situation free of cost. In this way, respondents face a trade-off between preferred changes and the cost of making these changes.

CE are often suggested as a prominent stated-preference technique to evaluate agri-environmental protection programs often described in terms of ecosystem services at different preservation levels (Huang et al., 2015; Villanueva et al., 2017). CE can account for the complex character of such programs (Bennett and Blamey, 2001; Hanley et al., 2001), through surveying respondents about their choices between multiple options which are described by number of attributes. Analysing these responses can reveal how respondents would trade-off different levels of choice attributes against payments as well as between each other. When it comes to policy design knowledge of trade-offs offers valuable information.

CE has been employed in past literature to assess citizens' preferences for agri-environmental policy and specific bundle of ecosystem services (demand side) as well as to assess the farmers' preferences for specific agri-environmental measures (supply side). From a supply side, Espinosa-Goded et al. (2010) used a CE to investigate farmers' ex-ante preferences for key elements of agri-environmental scheme design. Rocchi et al. (2017) elicited the preferences of a group of farmers about agri-environmental actions to be applied in the buffer areas of a natural regional park and Villanueva et al., (2017) explored farmers' preferences towards agri-environmental schemes across different agricultural subsystems. From the demand side, Novikova et al., (2017) applied a CE to explore the preference of residents for agro-ecosystem services at national scale and Varela et al., (2018) examined the demand for enhanced biodiversity of small forest patches in agricultural landscape through a CE. Hynes et al., (2010) estimated the welfare values for an agri-environmental policy using both contingent and CE approaches. Badura et al. (2019) explored spatial aspects of preferences for agro-environmental interventions in Great Britain and Liekens et al. (2013) estimated a value function for agricultural land use change in Belgium. Many of the above-mentioned studies highlight the presence of heterogeneous preferences and segmentation of respondents with distinct preferences. Both supply-side and demand-side CE applications are useful to inform policy makers about the public preferences for agricultural policies and the feasibility of these policies from farmers' perspective. What is often missing, however, is an explicit link to pressing policy questions – this is where our application aims to contribute. We use a demand-side CE designed for the Ministry of Agriculture in order to inform an ongoing process of National CAP Strategic Plan formation. It provides analysis of public preferences for the CAP pillar II policy characteristics and illustrates how the results could be used to advise on national funding strategy in light of different scenarios of CAP pillar II budget projections. More specifically, we use aggregate welfare estimates to determine different level of funding that the Czech Republic might consider to allocate to AECMs in order to follow the policy scenarios from the choice experiment.

3. Data and methods

3.1 Research design and valuation methods

3.1.1. Survey instrument

In October 2017 a questionnaire survey was developed and distributed to a representative sample of the citizens of the Czech Republic. The survey was implemented through an internet-based platform to a panel of respondents by a professional company Ipsos and yielded a total of 1,000 responses used for the analysis. Respondents were randomly sampled. Table 1 reports the sample and population mean values in regards to gender, age and education. One sample t-test revealed no statistical difference between the sample and the population mean across gender, age and tertiary education variables.

Table 1: Profile of respondents

Variables	Sample mean	Population mean[1]	Sig.(2-tailed)
Female (%)	49.5	51.0	0.343
Age (years)	41.37	41.0	0.387
Education			
No formal education to secondary education	47.9	53.9	0.000
Upper secondary to post- secondary professional education	38.8	32.9	0.000
Tertiary education	13.3	12.5	0.457

[1]: Source: Population census data, 2011 (www.czso.cz)

The questionnaire was divided into three sections. The first part focused on environmental problems related to agricultural sector and how agri-environmental policy aims to address these issues. The second section presented the choice experiment, i.e. the description of the valuation scenario, choice attributes and the choice sets. Section three comprised of the follow-up questions intended to explore peoples' views on the valuation questions and explanation behind willingness-to-pay (WTP) for the changes presented. The socio-demographic data was provided from the panel provider.

All questions were closed-ended questions: multiple-choice formulated with a 5-point-Likert-scale type, dichotomous yes/no and ordered-rank questions. All expressions and text in the questionnaire were written in simple terms, avoiding language jargon so as to ensure respondents' comprehension in order to elicit reliable responses.

3.1.2. Choice experiment

In the CE we focused on the attributes that are incorporated in the AECMs in the Rural Development Program of the Czech Republic (Table 1). Attributes were selected in consultation with the representatives of the Ministry of Agriculture and were based on the targets of AECMs and the environmental public goods they provide. All attributes were specified to have three different levels (low, medium and high). In each choice situation respondents were asked to choose from an alternative that would lead to removal of funding and low environmental outcomes, however at no cost to respondents, and two change alternatives with associated costs. The payment vehicle was specified as an income tax in six different levels. Respondents were asked to choose their preferable option within 8 different choice questions.

Table 2: Attributes of choice set

Attributes	Description	Levels
Plant diversity in meadows	Change in diversity of wet and mesophile, dry and alpine meadows	Low Medium High
Butterfly (Large blue) species	Population of 3 blue species: Maculinea nausithous, M. telejus, and M. arion	Low: 1 species less abundant, Medium: 3 species current abundance High: 3 species more abundant.
Bird species	Number of breeding pairs of corncrake	Low:500 Medium: 1500 High: 3000
Soil erosion	Tolerable soil loss and area of buffer strips (preventing erosion)	Low: Very strong Medium: Strong High: Medium to low
Water quality	Amount of nitrogen and phosphorus entering surface water and groundwater	Low: Bad Medium: Insufficient High: Good
Climate change	Amount of carbon stored on the agricultural land (preventing greenhouse gas emissions)	Low: More carbon emissions Medium: No change High: Less carbon emissions
Food quality	Quality of pesticides-free fruits, vegetable and wine products	Low: Lower quality Medium: No change High: Higher quality
Tax	Taxes	0,500,1000,1500,2500,5000 CZK

The six attributes and their varying levels allowed a large number of alternatives to be constructed. To reduce the number of choice sets, we used a balanced overlap design (derived with a Sawtooth software) and ended up with 100 versions of the choice sets. The balanced overlap procedure is a modified randomized design in which attribute levels are occasionally, but less often than in random design, repeated within the same choice task (Chrzan & Orme, 2000). All options were illustrated with images (Appendix I) and respondents were notified that the cost of options where funding remains is anticipated on an annual basis as household income tax for the next five years. Also, a reminder on the personal budget constraint preceded choice tasks.

The survey design and the selection of CE attributes were decided in line with the remarks and inquiries stated by representatives of the Ministry of Agriculture but due to limited time and budget resources focus group discussions were not employed. To ensure that CE design is comprehensive we tested the questionnaire among number of peers and colleagues and also conducted a pilot survey, using a small sample of respondents before launching the official survey.

3.2 Econometric models

3.2.1. Mixed logit model and model specifications

The random utility theoretical framework (McFadden, 1974) can be used for modeling individual preferences for public goods in a CE. The framework suggests that a respondent n faces a set of mutually exclusive alternatives, $j = 1, 2, \ldots, J$. The level of respondents' utility

U_j that is obtained from each alternative is decomposed into the deterministic part V_j and the unobserved part ε_j $\forall j$ which is considered random. V_j is linear in the k observable attributes x_j (Eq.1):

$U_{nj} = V_{nj} + \varepsilon_{nj} = \sum_k \beta * x_{nkj} + \varepsilon_{nj}$ (1)

Preference heterogeneity can be modelled by employing a mixed logit model (MIXL) (McFadden and Train, 2000; Train, 1998; Hensher & Greene, 2003; Train 2003). The model reveals preference variation both in terms of unconditional taste heterogeneity (random heterogeneity) as well as conditional heterogeneity (systematic heterogeneity) where individual characteristics or other factors of interest are interacted with choice-specific attributes and/or with the alternative specific constant (ASC) (Train, 2003; Hensher et al., 2015).

Accounting for heterogeneity, the utility model includes two additional terms; the term $\delta_n * x_{nkj}$ that aims to capture random taste among individuals and $\mu_m * z_{nm}$that captures the systematic heterogeneity around a term that corresponds to the ASC. The utility function takes the form:

$U_{nj} = a + \sum_k [\beta * x_{nkj} + \delta_n * x_{nkj}] + \sum_m \mu_m * z_{nm} * a + \varepsilon_{nj}$ (2)

where β represents the associate parameters of attributes x_{kj} and μ_m is the coefficient associated with individual specific characteristics z_{nm}. Equation (2) can be rewritten in a comparable to equation (1) form by substituting $b_n = \beta + \delta_n$, implying that the coefficients may now vary randomly across individuals n. Coefficients β vary across respondents and follow a distribution with density $f(\beta)$[1]. The probability of choosing an alternative over the choice set is a weighted average of the logit formula evaluated at different values of β. The weighting is based on the mixing distribution f(β) that can follow any continuous distribution motivated by researcher's assumptions (e.g. positive or negative values only) and model fit. The most commonly applied distributions are the normal, triangular, uniform and lognormal (Hensher et al., 2005). Choice probabilities are the integral of standard logit probabilities over a density of parameters

[1] In the standard logit, $f(\beta) = 1$ and β is fixed.

$$P_{nj} = \int \frac{\exp(x_{nj}\beta')}{\sum_{j=0}^{J}\exp(x_{nj}\beta')} f(\beta)d\beta. \qquad (3)$$

The integral has no analytical solution but can be approximated by simulation. One must make assumptions about how b coefficients are distributed over the population, take a set of R draws and then calculate the logit probability for each draw.

All environmental attributes are coded by applying effects-coding so as to avoid misinterpretation of estimates and correlation problems with ASC (Bech and Gyrd-Hansen, 2005; Hensher et al., 2015). We employed three MIXL models. Firstly, a MIXL with no interactions is applied where ASC and environmental parameters were specified to follow a triangular distribution while tax parameter was modelled as one-sided triangular distribution[2] (constrained triangular) distribution to restrict it to be negative. Then we examined whether socio-demographic and attitudinal variables can explain the difference in preferences by imposing interactions of these variables with the ASC and all parameters were specified to follow a triangular distribution. This specification was explored by employing two separate models one for the socio-demographic factors and the next for the attitudinal factors so as to avoid endogeneity problems. For the role of attitudinal factor we incorporated in our analysis only the attitudes of policy interest which are presented in table 1, Appendix II. All models were estimated using NLOGIT 6 and distribution simulations were based on 1000 Halton draws.

3.2.2. Welfare analysis

The parameters that may be obtained from the abovementioned models can serve as important inputs in welfare estimations, i.e. what monetary value individuals place on certain ecosystem services, or what change occurs in an individuals' welfare given a hypothetical change in the provision of the ecosystem services. Welfare estimations are crucial in policy assessment, as they can justify whether a policy measure or initiative is efficient in economic terms.

For the linear utility index, the marginal WTP estimate or the implicit price for attribute is provided by the ratio of the coefficient for any attribute to the negative of the coefficient for the price attribute with all else remaining constant (Louviere et al., 2000).

To evaluate hypothetical policy scenarios, the welfare change can be estimated by employing the compensating surplus (CS) measure, which refers to the amount of money a decision maker

[2] The one-sided triangular distribution assumes the mean and standard deviation are equal.

is willing to pay so that after the change he/she can be as well off as before the change. CS can be derived from the formula below (e.g. Colombo et al., 2009; Kosenius, 2010):

$$E(WTP) = -\frac{1}{\beta_p}(\sum \beta_i(x_i^1 - x_i^0)) \quad (4)$$

where $\beta_i x_i^0$ and $\beta_i x_i^1$ represent the indirect utility before (initial state) and after (alternative state) the change, respectively.

The CS estimation was adjusted so as to account for the fact that all environmental attributes are coded using effects coding. In this case the reference point is defined as the negative sum of the estimated coefficients. For a change where all attributes are improved from a baseline state, i.e. low preservation level to a high preservation state the CS will be:

$$E(WTP) = -\frac{\sum[b_{H,i} - (-b_{H,i} - b_{M,i})]}{\gamma} \quad (5)$$

Where $b_{H,i}$ correspondents to the estimated parameter of attribute i at high preservation state and $b_{M,i}$ at medium preservation state. The baseline state will be equal to the negative sum of both.

4. Results

4.1 Preferences for the CE attributes

The estimates of MIXL model are reported in Table 3. The negative coefficient of ASC indicates that respondents were willing to shift from "No funding" option to any other option where funding is ensured, all other things being equal. The negative coefficient of tax payment implies that a higher tax will significantly reduce the probability of choosing a management option. The coefficients of all other attributes should be interpreted considering that the effect coding was applied and thus coefficients correspond to the value of marginal utility change for the specified attribute level category relative to the unweighted average of the marginal utility change of all attribute level categories (Daly et al., 2016). For water and food quality attributes the value is substantially higher than for the rest of the attributes.

The 3rd column of table 3 shows the modified coefficients that represent the change in the marginal utility level when attributes move away from the reference level that is the low preservation state under the 'No funding' option. For all attributes respondents showed a preference for a better preservation state since coefficients indicated a positive utility change when funding is not removed. The higher utility change was noticed for water and food quality relative to other attributes. A positive utility change is also noticed when comparing the shift from the medium to high preservation state for all attributes. The proportional difference between these two states is larger for the climate change attribute although the coefficient estimate of the attribute at medium state wasn't found statistically significant.

4.2 Heterogeneity of preferences

The dispersion of the "No funding" ASC parameter represented by the standard deviation was statistically significant and of high magnitude implying that not all individuals within the sample may statistically dislike the "No funding" option. Standard deviation was found statistically significant for almost all attributes, implying the presence of strong heterogeneity in preferences.

The MIXL with interactions (Table 2, Appendix II) provided some insights on the sources of taste heterogeneity. The model where ASC interacts with socio-demographic variables showed that gender and education may explain some heterogeneity around the policy options. The model suggested that female and more educated respondents dislike the option to remove funding relative to the rest of the sample. The last model explored how attitudes may explain heterogeneity in choices. In particular the statements related to the objectives of agri-environmental policy and policy funding can explain much of the dispersion around the mean of the ASC of policy option. Individuals, who found that agri-environmental policy objectives are important, seem to disfavour the funding removal. Protest behaviour against funding may explain the preference of respondents towards removing funding. This implies that people choose the no funding option not necessarily because they are indifferent to the public good being valued but due to their disagreement with the funding *per se*.

Table 3: MIXL model estimates

Attributes	Estimate	Std.deviation†	Coef. estimate with reference to the low preservation level	% change of coef. between medium to high state
ASC: No funding	-2.893***	5.916***		/
Tax	-0.001***	0.001***	/	/
Plant diversity: Medium	0.055*	0.061	0.212	
Plant diversity: High	0.102***	0.252***	0.259	22.393 %
Butterfly species: Medium	0.039	0.278***	0.203	
Butterfly species: High	0.125***	0.203**	0.289	42.262 %
Bird species: Medium	-0.004	0.261***	0.076	
Bird species: High	0.084**	0.203***	0.163	115.375 %
Soil erosion: Medium	0.025	0.020	0.253	
Soil erosion: High	0.204***	0.277***	0.432	70.786 %
Water quality: Medium	-0.061**	0.109	0.406	
Water quality: High	0.528***	0.570***	0.995	144.855 %
Climate change: Medium	-0.038	0.220***	0.084	
Climate change: High	0.161***	0.237***	0.283	237.421 %
Food quality: Medium	-0.087***	0.190*	0.291	
Food quality: High	0.465***	0.449***	0.843	189.989 %
Number of observations		8000		
Log Likelihood		-5677.675		
Pseudo R^2		0.354		
AIC		11417.3		
Number of draws		1000		

*** 1% significance level. ** 5% significance level. * 10% significance level.

† The standard deviation is estimated based on the spread (s) of the distribution estimates. **The standard deviation** equals $\mathbf{s/\sqrt{6}}$.

4.3 WTP estimations

Table 4 reports the implicit prices of the marginal WTP values for each of the policy attributes of MIXL model. The implicit price of the ASC is also provided. On average respondents would require high compensation (negative WTP estimates) if funding would be removed and the environmental state of attributes would possibly deteriorate. Respondents are WTP more if the state of choice attributes improves. The highest mean WTP value were for ensuring a high water (35 EUR/household/ year) and food quality (29 EUR/household/year) as well as avoiding soil erosion problems (15 EUR/household/year). The lowest WTP was noticed for protecting bird species diversity at high preservation state (5 EUR/household/year)[3].Regarding the latter, the CE included three distinct choice attributes for biodiversity in line with the requirements set by the Ministry of Agriculture. Hence WTP for biodiversity is expressed through all three attributes together. i.e. plant butterfly and bird species diversity. It this sense WTP for biodiversity was found also substantial.

Table 4: Implicit prices for MIXL model (in EUR* per household), ranking of attributes and 95% confidence intervals of WTP estimates.

	WTP estimates	**Std. error**	**95% confidence intervals**		**Ranking of attributes at high level of preservation**
ASC: No funding	-100.19***	10.999	-121.7	-78.6	
Plant diversity: Medium	7.34***	1.885	3.6	11.0	
Plant diversity: High	8.98***	2.017	5.0	12.9	6
Butterfly species: Medium	7.03***	1.999	3.1	10.9	
Butterfly species: High	10.00***	1.995	6.1	13.9	4
Bird species: Medium	2.63	2.000	-1.3	6.5	
Bird species: High	5.66***	1.994	1.8	9.6	7
Soil erosion: Medium	8.77***	1.896	5.1	12.5	
Soil erosion: High	14.97***	2.020	11.0	18.9	3
Water quality: Medium	14.07***	2.035	10.1	18.1	
Water quality: High	34.46***	2.609	29.3	39.6	1
Climate change: Medium	2.90	1.957	-0.9	6.7	
Climate change: High	9.80***	1.987	5.9	13.7	5
Food quality: Medium	10.07***	2.016	6.1	14.0	
Food quality: High	29.19***	2.336	24.6	33.8	2

*:WTP are estimated in the mean of parameters using the Wald command. Exchange rate is 1CZK=0.04 EUR

4.4 Welfare change scenarios and policy projections

We estimated the expected welfare changes that would result from three policy scenarios. In the baseline scenario funding would be removed and all attributes would result in low levels. This is a plausible result, given the current trends of continued environmental degradation in agricultural lands in the EU and Czech Republic in particular (Reif and Vermouzek., 2018).

3 This finding is in line with the descriptive analysis of a question preceding the CE about the importance of ensuring a set of features of agri-environmental policy. Respondents had to rank the features and the highest in rank were water and food quality.

Scenario A which would keep the attribute levels at current medium levels requires funding for which welfare change is also estimated. Thirdly, in Scenario B a high level of attributes is assumed that would require even larger funding than scenario A. These scenarios and resulting changes in aggregated welfare – as presented below – represent three potential targets for future policy changes and hence provide useful information for the Czech policy makers in forming future CAP strategic plans.

Equation 5 was used to calculate the corresponding compensating surplus, including the ASC terms. Removal of funding (Baseline) would lead to a welfare loss of approximately 156 EUR/household/year. In aggregated terms the loss would approximately reach 679 mil EUR which is substantial considering also that the current CAP budget for AECM measures is approximately 905 mil. EUR (table 5). Preservation of attributes at the current medium levels (Scenario A) would result in a welfare gain estimated at around 153 EUR/household/year and increasing the attributes to their high levels (Scenario B) at around 213 EUR/household/year. Welfare will increase by 60 EUR/household per year when the preservation status of attributes change from average to high levels. Hence keeping the current levels of attribute or increasing them to their high levels results in welfare benefits that are anticipated within the range of 669 to 932 mil EUR[4].

[4] Welfare estimates were anticipated in yearly terms. An aggregation should be performed possibly for six years in line with the CAP programmatic period, accounting thus for the yearly payments. Future payments are susceptible to discounting and thus a discount rate should be estimated endogenously as former studies (e.g. Lew, 2018) have opposed the use of external rates such as the social discount rates. Tough, such an exploration is out of the scope of the present study. Instead we assumed that respondents confront payments in lump sum terms. This is very likely given that in stated preferences method respondents often apply enormously high discount rates ignoring hence the future payments.

Table 5. Scenarios and respective compensating surpluses (in EUR)

	Mean (95% C.I)	Aggregated* (lower to upper bound)
Baseline Funding status: National funding is removed Preservation of attributes: At low level	-155.5 (-177.8 to -133.1)	-679 777 531.5 (-777 525 457.9 to -582 031 354)
Scenario A Funding status: National funding remains Preservation of attributes: Change from low to average level	153.0 (129.9 to 176.1)	668 922 091.9 (568 101 343.2 to 769 742 840.5)
Scenario B Funding status: National funding remains Preservation of attributes: Change from low to high level	213.2 (188.2 to 238.3)	932 373 311.83 (822 717 106.3 to 1 042 029 517.4)

*: Aggregated for 4,372,257 households (www.czso.cz)

5. Budget projections

5.1 EU funding context and forthcoming changes for Czech Republic

One change associated with the new reform is the decrease of EU funding for Pillar II and also the proposed rebalance between EU and national financing that would imply an increase of national co-financing rates. At the same time, MS will be given the option to transfer up to 15% of funding from one Pillar to the other and an extra 15% from Pillar I to Pillar II specifically allocated to AECMs. Overall MS will have to dedicate at minimum 30%[5] of Pillar II budget to support AECMs that will remain at the voluntary basis for farmers and at minimum a 40% of the total budget to contribute to climate actions in line with Paris Agreement and the United Nations Sustainable Development Goals global agreements (EU, 2018).

The EU budget for Rural Development Plan (Pillar II) allocated to Czech Republic is projected to decrease by 16% from 2.2 to nearly 1.8 billion EUR (EC, 2018). Table 6 presents the estimated budget change and the allocation of budget to AECMs. The total budget though will depend upon transfers from Pillar I and national co-funding. Allowing for a minimum 1% (which was followed during current CAP) to a maximum 15%[6] transfer and in case national co-funding remains at same levels, the total budget will be between 2.6 to 3.5 billion. If national co-funding is removed then the budget for Pillar II will drop by 39% which might in effect

[5] Though, the expenditures on areas of natural constraints and areas with other specific constraints are excluded of this 30% requirement which is a new development. Also EU funding for rural development contributes up to 80% to AECMs which is by 5 % more than the current share.

[6] As stated above the new proposal allows for an additional 15% transfer fare so as to support AECMs in particular but we won't examine this option in the present study.

diminish significantly the budget available for AECMs and the ability of the policy to meet the associated CAP objectives (Navarro and López-Bao, 2018).

Table 6: Funding of Pillar II (in current prices. mil EUR)

	EU for pillar II	Transferred budget from Pilar I	National co-funding	Total funding for Pillar II	Agri-Environment climate (≈30% of budget)
2014-2020	2 165	135	769	3 069	905
2021-2027	1 811.47	TBE	TBE	TBE	TBE
Projections					
1% transfer and current level of national funding	1 811.47	58.71	769	2 639.18	791.75
15% transfer and current level of national funding	1 811.47	880.785	769	3 461.255	1 038.376
1% transfer and removal of national funding	1 811.47	58.71	0	1 870.18	561.054
15% transfer and removal of national funding	1 811.47	880.785	0	2 692.255	807.677

TBE: to be estimated

Source: https://ec.europa.eu/agriculture/rural-development-2014-2020/country-files_en. http://europa.eu/rapid/press-release_MEMO-18-3974_en.htm and own elaboration.

5.2 AECM budget change projections accounting for national funding options and in light of welfare estimates

Considering the CAP reform, MS may decide to modify their contribution and hence budget projections may be investigated under such possibility. Figure 1 shows the % change of budget for AECMs in light of changes in national funding and under different transfer shares from Pillar I. In case national funding remains at the same levels as in 2014-2020 program period the budget change becomes positive only if transfer share is somewhat over 7%. If national funding is removed no matter the transfer the budget will decrease by as much as 40%.

Czech Republic can decide to change national co-funding given also different transfer shares from Pillar I. We use the welfare estimates that focused on AECMs policy from the previous section (Table 5) to consider different transfers levels. We assume that the funding would be used in such a way that it generates welfare benefits up to the level where the estimates aggregated over population are equal to costs of their implementation in terms of possible transfer. In other words, we assume that the funding would be used well. Under this assumption, national co funding could change in light of the welfare estimates for the preservation scenarios, scenario A and B. Budget estimates are depicted in table 3 in Appendix and figure 1 illustrates the budget change in case national co funding reflects the welfare change of the two preservation scenarios (i.e. that national co-funding is determined by the aggregated welfare estimates for each scenarios). For a national funding that would be at the same level as the welfare estimates of scenario A, the 'stay even' point (i.e. no change between program periods on funding of AECMs) is at a transfer share of almost 9%. In case for a more ambitious preservation scenario, Scenario B, national co funding should increase substantially and hence transfer share should be at least 5% for a positive budget change. The lower level of transfer of scenario B reflect higher co-funding which is assumed to be equal to welfare estimates which is higher for this scenario.

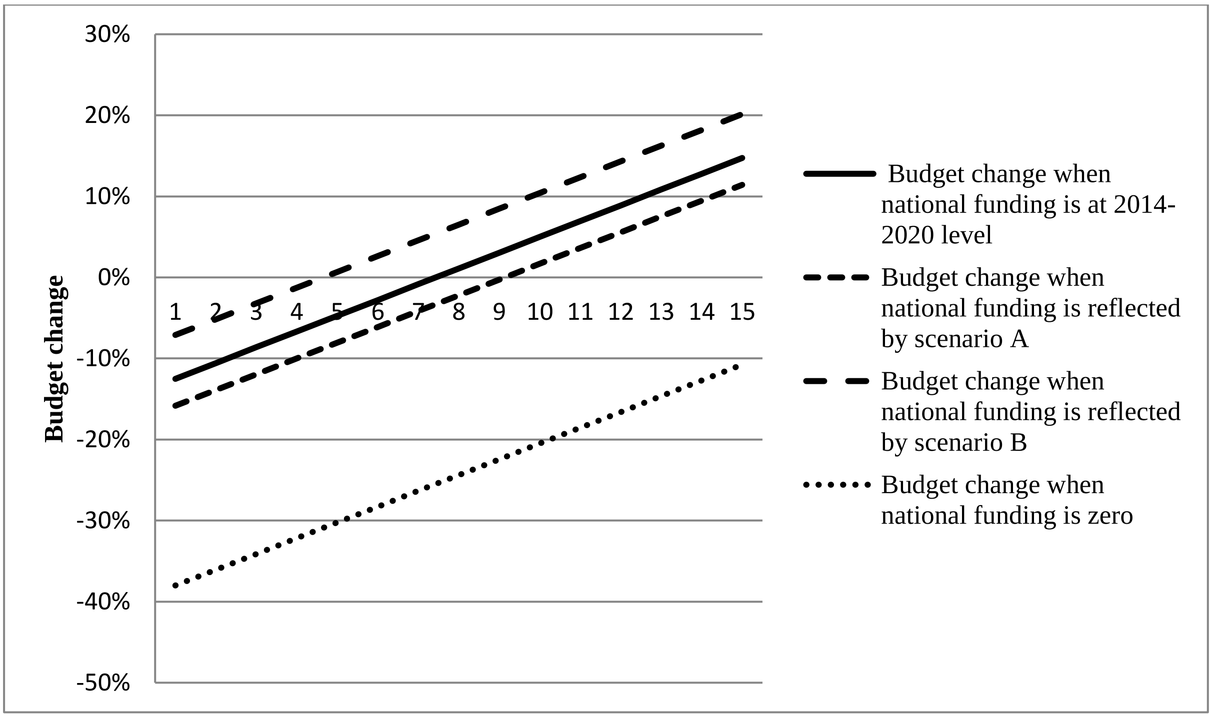

Fig 1: Budget change projections for different national funding levels and transfer shares

6. Discussion of findings and policy implications

According to newly published EU proposal regarding the CAP reform, New CAP architecture will help EU meet its international agreements related to climate change mitigation and adaptation (COP 21 Paris Agreement) and sustainable development goals (UN's SDGs). The new architecture of CAP should embrace 'a higher level of environmental and climate ambition addressing citizens concern about sustainable agricultural development' (EC, 2018: Article

92). MS will have to decide their specific objectives and targets and describe them in a strategic plan in line with a general and broad EU framework (Hart et al., 2018). This plan should contain certain sections the first of which refers to the assessment of needs (EC, 2018: Article 95). For MS to confront the next CAP reform public consultation and public engagement seems more than imperative as it is a way to justify allocation of public funds and legitimize decision making in the context of environmental and climatic concerns.

In view of the above the Ministry of Agriculture in Czech Republic contracted a national survey to explore preferences for a range of potential CAP scenarios with associated targets and financing levels.

First, our results suggest that large majority of respondents do not support removal of funding and that such move would result in great welfare loss to our sample respondents. Further, the results from the presented survey revealed that the water and food quality were, on average, the most appreciated attributes of the agro-environmental policy by our sample, followed by soil quality, butterfly species diversity, climate change, plant diversity and bird species diversity attributes. This is in line with former studies that highlighted that public assigned higher preference for public goods that can be of direct use such as water and food quality (Moran et al., 2007; Novikova et al., 2017).

The welfare estimates showed that respondents would be WTP for water and food quality in high standards much higher than any for any other agri-environmental attribute. The prominence of the water attribute is likely to be related to the recent droughts in Czech Republic (Trnka et al., 2016) and associated media coverage. Moreover, the high WTP for food quality may have been driven by the current situation in food retail sector where food companies were found to sell food products inferior in quality in central European compared to other MS (http://europa.eu/rapid/press-release_IP-19-3332_en.htm). This situation has raised great public frustration that may have been reflected in choice preferences.

The low ranking in preferences for biodiversity contradicts the country's priorities of current Rural Development Program where contracts are largely focusing on biodiversity protection and less on water management. Such finding possibly reflects people's lack of knowledge about biodiversity and its broader importance, but might also signify the gap in public understanding of the negative consequences that farming practices has on biodiversity in general and on major indicators species, such as birds, in particular (Green et al., 2005; Pe'er et al., 2014; Reif and Vermouzek, 2018). These results may be country and/or context specific as some former studies revealed high relative welfare estimates for biodiversity and habitats (e.g. Christie and Rayment, 2012; Badura et al. 2019), but not all (e.g. Liekens et al. 2013). Further, biodiversity in CE was expressed through three district attributes and thus in additive terms WTP for plant, butterfly and bird species diversity may be comparable to the WTP for water and food quality. While protection of biodiversity constitutes an important goal *per se*, it is increasingly understood that its protection is also important due to its complex role in underpinning ecosystem functioning, their resilience and provision of ecosystem services (e.g. Balvanera et al., 2006; Mace et al., 2012; Naeem et al., 2012; Isbell et al. 2015; Wang et al., 2019).

Further analysis revealed significant heterogeneity in preferences that could be partially explained by a number of socio-economic variables including gender and education as well as attitudinal factors related to agri-environmental policy and funding. Interestingly, some respondents' preference for removing funding structure is to a great extent explained by protesting behaviour (i.e. disagreement with the policy *per se*) rather than actual effect on their utility level.

The welfare analysis revealed a positive welfare change for moving from a low to a medium (scenario A) or to a high preservation state (scenario B). This change may be regarded as a signal of social consent for keeping the environmental quality (and related public goods) at the current or higher levels of preservation. However, keeping the state of the environment (or improving) it requires clearly an increase in funding for the Pillar II measures in face of continued environmental degradation of agricultural lands in the EU generally and in Czech Republic in particular (Reif and Vermouzek, 2018). Alternatively, another way to avoid the loss of biodiversity while keeping budget at current levels would require reforming AECMs interventions possibly towards tailored more efficient measures (measures that would target areas with the highest benefits for the given costs).

Regarding the future budget projections for AECMs, if Czech Republic decides to remove national funding then no matter the transfer decided the final budget funding available for Pillar II will decrease by as much as 40%. In case the state decides to stay at current level of funding (769 mil EUR) then the transfer should be around 7% in order to stay even. The state may also change national funding in line with the welfare benefits attached to the preservation scenarios 'A' and 'B'. In this case transfer shares can be adjusted depending on the level of national funding. Hence if the state anticipates a national funding that is aligned with scenario 'A' then a transfer of 9% ensures a zero budget change for AECMs while for scenario B the share decreases to 5%. Low transfer shares imply an increase in national funding and vice versa. All these projections should be considered in relation to the enhanced subsidiarity that is expected by MS in the forthcoming CAP and the fact that Pillar II may indeed demand greater than current level of national funding. Also, final decisions regarding national funding will be made considering also the contribution of eco-schemes of Pillar I which (as AECMs) aim to address environmental-and-climate related objectives.

Our CE study has limitations related to lack of comprehensive pre-testing and focus groups due to time and budget limitations allowed for the study. This was not ideal which could question the content validity of our study, and thus our concluding notes should be interpreted in this context. We call for future studies that could provide more evidence in this area of research.

7. Conclusions

In this paper we present findings supporting the preparation process for compiling Czech Republic's CAP strategic plan. This is the first study in Czech Republic that investigates public preferences on the post 2020 CAP structure of agri-environmental climatic measures on a national level.

We found that citizens are generally supporting the agri-environmental policy and are willing to pay for the provision of public goods, including biodiversity, and ecosystem services. Policy scenario of keeping or increasing the funding for public goods and ecosystem services would imply an aggregated welfare gain of 669 to 932 mil EUR as opposed to funding removal and expected environmental degradation. The highest mean WTP values were for ensuring a high water and food quality.

The significant change that the new CAP reform aims to bring compared to past CAP forms and reforms, is the greater overall contribution of MS for achieving the environmental-and-climatic related objectives (EC, 2018: Article 92). This greater contribution bears both a greater financing burden as well as a greater burden for effort and efficiency. MS should be accountable as to how they will deliver their targets and to align such efforts with the preferences of their citizens. To this end MS should seek for knowledge-based decisions to which our study aimed to have contributed.

Considering the CAP policy more broadly, and given the decreasing financial resources for agri-environmental policies in the EU, we believe that our results provide some support for public funding for public goods approach advocated by, e.g., Bateman and Balmford (2018) in the UK. Present system makes public pay twice for food; once via taxes and secondly via food market (*ibid*). While greatly increasing the level of food production, the same system has also historically led to an ever increasing degradation of the European natural environment including soil and water quality and as of yet has not delivered on the goal of halting the loss of biodiversity. As our – and other studies' (e.g. Moran et al., 2007; Arriaza et al., 2008; Badura et al., 2019) – results suggest, the European public supports policies that focuses on delivery of multiple public goods that agricultural lands can provide, such as landscape amenity, biodiversity protection, water and soil quality retention, and carbon sequestration. However, the majority of current CAP funding is made for mere land ownership rather than for delivery of such public goods. Reorienting the CAP payments towards actual delivery of such goods would likely to lead to better investments in the European agricultural landscapes that support both its citizens as well as healthy environment.

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Appendix I

Survey questionnaire

Agri-environmental policy as applied by Czech Republic supports payments to farmers so as to change their farming practice towards certain environmental goals. High diversity of meadows, species of birds and butterflies, aversion of soil erosion and decrease of pesticide use are some examples of the environmental goals that agri-environmental policy sets.

These payments are designed to encourage farmers to protect and enhance the environment on agricultural land. These are voluntary measures and farmers are compensated based on standard costs and assumptions for income foregone resulting from implemented measures.

In the following survey, you can select from the available alternative options (scenarios) of environmental management, presented with expected costs.

Option A: Removing payments for farmers, as they are not supported by state in protecting the environment.

Option B: Keeping payments, keeping the current state of protecting the environment on agricultural land.

Option C: Keeping payments, increasing the current state of protecting the environment on agricultural land.

.

Every policy option incurs yearly cost to your household from your taxes, for the next five years. If you do not prefer any of the scenarios available, you can choose the base option to remove current funding, when there is no agri-environmental measure implemented and you can spend your income for something else.

Please during your choices pay attention to give a realistic response that can be in line with your personal income and your yearly expenses for other goods and services.

C1_1-8. Imagine, that you would make yearly contributions to environmental management on agricultural land. You will be consecutively shown 8 different combinations of environmental management parameters explaining the level of environmental protection carried out with your contribution. From the 3 options available, select always the one, which you would really prefer.

Basis choice set:

Options	**Option A**	**Option B**	**Option C**
Attributes			
Plant diversity in meadows	Low diversity of plants	Medium diversity of plants	High diversity of plants
Butterfly (Large blue) species	1 species of butterfly. less abundant	3 species of butterflies. current level of abundance	3 species of butterflies. more abundant
Bird species	Threefold decrease in the number of pairs of corncrake (500 pairs)	No change in the number of pairs of corncrake (1500 pairs)	Twofold increase in the number of pairs of corncrake (3000 pairs)
Soil erosion	Very strong erosion and no buffer strips	Strong erosion and some buffer strips	Medium to low erosion and more buffer strips
Water quality	Bad water quality also for swimming and drinking uses	Current (insufficient) water quality. also for swimming and drinking uses	Good water quality. also for swimming and drinking uses
Climate change	More carbon emissions: Agriculture contributes to climate change because land is a source of carbon	No change in carbon emissions: Agriculture contributes to climate change at current rate	Less carbon emissions: Agriculture mitigates climate change because carbon is stored on the land
Food quality	Deterioration in the quality of fruits. vegetables and wine	No change in the quality of fruits. vegetables and wine	Improvement in the quality of fruits. vegetables and wine
Tax expenses (CZK/household/year)	0	500	5000
My choice is:	☐	☐	☐

Appendix II

Table 1: Share (%) of respondents that show a certain level of agreement in attitudinal statements

	Level of agreement (%)				
	1	2	3	4	5
ATT1: Familiarity with agricultural policy (1:not familiar. 5: very familiar at all)					
How familiar do you think you are with the agricultural policy towards environmental protection. also referred as agri-environmental policy?	11.7	23.9	38.7	13.3	3.1
ATT2: Importance of agri-environmental policy objectives (1: completely irrelevant. 5: very important):	0.43	2.91	13.79	44.18	38.69
Preservation of biodiversity and species related to agriculture soil	0.74	2.02	12.21	40.98	44.06
Prevention of soil erosion and better soil management	0.63	1.89	7.76	26.02	63.69
Water quality through the reduction of fertilizer and pesticide use	1.00	3.20	10.20	34.20	51.30
Landscape protection including preservation of traditional rural landscapes	2.02	4.04	15.30	41.34	37.30
Mitigation of climate change by agricultural sector	0.96	4.39	16.06	43.79	34.80
Adaptation of agricultural production to climate change	0.43	2.91	13.79	44.18	38.69
Mean of ATT2*	0.3	1.0	10.3	44.0	44.4
ATT3: Protesting towards funding of agri-environment climatic measures (1: Fully disagree. 5: Fully agree)					
Funding should be allocated to other purposes than agri-environmental policy	12.3	23.1	38.9	16.8	8.9
Farmers shouldn't be compensated for protecting their agricultural land	11.1	22.5	31.0	21.4	14.0
Farmers shouldn't be compensated for protecting biodiversity and the environment	13.8	26.4	29.8	17.7	12.3
Mean of ATT3*	8.4	25.1	40.1	19.1	7.4

*Cronbach's Alpha for ATT2 and ATT3: 0.883. 0.781 respectively.

Table 2: Estimates of mixed logit with interactions model

	Mixed logit: interactions with socio-demographic variables		Mixed logit: interactions with attitudes	
Attributes	**Coef. Estimate**	**Std.deviation**	**Coef. Estimate**	**Std.deviation**
ASC: No funding	-1.853*	5.676***	-0.705	4.934***
Tax	-0.001***	0.002***	-0.001***	0.002***
Plant diversity: Medium	0.075**	0.083	0.074**	0.127
Plant diversity: High	0.092***	0.121	0.092**	0.174*
Butterfly species: Medium	0.047	0.287***	0.065*	0.275***
Butterfly species: High	0.093***	0.178*	0.088**	0.150
Bird species: Medium	0.000	0.269***	0.006	0.206**
Bird species: High	0.083**	0.124	0.103***	0.083
Soil erosion: Medium	0.026	0.026	0.036	0.050
Soil erosion: High	0.205***	0.302***	0.168***	0.254***
Water quality: Medium	-0.058*	0.142	-0.047	0.080
Water quality: High	0.546***	0.606***	0.536***	0.614***
Climate change: Medium	-0.044	0.237***	-0.050	0.191*
Climate change: High	0.153***	0.086	0.150***	0.198**
Food quality: Medium	-0.078**	0.210**	-0.063*	0.148
Food quality: High	0.474***	0.471***	0.438***	0.399***
Interactions				
ASC: No funding X Female	-1.174***			
ASC:No funding X Age	0.026			
ASC:No funding X Education level	-1.070**			
ASC:No funding X Work in agric.sec	-0.264			
ASC:No funding X Income class	-0.062			
ASC:No funding X ATT1			0.150	
ASC:No funding X ATT2			-2.184***	
ASC:No funding X ATT3			2.110***	
Number of observations	8000		8000	
Log Likelihood	-5508.278		-4498.651	
Pseudo R^2	0.373		0.370	
AIC	11090.6		9067.3	
Number of draws	1000		1000	

Table 3: National funding projections for different welfare scenarios and transfer shares

Transfer %	**A:Budget for Pillar II**	**B:Transfer from Pillar I**	**C:National co funding**				**Total funding (A+B+C)**				**Budget for AECM (=30%*Total funding)**				**Budget change**			
			C1: Based on 2014-2020 levels	**C2: Based on welfare benefis_Scenario A**	**C3: Based on welfare benefis_Scenario B**	**C4: National funding is zero**	**T1= A+B+C1**	**T2= A+B+C2**	**T3= A+B+C3**	**T4= A+B+C4**	**B1=30%*T1**	**B2=30%*T2**	**B3=30%*T3**	**B4=30%*T4**	**Budget change when national funding is at 2014-2020 level (current level)**	**Budget change when national funding is reflected by scenario A**	**Budget change when national funding is reflected by scenario B**	**Budget change when national funding is zero**
1	1811.47	58.719	769	668.92	932.37	0	2639.19	2539.11	2802.56	1870.19	791.76	761.73	840.77	561.06	-13 %	-16 %	-7 %	-38 %
2	1811.47	117.438	769	668.92	932.37	0	2697.91	2597.83	2861.28	1928.91	809.37	779.35	858.38	578.67	-11 %	-14 %	-5 %	-36 %
3	1811.47	176.157	769	668.92	932.37	0	2756.63	2656.55	2920.00	1987.63	826.99	796.96	876.00	596.29	-9 %	-12 %	-3 %	-34 %
4	1811.47	234.876	769	668.92	932.37	0	2815.35	2715.27	2978.72	2046.35	844.60	814.58	893.61	613.90	-7 %	-10 %	-1 %	-32 %
5	**1811.47**	**293.595**	**769**	**668.92**	**932.37**	**0**	**2874.07**	**2773.99**	**3037.44**	**2105.07**	**862.22**	**832.20**	**911.23**	**631.52**	**-5 %**	**-8 %**	**1 %**	**-30 %**
6	1811.47	352.314	769	668.92	932.37	0	2932.78	2832.70	3096.15	2163.78	879.84	849.81	928.85	649.14	-3 %	-6 %	3 %	-28 %
7	**1811.47**	**411.033**	769	668.92	932.37	0	2991.50	2891.42	3154.87	2222.50	897.45	867.43	946.46	666.75	-1 %	-4 %	5 %	-26 %

8	1811.47	469.752	769	668.92	932.37	0	3050.22	2950.14	3213.59	2281.22	915.07	885.04	964.08	684.37	1 %	-2 %	7 %	-24 %
9	**1811.47**	**528.471**	**769**	**668.92**	**932.37**	**0**	**3108.94**	**3008.86**	**3272.31**	**2339.94**	**932.68**	**902.66**	**981.69**	**701.98**	**3 %**	**0 %**	**8 %**	**-22 %**
10	1811.47	587.19	769	668.92	932.37	0	3167.66	3067.58	3331.03	2398.66	950.30	920.27	999.31	719.60	5 %	2 %	10 %	-20 %
11	1811.47	645.909	769	668.92	932.37	0	3226.38	3126.30	3389.75	2457.38	967.91	937.89	1016.92	737.21	7 %	4 %	12 %	-19 %
12	1811.47	704.628	769	668.92	932.37	0	3285.10	3185.02	3448.47	2516.10	985.53	955.51	1034.54	754.83	9 %	6 %	14 %	-17 %
13	1811.47	763.347	769	668.92	932.37	0	3343.82	3243.74	3507.19	2574.82	1003.15	973.12	1052.16	772.45	11 %	8 %	16 %	-15 %
14	1811.47	822.066	769	668.92	932.37	0	3402.54	3302.46	3565.91	2633.54	1020.76	990.74	1069.77	790.06	13 %	9 %	18 %	-13 %
15	1811.47	880.785	769	668.92	932.37	0	3461.26	3361.18	3624.63	2692.26	1038.38	1008.35	1087.39	807.68	15 %	11 %	20 %	-11 %