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Valuation of environmental and social functions of the multifunctional Cypriot agriculture

Athanasios Ragkos[a,*], Alexandros Theodoridis[b]

[a] Department of Agricultural Technology, Alexander Technological Educational Institute of Thessaloniki, 57400 Sindos, Thessaloniki, Greece
[b] Lab. of Animal Production Economics, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, P.O. Box 410, 54124 Thessaloniki, Greece

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ABSTRACT

The multifunctional farming sector in Cyprus poses threats on the island's water resources, but highly contributes to the protection of the cultural identity and to the provision of incomes and employment in its rural areas. These services are externalities, as farmers are not remunerated in markets for the environmental and cultural services they provide, nor for the fact that they maintain vivid rural areas. This paper presents an application of the Choice Experiment method, in order to evaluate these non-traded outputs of Cypriot agriculture. The results of the empirical analysis demonstrate that the Cypriot public is in favor of a less intensive pattern of agriculture. Furthermore, Cypriots are willing to pay in order to mitigate adverse environmental effects of agriculture, to improve cultural heritage and to safeguard the continuation of farming trade on the island. The estimated benefits often exceed income losses from changes in the cropping pattern towards extensification, which verifies that EU rural development policies are regarded as beneficial by the public.

1. Introduction

The agricultural sector is multifunctional, which is manifested through complex interactions with the environment and the provision of rural amenities. Agriculture's multifunctionality has been a central issue during trade liberalization negotiations within the World Trade Organization (WTO) and is steadily gaining attention in the agricultural policy reform agenda. Proponents of multifunctionality claim that the maintenance of rural landscapes, the viability of rural areas and food security are some of the non-traded outputs of agriculture, which are endowed with public good characteristics or are externalities (OECD, 2001). As such, these non-traded outputs provide additional arguments in favor of policy interventions and protectionism in the farming sector.

The debate over agriculture's multifunctionality mainly involves societal perceptions of goods and services that stem from agricultural activity. Farmers continue to maintain landscapes and vivid rural economies, but they are not rewarded by markets. A positive approach of multifunctionality recognizes multiple functions of agriculture, but favors policy measures to arrange their provision only as long as they are perceived and valued by society (Vermersch, 2001; Allaire and Dupeuble, 2002; OECD, 2003); if society is not affected by the non-traded outputs of agriculture, there is no room for public intervention. Therefore, central to the integration of multifunctionality in the agricultural policy reform agenda is to provide estimates of the values of non-traded outputs that society attributes to them, which sum up to the Total Economic Value (TEV) of agriculture (Hediger and Lehmann, 2003).

The multifunctional character of agriculture is also an emerging issue in academic circles. Many authors have examined the implications of joint production of traded and non-traded outputs (Paarlberg et al., 2002; Havlík et al., 2005) and the effects of price policies on the production of non-traded outputs (Randall, 2002; Peterson et al., 2002; Romstad, 2004a, 2004b). The effects of the spatial distribution of agricultural and environmental resources on production and development patterns and, consequently, on the manifestation of agriculture's multifunctionality have also been examined (Baumgartner, 2000; Freshwater, 2005; Polyzos and Arabatzis, 2008). The role of preferences and the valuation possibilities of agricultural externalities have also been of interest (Randall, 2002; Boody et al., 2005). More recently, Howley et al. (2014) found that the aspirations of farmers and of the general public do not differ substantially when it comes to the environment. This broader consensus between the "producers" and the "consumers" of environmental public goods from agriculture, however, needs to be

* Corresponding author.
E-mail addresses: ragkosagrecon@gmail.com (A. Ragkos), alextheod@vet.auth.gr (A. Theodoridis).

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closely examined, as it may conceal conflicts regarding particular issues *e.g.* the wild flora and fauna. Hence, the authors highlight the necessity of a segmented approach of farmers and the public in order to detect individual-specific characteristics shaping preferences for multifunctionality. Kvakkestad et al. (2015) undertook a sub-sample Q survey and a linked Likert scale survey to examine whether Norwegian farmers were aware of their numerous roles. It was verified that the farmers recognize their cultural role and their essential contribution to the provision of landscapes, nonetheless they prefer payments linked to agricultural activity rather than mere payments for public goods. Stated preference techniques, such as Contingent Valuation (CV) and Choice Experiments (CE), have been employed in order to attach monetary values to non-traded outputs of agriculture (Yrjola and Kola, 2004; Kallas et al., 2007). Villanueva et al. (2015) applied a CE in order to estimate the heterogeneity of farmers' preferences towards participation in an agri-environmental scheme for olive groves in Spain, providing high-quality information for the implementation of the new Rural Development Program (RDP) 2014–2020 in the country.

The purpose of this paper is to provide estimates of the value that society places on features of multifunctional agriculture. The CE method is employed in order to examine the factors that affect individual preferences regarding functions of agriculture and to estimate monetary values for these functions. The experimental design considers four attributes. The first two attributes concern the adverse environmental effects of agriculture, namely pollution of water resources by pesticide and fertilizer use and pressures on water reserves from irrigation. The third attribute is related to the protection of cultural heritage and rural landscapes, which shape the identity of rural regions of the island. The fourth attribute evaluated within this survey is the maintenance of the farming trade, which is multifunctional and, because of that, it is expected that the public is positively predisposed towards farmers. The CE data are analyzed by estimating Conditional Logit (CL) and Random Parameters Logit (RPL) models. The estimated coefficients reveal public preferences about multifunctional agriculture and focus on the effects of particular individual characteristics and attitudes on the acceptance of changes in the level of provision of agriculture's externalities. Furthermore, these coefficients are used in the estimation of the Marginal Willingness to Pay (MWTP) for the valued functions of agriculture. As a final step, income losses from potential changes in the cropping pattern of the Cypriot agriculture are compared to benefits from the provision of non-traded outputs. The analysis provides information of crucial importance for the implementation of the new Common Agricultural Policy (CAP) and RDP of Cyprus, implementing Reg. EC/1305/2013, as it links societal preferences directly with land uses and depicts the directions towards which the cropping pattern in Cyprus should shift under the new policy in force.

2. Agriculture's multifunctionality in the policy agenda

Multifunctionality reflects the fact that the agricultural sector produces food and fiber jointly with non-traded outputs. The former, referred to as "non-trade concerns" in the WTO agenda, are often externalities or are endowed with public good characteristics. Despite controversial, the concept of agriculture's multifunctionality has been central among countries' claims of widening the "green box" measures in order to protect unique farming systems that produce some of these externalities. It is worth noticing that the negative externalities of agriculture, such as pressures on water resources and air quality, have been recognized in literature (see Pretty et al., 2000), but the concept of multifunctionality in agricultural policy has focused on positive externalities (employment, income, cultural heritage, rural development).

The European Union (EU) farming sector has been long recognized as multifunctional, which is manifested through the small family farms that prevail in the continent (de Vries, 2000). This "European Model of Agriculture" plays a significant role in maintaining vivid rural areas and protecting the environment and cultural heritage (Casini et al., 2004). EU favors protectionism in the farming sector, because market competition could abolish this model of agriculture and cease the provision of relevant goods and services. In this context, the CAP provides economic incentives through its second pillar, many of which have affected land uses (Arabatzis and Polyzos, 2007), and, consequently, non-traded farm outputs, but have not achieved environmental and rural development goals. The new Regulations EC/1305/2013 and EC/1307/2013 verify that the EU is committed to safeguard its multifunctional agriculture, as new dimensions are added in rural development policies, strengthening the social role and the environmental sustainability of the European farming sector. In particular, the CAP actually in force envisages the socioeconomic development of mountainous, less-favored (LFA) and remote areas and the promotion of their cultural identity.

The relationships between agriculture and the environment are predominantly complex. The extent to which farming affects the environment, either positively or negatively, depends on input use and on the cropping pattern. Conventional EU farming systems produce negative environmental externalities which affect soil, air quality and surface and ground water resources. The main pressures of agriculture on water resources and aquatic ecosystems are due to poor management of irrigation and non-point sources of pollution, mainly agrochemical residuals (Pretty et al., 2000). Agro-environmental measures have emerged in order to minimize adverse environmental effects of agriculture (Dobbs and Pretty, 2004). The recent CAP reform (Reg. EC/1305/2013) still proposes payments to farmers who adopt integrated or organic farming (see for instance Pauloudi et al., 2009) and motives to expand fallow lands and forests, much like the previous periods. The latter were examined within the framework of past RDPs in Greece by Arabatzis et al. (2006) and Arabatzis (2008), who found that agroforestry measures were adopted by a rather heterogeneous cohort of farmers, whose decision, nonetheless, was influenced *inter alia* by prior participation in other relevant schemes, land ownership and gender. Payments for ecosystem services also constitute tools regulating the provision of environmental services (Villanueva et al., 2015) with benefits for rural and rural-urban societies alike. Such payments are viewed within a generalized framework of designated land use policies at the regional level (Caro-Borrero et al., 2015); at the country level, Lizin et al. (2015) estimated significant perceived costs for farmers if land use restrictions were to be implemented in agriculture in Belgium, including crop restrictions and less use of pesticides.

Another category of agriculture's externalities is the formulation of agricultural landscapes (Lindland, 1998; Peterson et al., 2002; Casini et al., 2004). These include natural and man-made elements which reflect structural changes in the farming sector as well as social, cultural and political changes that occurred during centuries. Rural landscapes characterize and differentiate the countryside and constitute important resources for the development of these areas. Arabatzis et al. (2010) demonstrated that relevant strategies were proven efficient in a study of the implementation of Leader+ in Greece, which was more successful when undertaken by agents aiming at the amelioration of the natural and man-made landscapes.

Agriculture's role in rural development is undeniably significant. Functions such as aversion of depopulation, protection of cultural heritage and maintenance of the farming trade are some of its non-traded outputs that affect rural amenities. Farm policies are considered necessary in regulating their provision, but it is ambiguous that market interventions are the ideal measures to induce rural development. Most countries agree that the diversification of rural economies is a prerequisite for lively rural areas (Potter, 2004); it is argued, however, that in regions where the rural economy is poorly diversified, such as in EU's LFAs, the role of agriculture is predominant in the local economy and in employment. EU rural development legislation incorporates such issues and acknowledges that basic infrastructure, rather than a heavily subsidized primary sector, is necessary to retain acceptable population levels.

Cultural heritage and the mere identity of rural regions have been shaped throughout the years by agricultural activities. The countryside is endowed with a wide range of cultural features, such as traditions, music, dances and architecture. These elements vary among regions and constitute resources that support rural development, based on existing advantages (Lowe et al., 2002; Jervell and Jolly, 2003). The public perceives farmers as the keepers of this "agricultural cultural heritage" (Abler, 2003), thus recognizing concrete links between farming and culture. Nevertheless, markets often fail to remunerate farmers for these services.

Farming has traditionally been viewed by society as a particular trade, since life in the countryside and constant interactions with nature are unique to the profession. The multifunctional character of agriculture impels farmers to redefine their scopes and to integrate them in a modern framework which embraces economic, environmental and social aspirations (Deverre, 2002). In this context, Cayre et al. (2004) recognize social and ethical motivations in engaging with farming, which are reflected in the maintenance of small family farms with poor economic performance, as well as in pluriactive farmers, who take over other activities in order to "subsidize" the continuation of farming (Streeter, 1988; Sumner, 1991). According to Harvey (2003) the positive way in which society regards farming stems from the development process during the industrial revolution, of which farmers were the "losers", who did not have the opportunity to move from the countryside and to seek new forms of employment and a modern way of life in urban areas. Urban dwellers, the "winners" of this process, have retained a romantic view for farmers up to now. Within this context, the CAP recognized farmers as a disadvantaged trade even from its origins (Potter and Burney, 2002).

3. Material and methods

3.1. The farming sector in Cyprus

The Cypriot farming sector in 2013 stood for 2.1% of the Gross Domestic Product (3.1% in 2008), for 4.9% of employment (6.7% in 2008) and for 15.2% of exports. The contribution of agriculture in the Cypriot economy over time has been reduced, while the tertiary sector is booming, mainly due to the development of tourism-related services. However, its role is vital in parts of the Mountainous and Semi-mountainous areas (explained below), where tourism and manufacturing activities are limited.

In 2013 there were 35,385 farms in the country, of which the vast majority (88.7%) were exclusively engaged in crop production and less than 1% reared livestock exclusively. Crop production (65% Of the total arable land) and arboriculture (27,5% of the total arable land) constitute the main agricultural land uses, followed by intensive vegetable production (www.mof.gov.cy). The main exported crops are typically Mediterranean (potatoes, citrus trees, olive groves, vineyards, vegetables), while animal production is of less importance. Using agronomic criteria, four agricultural production zones can be defined for Cyprus. The Mountainous zone, characterized by cold winters and warm summers, is covered by orchards (fresh fruit production) and vineyards, which are important sources of income, and by cereal in the non-irrigated part. The Semi-mountainous area is typically the center of wine production, as exceptional varieties of wine grapes are cultivated in sloping arid land. The Non-irrigated lowland area in the center of the island is suitable for cereal and fodder crops, whose economic importance is, nonetheless, limited (Markou and Papadavid, 2007). Finally, the coastal zone is the most typical Mediterranean one, being ideal for the intensive production of vegetables and citrus fruit and achieving the highest added value among all four production zones.

The most severe environmental problem in Cyprus is water management, as low annual rainfalls threaten surface and ground water reserves on the island. Given that the farming sector accounts for 70% of the total water consumption in Cyprus, irrigation policies are of vital importance not only for the farming sector, but also for the economy as a whole. During the last 30 years, the government has prioritized the implementation of integrated irrigation water management policies. An estimated 80% of total funding of the Ministry of Agriculture, Natural Resources and the Environment has been directed to irrigation projects; as a result, nowadays, 23% of total farmland is irrigated. The amelioration of irrigation networks has permitted the expansion of Improved Irrigation Systems, which actually supply approximately 95% of the irrigated farmland and have brought about water savings up to 70 mil. m^3/year. Nevertheless, continuous droughts have deteriorated salinization and have intensified pressures on water reserves, with considerable adverse effects on ecosystems and biodiversity. Desalinization and the use of recycled water in crop production constitute two alternatives which are being adopted by the Cypriot state at increasing rates. Water reserves are also threatened by agrochemical use. The expansion of irrigated crops (potatoes, citrus, olives and grapes) has resulted in increased use of fertilizers and pesticides, whose residuals pollute the limited water resources on the island. In 2013 arboriculture was the main source of pesticide pollution (www.mof.gov.cy), while nitrogen pollution caused severe eutrophication in surface water reserves. Under the light of environmental pressures, the new RDP of Cyprus (2014–2020) foresses agri-environmental measures (M10), support for organic farming (M11) and payments for designated protected areas (M12).

Features of agricultural cultural heritage are widespread in rural areas of the island, including festivals, monuments, museums and buildings (windmills, bridges, oil mills *etc.*). The importance of these cultural resources in maintaining vivid rural areas has been recognized and considerable efforts have been put in order to incorporate them into development strategies. The RDP 2007–2013 endorsed investments and actions to protect cultural features through measure 3.2, in order to prevent depopulation of rural areas. Under the new RDP a wide set of tools (M07) is available for rural communities to ameliorate their infrastructure for local population, in order to become more alluring places of residence.

3.2. Theoretical underpinnings and analysis of CE data

The effects of agriculture's public goods and externalities are difficult to evaluate, as they are not captured in the production functions. Stated preference techniques have recently been applied by numerous authors, in order to attach monetary values to non-marketed goods and services (Birol et al., 2006; Christensen et al., 2011; Rolfe and Windle, 2014; Villanueva et al., 2015). Among them, this paper adopts the Choice Experiment (CE) method to value agricultural externalities.

The design of a CE is based on Lancaster's (1966) theory of consumer preference and requires the choice of attributes that describe a good or service as well as the determination of levels for each attribute. The researcher adds a monetary attribute that corresponds to an amount that a member of a hypothetical market would be willing to pay in order to achieve the attribute levels they desire. The possible combinations of attributes and levels yield the alternatives, which are then organized in pairs formulating the choice sets. Each respondent is presented with 4–16 choice sets (Louviere et al., 2000) and for each one he/she is asked to mark the alternative he/she prefers.

The econometric analysis of CE data uses Random Utility Models (RUM) where utility is distinguished in an observed (V_{ij}) and an unobserved (ε_{ij}) part.

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

Several RUM-based econometric models have been proposed for the analysis of choice data, among which Conditional Logit (CL) models (McFadden, 1973) have been widely applied. In CL, the indirect utility function is linear and the stochastic component of the utility is Gumbel extreme Type-B independently and identically distributed. The probability distribution function is as follows, where the probability (denoted P_{ij}) that respondent i chooses alternative j over all other k alternatives in choice set B equals the utility derived from this alternative over the utility derived from all other alternatives.

$$P_{ij} = \frac{e^{\mu V_{ij}}}{\sum_{k=1}^{J} e^{\mu V_{ik}}} \forall j, k \in B \tag{2}$$

Observed (systematic) preference heterogeneity can be captured in respondents' social and economic characteristics, which enter the model as interaction terms. Unobserved heterogeneity is captured in the random part of the RUM. Random Parameters Logit (RPL) models (Revelt and Train, 1998; Rolfe and Windle, 2014) are more suitable for accounting for unobserved preference heterogeneity, therefore better suited for a detailed examination of preferences concerning multifunctionality. They are based on the same distributional and behavioural grounds as CL, but in RPL a separate linear utility function is introduced for each respondent and the estimated standard deviations for random coefficients account for unobserved heterogeneity; hence, utility from choosing an alternative in a choice set is itself a random variable. The probability distribution function is as follows, where η_i is the random factor in the utility function.

$$P_{ij} = \frac{e^{Z_{ij}(\beta+\eta_i)}}{\sum_{k=1}^{J} e^{Z_{ik}(\beta+\eta_i)}} \forall j, k \in B \tag{3}$$

Formula (3) can be solved by simulation, using the simulated maximum likelihood estimation method (Train, 2003). The choice of random coefficients and distributional forms depends on the researcher (Hensher et al., 2005).

Welfare measures are estimated for each attribute using logit estimates. The monetary value of the good or service under consideration is reflected in the compensating surplus (CS) (Hanemann, 1984), using Formula (4) (Hanemann, 1989).

$$CS = \frac{\ln \sum_{i=1}^{I} e^{V_{i1}} - \ln \sum_{i=1}^{I} e^{V_{i0}}}{\beta_{\text{payment}}} \tag{4}$$

where V_{i0} και V_{i1} are the utilities of individual i before (status quo situation) and after the implementation of the proposed valuation scenario (*i.e.* the specific levels of attributes in a choice set) and β_{payment} is the coefficient of the monetary attribute, which stands for the marginal value of income.

In CEs the experimental design allows for the estimation of the Marginal Willingness to Pay (MWTP), for marginal changes in the level of each attribute, which is the trade-off between income and a marginal change in the level of the attribute. For CL models, as well as for attributes with fixed coefficients in RPL models, trade-offs are estimated by means of Formula (5)

$$MWTP = -\frac{\beta_{\text{attribute}} + \beta_1 S_1 + \ldots + \beta_n S_n}{\beta_{\text{payment}}} \tag{5}$$

where $\beta_1 \ldots \beta_n$ are the coefficients of interaction terms $S_1 \ldots S_n$. It is obvious that Formula (5) takes into account the observed part of preference heterogeneity.

MWTP for random coefficients in RPL is estimated using Formula (5) through a technique which takes into account the standard deviations (Hensher et al., 2005). This technique uses the population moments in order to simulate the unknown distribution of MWTP; then it is possible to estimate means, medians and standard deviations, depending on the distributional assumptions of the random coefficients (Abou-Ali and Carlsson, 2004).

Confidence intervals for MWTP are estimated using the bootstrapping technique of Krinsky and Robb (1986) in order to simulate the unknown and complex distributions of MWTP. This method uses random draws from a multivariate normal distribution for non-random coefficients and the population moments for random coefficients. In both cases, the vector of estimated coefficients and the estimated variance-covariance matrix are needed; MWTP is estimated for each draw and the resulting welfare measures generate the unknown distribution.

3.3. Survey design and administration

The CE survey questionnaire includes three parts, following common recommendations in literature (Mitchell and Carson, 1989; Arrow et al., 1993; Boxall et al., 1996). In the first part, respondents are asked about their attitudes towards multifunctionality, using Likert-scale questions; in the third part respondents' social, economic and behavioral characteristics are recorded. The second part of the questionnaire starts with a brief explanation of the implications of environmental and externalities of agriculture and a change in the cropping pattern is proposed as a solution. The introduction of an agro-environmental, non-government trust-fund is described, which will be in charge of actions and synergies necessary to carry out changes in the cropping pattern. Individuals who are interested in this management scenario are invited to volunteer by paying an amount to the trust-fund.

The payment scenario is based on the results of a mathematical programming model. Using published technical and economic indicators of the main crops in Cyprus (Markou and Papadavid, 2007), the effects of land use changes on the level of externalities were predicted. In particular, a parametric programming model yielded 15 alternative cropping patterns for the country, each one resulting from subsequent reductions in the use of purchased inputs. The basic characteristic of these patterns is the predominance of wheat, which gradually substitutes arboriculture and vegetables, thus reducing the use of agrochemical inputs and irrigation water. Indeed, cereal have much less requirements in pesticide use, so their expansion means less use of resources. Nevertheless, this shift to wheat brings about a loss in farm jobs – because of its low requirements in human labor –, reduced total revenues – because the gross income per hectare for wheat is significantly lower than for other crops – and a raise in incomes per farmer – as the losses in total revenues are counterbalanced by the reduction of the number of farmers. The 15 cropping patterns are presented in Table 5 and more details are available in Ragkos et al. (2010).

The CE attributes are determined based on the results of the parametric programming model; it is a very important task to choose the right type and number of attributes, as this choice should balance realism with complexity (Rolfe and Windle, 2015). Here, this choice is supported by the findings of another analytic

Table 1
Attributes and levels in the CE design.

Attributes	Levels	Description
Reduction in agrochemical use	11%, 34%, 46%	*Reduction in the value of pesticides and fertilizers used, as a result of changes in the cropping pattern*
Reduction in water consumption	16%, 41%, 60%	*Reduction in irrigation water consumption, as a result of changes in the cropping pattern*
Rural development and cultural heritage	18.571 farmers 24.910 farmers 27.852 farmers	*Number of farmers who will leave farming, as a result of changes in the cropping pattern, and will be retrained in other sectors of the rural economy (development of rural landscapes and rural cultural heritage)*
Increase in incomes from agriculture	18%, 25%, 37%, 45%	Increase in incomes per farmer as a result of changes in the cropping pattern, which entail less employment in the sector
Payment	30€, 80€, 150€, 350€, 500€	Amount of money paid for each alternative

approach (mathematical programming), which is proposed as an alternative to common methods for the choice of attributes *e.g.* with focus groups. The five attributes included in the experimental design are (see also Table 1):

1. "Reduction in agrochemical use". This attribute captures respondents' preferences about environmental externalities of agriculture, considering the adverse effects of detrimental inputs on the environment.
2. "Reduction in water consumption". The consideration of public preferences towards irrigation water use could inform water management policies.
3. "Rural development and cultural heritage". This attribute involves retraining farmers who will leave farming in order to engage in other sectors of the rural economy, as a result of changes in the cropping pattern. It reflects the values of rural cultural heritage and rural landscapes.
4. "Increase in incomes from agriculture". An increase in farm incomes induces farmers to remain in the trade. Preferences regarding this attribute reflect public interest in safekeeping the farming sector and imply the degree of consent for protectionism in the sector.
5. "Payment" is the amount of money that a respondent would pay by choosing an alternative.

The full-factorial model yielded 540 alternatives, which were reduced to 25, using the orthogonal design command in the statistic package SPSS 17.0. The 25 remaining alternatives were organized in 25 choice sets, which were then divided into four groups, three of six alternatives and one of seven. This process yielded four different versions of the questionnaire. Each respondent was presented with one version, therefore making six or seven choices.

The sampled population consisted of the total adult population in the Republic of Cyprus. A stratified random sampling yielded a sample size of 407 respondents. Enumerators approached all respondents and the response rate was very high (81%), which finally produced a total of 330 valid questionnaires. After removing protest votes (see a discussion in Arrow et al. (1993)), a total of 1558 choices was used for the empirical analysis.

Responses to the Likert-scale questions in the 1st part of the questionnaire were analyzed and five multiple-item indexes (latent variables) were formulated, which represent respondents' attitudes towards specific aspects of multifunctionality of agriculture in Cyprus. In particular, after testing the latent constructs for their internal validity, by calculating a-Cronbach and r-coefficients, individual scores were summed up for each individual in each item, thus generating the latent variables, which are explained in Table 2, along with other variables in the analysis.

Table 2
Variables used in the empirical analysis.

Variables	Description
Agrochemicals	Attribute "Reduction in agrochemical use"
Water	Attribute "Reduction in water consumption"
Retrain	Attribute "Rural development and cultural heritage"
Farm_Income	Attribute "Increase in incomes from agriculture"
Payment	Attribute "Payment"
Gender	Male/Female
Age	Numeric variable
Income	Ordinal variable
Education	Numeric variable (Years of schooling)
Resident	Lives/Does not live in a rural area
Farm_Family	Comes/Does not come from a farm family
Rural_Family	Has grown/Has not grown up in a rural area
Env_Group	Membership in an environmental club
Knowledge	Latent variable—Knowledge about multifunctionality
Water_Management	Latent variable—Attitude towards water use
Environment	Latent variable—Environmental consciousness
Cult_Her	Latent variable—Attitudes towards agricultural culrutal heritage
Farming	Latent variable—Attitudes towards the farming trade

4. Empirical results

4.1. CL and RPL models with no interactions

The CL model is reported in the first column of Table 3. All coefficients are significant at the 1% level, which indicates that all attributes are important explanatory factors of preferences towards multifunctionality. The positive signs of "Agrochemicals", "Water", "Retrain" and "Farm_Income" reveal that the probability that a respondent chooses an alternative is increased by an increase in their levels, while, as expected, the opposite holds for an increase in "Payment". The CL model was tested for the Independence of Irrelevant Alternatives (IIA) using the Hausman – Hausman and McFadden (1984) test. The null-hypothesis that IIA does not hold could not be rejected when Alternatives B or C were removed, so the results of the CL are potentially biased.

In order to overcome this drawback RPL models were estimated; the results are reported in the second column of Table 3. All coefficients are significant at the 1% level and of the expected sign, while the coefficients of "Water" and "Payment" are random and normally distributed. These results indicate that an increase in the level of non-monetary attributes affects utility positively, whereas higher payments reduce the level of utility. The latter finding was expected, due to income constraints. Unobserved preference heterogeneity is incorporated in the standard deviations of the random coefficients, which are significant at the 1% level. The reported standard deviations indicate that changes in "Water" and "Payment" have a positive impact on utility, verying among individuals.

Table 3
Conditional logit and random parameters logit models.

Variables	Conditional logit (CL)	Random Parameters Logit (RPL)	Random Parameters Logit with interactions (RPL-INT)
Intercept	−2.48927***	−2.11162***	−2.48527***
	(0.35727)	(0.47357)	(0.47647)
Agrochemicals	0.01883***	0.02879***	
	(0.00363)	(0.00641)	
Water	0.02674***	0.03165***	−0.10711***
	(0.00264)	(0.00438)[a]	(0.03842)[a]
Retrain	0.5177×10^{-4}***	0.5567×10^{-4}***	
	(0.1394×10^{-4})	(0.1999×10^{-4})	
Farm_Income	0.01645***	0.03277***	
	(0.00450)	(0.00782)	
Payment	−0.00756***	−0.02331***	−0.06303***
	(0.00040)	(0.00369)[a]	(0.01152)[a]
Water × Gender			0.01333**
			(0.00626)
Payment × Gender			−0.00488**
			(0.00196)
Agrochemicals × Age			0.00041*
			(0.00022)
Water × Age			0.00106***
			(0.00028)
Payment × Income			0.00389***
			(0.00093)
Water × Education			0.00589***
			(0.00119)
Retrain × Resident			−0.2618 × 10−4***
			($0.0102*10^{-4}$)
Agrochemicals × Farm_Family			0.01632
			(0.01019)
Farm_income × Farm_Family			−0.03678***
			(0.00977)
Agrochemicals × Rural_Family			−0.03701***
			(0.01245)
Retrain × Rural_Family			0.5901×10^{-4}***
			(0.1608×10^{-4})
Water × Env_Group			−0.03032***
			(0.01038)
Farm_income × Knowledge			0.00225***
			(0.00065)
Payment × Knowledge			0.00089***
			(0.00022)
Water × Water_Management			0.00311***
			(0.00091)
Agrochemicals × Environment			0.00271***
			(0.00083)
Farm_income × Cult_Her			−0.00240*
			(0.00134)
Retrain × Cult_Her			0.1618×10^{-5}
			(0.1404×10^{-5})
Farm_Income × Farming			0.00473***
			(0.00126)
Standard Deviations			
Water		0.03379***	0.03697***
		(0.01068)	(0.01088)
Payment		0.01411***	0.01397***
		(0.00266)	(0.00246)
Log-Likelihood function	−1282.955	−1251.210	−1079.931
McFadden R^2	0.25045	0.26900	0.36959
Draws		500 Halton	1000 Halton
Likelihood Ratio Test	857.366***	920.856***	1265.213***
Observations	1558	1558	1558

*Significant at the 10% level, **Significant at the 5% level, ***Significant at the 1% level.
Note: [a]denotes random parameters.

4.2. Observed preference heterogeneity

In order to account for observed and unobserved preference heterogeneity simutaneously, a RPL model with interaction terms (RPL-INT) was estimated (Table 3). The coefficients of "Water" and "Payment" are random and normally distributed and their estimated standard deviations are significant at the 1% level. The McFadden R^2 (0.36959) is significantly improved compared to the models without interaction terms, indicating the effects of observed preference heterogeneity. The internal validity of the model is verified by the positive sign of the interaction term "Payment*Income", which demonstrates that individuals of low

Table 4
Marginal willingness to pay for attributes of multifunctional agriculture.

Attributes	Marginal Willingness to Pay (€/person) Confidence Intervals (95%) (€/person)		
	CL	RPL	RPL-INT
Reduction in agrochemical use	2.49*** (0.48)[a] (1.57)-(3.42)[c]	2.02[b] (−5.45)-(8.18)[d]	1.75[b] (0.61)-(8.63)[d]
Reduction in water consumption	3.54*** (0.39)[a] (2.81)-(4.35)[c]	3.74[b] (−18.94)-(22.48)[d]	2.16[b] (−0.97)-(21.04)[d]
Increase in incomes from agriculture	2.17*** (0.60)[a] (0.99)-(3.38)[c]	2.30[b] (−6.20)-(9.32)[d]	1.65[b] (0.57)-(8.13)[d]
Rural development and cultural heritage	0.0068*** (0.0019)[a] (0.0033)-(0.0106)[c]	0.0039[b] (−0.010)-(0.016)[d]	0.0031[b] (0.0011)-(0.0152)[d]

[a] MWTP estimated using the WALD procedure in LIMDEP 8.0 NLOGIT 3.0. Numbers in parentheses are standard errors.
[b] MWTP estimated using population moments.
[c] Numbers in parentheses denote the lower and upper confidence intervals, at the 95% level, estimated using the bootstrapping procedure by Krinsky and Robb (1986).
[d] Numbers in parentheses denote the lower and upper confidence intervals, at the 95% level, estimated using population moments.

incomes are less inclined to pay higher amounts than individuals of higher incomes. The signs of the other coefficients of the interaction terms provide indications as to the preferences of particular segments of the population.

4.3. Marginal willingness to pay

The coefficients of the three models were used in the estimation of the MWTP for each attribute by means of Formula (5), while for random coefficients, standard deviations were also taken into account. The MWTP estimates are presented in Table 4. The results produced by the RPL-INT model are considered more reliable, as they incorporate all sources of preference heterogeneity. Following these, the Cypriot public is willing to pay:

1. 1.75 €/person for a 1% reduction in the use of agrochemicals, in order to decrease pressures on ecosystems
2. 2.16 €/person for a 1% reduction in the use of irrigation water
3. 1.65 €/person to achieve a 1% raise in the average farm incomes, which would induce farmers to remain in the profession
4. 0.0031 €/person in order to retrain a farmer who would leave the trade, in order to undertake another sort of economic activity in a rural area

The MWTP indicates that the Cypriot public is willing to pay for the reduction of adverse environmental effects of agriculture, but also for benefits that affect society and rural development.

4.4. Economic implications of extensification scenarios

The estimated monetary values can be used for the quantification of benefits derived from non-traded outputs in each alternative cropping pattern (extensification scenario). Each cropping pattern corresponds to different levels of the four non-monetary attributes and, consequently, to different levels of benefits. The monetary value of each scenario is the CS between the status-quo situation and the levels of attributes in the specific scenario The CS is estimated using the coefficients of the RPL-INT model by simulating the population moments.

CS estimations for the 15 scenarios are presented in Table 5. CS per person is minimized in scenario 2 (−51.28 €/person), it is increased between scenarios 3–7 and 9–11 and reaches a maximum at scenario 11 (309.49 €/person). It is, therefore, evident that society attaches monetary values to the implementation of agricultural extensification scenarios, which would entail reduced agrochemical and water use, more human resources to protect cultural heritage and increased farm incomes to assure the continuation of farming in Cyprus.

Losses in gross margin, due to the substitution of tree crops and vegetables by wheat, vary between 4.7% and 64.2%. However, these considerable losses are counterbalanced by the total benefits, aggregated to the Cypriot population, in scenarios 3–12. The comparison between total benefits and income losses reveals a net social surplus, between 19.7 mil.€ and 91.7 mil.€ for scenarios 12 and 5 respectively. It is evident that the inclusion of the value of agriculture's externalities in the decision-making process, for example considering the introduction of an environmental-friendly policy, would heavily influence the final decision, compared to the case where only traded outputs would be taken into account. The social and environmental impact of farming represents an important part of the total economic value of agriculture and needs to be included in the decision-making process, alongside with market criteria.

5. Discussion - conclusions

The CE approach in valuing outputs of the multifunctional farming sector in Cyprus verifies that agriculture is endowed with environmental and social externalities and that the public is aware of them. Cypriots are willing to pay for environmental benefits through the reduction in pesticide and irrigation water use, for the protection of the agricultural landscapes and cultural heritage and for the continuation of farming on the island. This positive MWTP reflects public consent to a shift towards less input-intensive crops which would mitigate environmental pressures, reduce jobs in the farming sector and improve individual farm incomes. The contribution of farming in local economies would be reduced, without however ceasing to perform its environmental and social functions. Farmers who would leave the farming sector, because of this extensification, could be employed in other sectors of a new diversified model of rural economy, which would develop local characteristics formulated by agriculture, such as landscapes and cultural heritage. According to the results of this study, the public is in favor of policies that aim at the diversification of the rural economy (such as the ones within Reg. (EC) 1305/2013), using existing cultural, environmental and social resources and know-how. In this context, agriculture's externalities are resources for sustainable development that could bring about considerable benefits in terms of non-traded goods and services, overlapping income losses from marketed goods.

Policy tools are available to farmers in order to move towards this type of extensive production. Indeed, the EU is consistent in its resolution to continue supporting a multifunctional model of agriculture by providing funding and policy incentives. The new

Table 5
Compensating surplus and gross margin of the 15 alternative cropping pattern scenarios.

Attributes Benefits	Cropping patterns Benefits														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Compensating surplus and gross margin of the 15 alterna	2543.4	2116.4	1250.4	1250.4	1140.8	1013.0	992.6	988.9	988.9	926.6	893.1	875.0	522.9	484.7	454.7
Vineyards (th.ha)	1624.6	1624.6	1284.8	910.3	956.9	1084.7	1111.0	1362.8	1362.8	1398.5	1402.0	1407.4	1407.4	1415.0	1418.7
Vegetables/Potatoes (th.ha)	1134.1	1134.1	1134.1	970.8	977.4	977.4	888.7	636.1	577.3	572.9	582.3	582.3	582.3	592.8	619.1
Cereal/Fodder crops (th.ha)	10336.2	10763.2	11969.0	12506.8	12563.2	12563.2	12646.0	12650.5	12709.3	12740.3	12760.9	12773.6	13125.7	13145.8	13145.8
Total (th.ha)	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3	15638.3
Reduction in agrochemical use (%)	0	11	28	34	37	42	44	46	47	48	49	50	51	51	51
Reduction in water consumption (%)	0	16	41	48	53	57	60	66	69	71	73	73	78	80	80
Increase in incomes from agriculture (%)	0	4	46	59	62	63	60	45	44	43	42	37	25	18	13
Retained farmers	0	198	18751	22121	23352	24910	25311	24328	25474	26594	27607	27582	29877	30229	30936
Compensating surplus (€/person)	0	−51.28	172.51	233.71	260.38	285.92	292.89	281.8	292.8	301.32	309.49	302.58	303.03	296.84	290.46
Total benefits[a] (mil.€)	0	−35.4	119.0	161.2	179.5	197.2	202.0	194.3	201.9	207.8	213.4	208.6	209.0	204.7	200.3
Gross margin (mil.€)	406.8	387.5	348.1	331.5	318.9	298.5	286.2	271.8	255.2	240.4	224.4	217.8	173.0	159.2	145.4
Reduction in gross margin[b] (mil.€)	0	19.2	58.6	75.2	87.9	108.2	120.6	135.0	151.5	166.4	182.3	188.9	233.8	247.6	261.3
Reduction in gross margin[2] (%)	0	−4.73	−14.42	−18.49	−21.61	−26.61	−29.64	−33.18	−37.25	−40.91	−44.83	−46.44	−57.48	−60.86	−64.24

[a] Total benefits are calculated by aggregating the compensating surplus to the entire population.
[b] The reduction in gross margin is calculated by extracting the gross margin of cropping pattern (1) from the gross margin in each cropping pattern.

RDP in Cyprus proposes a set of measures for the mitigation of environmental externalities, within the EU framework, and the transformation of rural communities to places of opportunity for urban dwellers. If such funding incentives are to be used by Cypriot farmers, a more pluriactive primary sector will emerge, enriched with employment and income sources stemming from its multifunctional character. Kallas et al. (2007) found a positive MWTP of the Spanish public for the protection and continuation of the farming profession. It is obvious from this study that the Cypriot public would welcome such a development, as it would ensure more environmental benefits without the danger of loss of culture and/or the farming sector itself. It is also highlighted that agriculture is able to return to a more environmentally pristine state by continuing to play its very important cultural and social roles. Income losses from this transition do not seem to be as important as non-market benefits and EU policies are available to support a diversification of activities, which would counterbalance these losses by transforming non-market benefits to sources of income, thus internalizing externalities. Besides, it is highlighted that competitiveness in the primary sector is not always to be pursued through intensification; extensive production systems and diverse activities, all of which are motivated by the new RDP of Cyprus, can lead to satisfactory results through an alternative trajectory.

The results of the analysis can be of use in the design and quantification of the impact of targeted measures. The MWTP for environmental functions does not provide only a monetary approximation of the environmental pressures actually caused by the farming sector but also a basis for the calculation of relevant payments to farmers in order to avoid polluting practices. The idea of payments to those who provide environmental services has also been recently supported by Caro-Borrero et al. (2015), nonetheless not for agricultural environmental services. Previously, Kallas et al. (2007) estimated positive MWTP for the reduction of agrochemical use to ensure environmental benefits, through a shift to organic farming—note however that their results do not permit inference concerning the profile of those willing to pay for such services. Therefore, strategic decisions about the cropping pattern, rural development and price policies should always incorporate the values of non-marketed services provided by the agricultural sector in order to account for the true societal demand. Moreover, educational and information campaigns should be – more than ever – targeted to pluriactivity and diversification, aiming to help farmers undertake non-agricultural activities, which would be, nonetheless, highly connected to the local/regional cultural identity, history and environmental resources. Special attention needs to be directed to the values of the farm trade, as the continuation of farming on the island is valued by the public, providing an argument for intervention in the sector.

Comparisons between the estimated benefits and income losses are not the only criteria for the choice of the desirable profile of agriculture in Cyprus. Other significant factors are transaction costs, constraints set by EU and local legislation, the existing infrastructure for rural populations and other externalities of agriculture, which were not included in the experimental design. An integrated approach of multifunctional agriculture could provide more accurate estimates of the total economic value of Cypriot agriculture. Furthermore, a common valuation framework, applicable to other EU countries as well, could provide valuable information in planning the future of the CAP.

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