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Summary

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Keywords: Periurban Agriculture, Agri-environmental Policy, Choice Experiment, Random Parameter Logit Model, Error Component, WTP Space

JEL Classification: Q18, Q57, C35

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Abstract

In the European Union (EU) periurban agriculture is under the same agri-environmental policy regime designed for general agriculture. We argue that the specific needs of periurban agriculture may justify *ad hoc* agri-environmental policy measures. We present results from a Choice Experiment (CE) performed on a sample of 600 people living in the municipality of Milan, which was designed to assess the willingness to pay (WTP) for ecological benefits generated by four agri-environmental practices implementable in the periurban area and already included in the Rural Development Programmes of the Lombardy region. Results suggest that a large population share is willing to pay to support an increase in the use of the agricultural practices studied with an average WTP ranging between 5.6 to 16.3 euro/person/year, according to the type of practice. These results are in contrast with their current low level of adoption. The sub-optimal uptake rate is likely due to an insufficient per hectare compensating payment, which is too low to cover the income foregone consequent to the adoption of sustainable agriculture measures in this area. The mismatch between the low uptake rate and the high social benefits generated by the four agri-environmental agricultural practices sheds light on the need to design agri-environmental policy programmes specifically targeted to periurban areas, where the costs of compliance with AEMs are high and the social benefits of their adoption are large.

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1. Introduction

In recent decades rural areas surrounding cities have been gradually included into urban borders. This process has affected most of the largest cities in Europe. Agriculture is one of the main landscape-shaping forces of the periurban fringe, where urban and rural features intermingle. Due to its proximity to urban centres, periurban agriculture (PUA) is constantly threatened by urban encroachment. On the other hand urban dwellers pay growing attention to the environment and are increasingly interested in recreational activities carried out in farms (Zasada, 2011a). In order to survive the PUA cannot focus on production only, it must also find a suitable adaptation strategy by developing its multifunctionality and by providing citizens with ecological, cultural and social services. Zasada et al. (2011b) identify three types of adaptation strategies for periurban agriculture: (a) specialisation in high-value cropping systems, (b) adoption of environmentally-friendly practices and (c) provision of recreational and cultural services. The literature shows that many periurban regions in North America and in Europe focus on high-value products (e.g. horticultural products) and in some of them the adoption of environmentally-friendly practices is higher compared to other rural areas (Zasada et al., 2011b). The presence of organic farming in periurban areas is controversial: some studies find a higher rate of adoption, while others find a lower adoption rate compared to the other rural areas. The provision of recreational and cultural activities by farms is widespread in many periurban areas (van Zanten, 2014). A multifunctionally oriented agriculture represents an opportunity for periurban farmers to diversify their activity and to simultaneously generate benefits for urban dwellers. Ives and Kendal (2013) find that Melbourne dwellers attach a value to many multifunctional components of the PUA and they state the need to account for these components when planning land use policies.

Developing multifunctional agricultural systems means supporting the provision of ecosystem services from agriculture. Ecosystem services include goods and services supplied by the agricultural landscape (van Zanten, 2014), which can be divided into commodities and non-commodities goods and services (environmental, cultural and social goods and services). Missing complete markets for the non-commodities of ecosystem services leads to a sub-optimal level of their provision. Thus, corrective policy measures are required to guarantee that these services are provided at their social-optimal level. Over the last decades agricultural policy in the European Union (EU) has been paying increasing attention to the ecosystem services provided by selected agricultural practices. Since the ‘80s the EU Common Agricultural Policy (CAP) has introduced agri-environmental measures (AEMs) as an option to be applied by Member States. Later on such measures became compulsory for all Member States with the Council Regulation 2078/92 of the Mac Sharry reform. AEMs are measures specifically targeted to pay farmers who subscribe, on a voluntary basis, to environmental commitments for at least 5 years to protect the environment and preserve the countryside. The payment aims at compensating the additional costs and the income lost as a result of adopting environmentally-friendly practices. AEMs are defined at the regional level to account for the regional specificities and they are co-financed by the EU and Member States. They are a section of the Rural Development Programmes (RDPs), which are regional programmes belonging to the CAP with the aim of supporting the development of rural areas. In the 2007-2013 budget framework, the EU expenditure for AEMs amounted to nearly 20 billion euro, 22% of the EU overall expenditure in the RDPs. Approximately 25% of the EU Utilised Agricultural Area (UAA) is under AEMs (European Commission, 2017).

Doubts about the effectiveness of the AEMs arise as their flat rate application within a region ignores the heterogeneity of the agricultural conditions within the region. The flat rate application is likely to imply that areas where the costs of compliance with the measures are low (e.g. marginal areas) record a high rate of adoption and a large windfall effect (Chabé-Ferret and Subervie, 2013), i.e. the measures would have been adopted even in the absence of payments. On the other hand, areas where the costs of compliance with the measures are high (e.g. intensive agricultural areas) may record a low rate of adoption. However, it is noteworthy that the compliance costs for a farmer with AEMs are not related to the social desirability of that measure. There may exist some areas where the adoption of AEMs is highly desirable from the social perspective, but the adoption rate is low because of the high cost of compliance. In this case, an increase in the compensation payment for the AEMs in those areas is desirable in order to increase the adoption and satisfy collective demand. We argue that the PUA of the municipality of Milan may be one of these cases of misalignment between the extent of AEMs uptake and the social benefits potentially derivable from AEMs. Indeed, the participation in AEMs by farmers in the periurban area of Milan is rather low, although Milanese dwellers could benefit from environmentally-friendly practices given the proximity of PUA to the city. In order to check this hypothesis we assess the preferences and the willingness to pay of the population of the municipality of Milan for the ecological benefits provided by an increase in some environmentally friendly agricultural practices in the periurban area of the municipality. All the practices analysed are AEMs included in Lombardy's RDP. The reason for considering existing AEMs lies on the intention to use the already existing policy framework and to evaluate the potential benefits derived from an improvement of its application. Willingness to pay (WTP) measures give an indication of the social benefits generated by a marginal rise in the adoption of those practices.

Although an extensive literature exists on the economic valuation of landscape and recreational services (van Zanten, 2014), there are only a few studies investigating the economic value of the ecological benefits provided by some environmentally-friendly agricultural practices. We are not aware of studies that assess these ecological benefits when the practices are adopted specifically in the periurban area. This goal has been pursued here by means of a choice experiment (CE) on a sample of 600 people living in the municipality of Milan. In the CE the respondents were provided with a description of each of the selected practices along with the ecological effects of each practice. As respondents may not be aware of the relationship between agricultural practices and environmental consequences, the description of the ecological effects generated by each practice is central to our study. The results thus indicate the preferences and the WTP of Milan dwellers for each sustainable agricultural practice and the judgment is based on the environmental consequences of these practices when implemented in the periurban area of Milan.

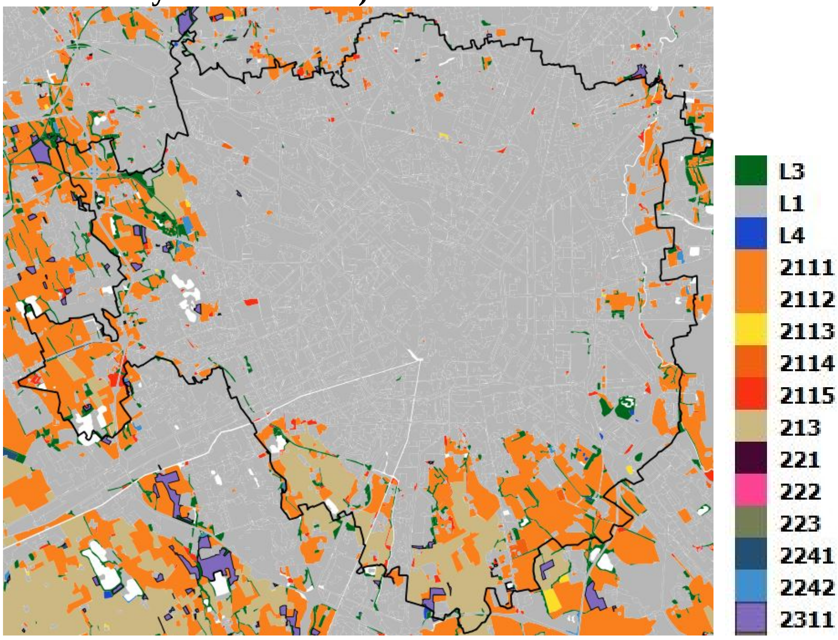
Results indicate that there is a large share of Milan dwellers who are willing to pay for the ecological benefits derived from increasing those practices. The average WTP is positive and statistically significant for all the agri-environmental practices assessed and ranges between 5.6 euro/person/year (for having biodiversity strips between the main crop and the field border with a reduced application of chemicals) and 16.3 euro/person/year (for having biodiversity strips sown with wildflowers). In addition, the WTP is heterogeneous across respondents and it is better described by including an error component in the model. Thus, a random parameter logit model with error component is suitable to analyse the CE data. The outcome supports the hypothesis of a misalignment between the high social desirability of agricultural sustainable practices in the periurban area of Milan due to its low rate of adoption. The policy implications consist in the need to move towards a more sustainable agriculture in the periurban area by increasing the compensating payments for farmers when uptaking AEMs. It is noteworthy that the results highlight the need to evaluate the development of *ad hoc* agri-environmental policies specifically targeted to the periurban areas, in order to account for the specificities of agriculture in these areas.

In their analysis on the provision of ecosystem services by PUA in Belgium, Vandermeulen et al. (2006) show that the adoption depends on local agricultural policies. Their ex-post analysis on the adoption stresses the role of local policies in the development of a multifunctional agriculture in periurban areas and they state that current agricultural policies are still too much upscale, refer to general agriculture and are not suitable for PUA.

Periurban agriculture and agri-environmental practices

Agricultural activity in the periurban area of Milan is mainly concentrated in the south and in the east side of the city. It consists mostly of rice and corn, which represent 75% of the utilised agricultural area (UAA) followed by grassland (7.5%) (Istat, 2010. See Figure 1). Agriculture in this area can be classified as intensive and the costs of compliance with the AEMs are rather high. This may contribute to explaining the very low rate of uptake of environmentally-friendly measures. The only exception is represented by an area of approximately

Figure 1. Map of land use in the municipality of Milan (the border of the municipality is indicated by the black line)



Legend: L3= permanent wood and semi-natural landscape; L1=anthropized areas; L4=wet areas; L2111 and L2112= arable crops; L2113, L2114 and L2115= horticultural crops; L213= rice; L221=vineyards; L222=orchards; L223=olive groves; L2241 and L2242= fast growing trees; L2311= permanent grassland

90 hectares in the south side of the city corresponding to the Ticinello Park. There is only one farm in the Ticinello Park and this farm is highly focused on the provision of environmental services such as hedgerows, ponds, tree lines. However, this focus is justified by the farm area being embedded in a park.

Outside Ticinello Park, the majority of the farms that provide ecosystem services in the periurban area of Milan are focused mainly on the provision of recreational and cultural activities such as walking trails, agro-tourisms, recreational events, as well as direct sales of farm products. Most of these recreational ecosystem services imply a reward for the farmers in the form of payments by users for access, participation and services. On the contrary, the ecological benefits provided by farmers by the uptake of sustainable agricultural practices do not imply any reward from the beneficiaries and thus, in order to be provided, they require public funding, such as subsidies. However, it is likely that the compensating payments for the AEMs defined at regional level are too low to compensate full compliance costs in such area. Indeed, the per hectare subsidies level for AEMs are defined at the regional level and they concern the general agriculture, they do not account for the specificities of periurban agriculture.

Despite the low adoption of AEMs, given their proximity to the urban areas, it is likely that the provision of ecological services by the PUA of Milan may largely benefit city dwellers. Our study is focused on four environmentally-friendly agricultural practices (and related ecological benefits), all four belonging to the AEM framework of the RDP of the Lombardy region and thus eligible for a per hectare compensating payment. Specifically, the practices we assessed and their corresponding ecological benefits are:

(1) organic farming – ecological benefits: reduction in nitrogen leaching and nitrous oxide emissions,

(2) fast growing trees plantation on agricultural land – ecological benefits: increase in carbon sequestration, shadowing and refreshing,

(3) field margins management – ecological benefits: positive effect on biodiversity (farmland bird population and pollinators),

(4) cover crops – ecological benefits: reduction in nitrogen leaching.

The environmentally friendly agricultural practices and their levels examined in this study were developed from a focus group with local farmers as well as from an expert consultation. The expert consultation together with a literature review has also revealed the ecological benefits associated to each of these practices. Among the other benefits, organic farming significantly decreases nitrogen leaching in the watershed as well as the nitrous oxide emissions which have a greenhouse effect 298 times stronger than carbon dioxide (Tuomisto et al., 2012). Fast growing tree plantations (e.g. poplars) contribute to carbon sequestration and cool the air by providing shadow during hot seasons (Palma et al., 2007). Biodiversity-strips consist in land strips located between the main crop and the field border. They are specifically targeted to increase biodiversity (e.g. by providing nectar to pollinators and nesting site and seeds for some species of birds). It has been shown that according to the management of the strips a different effect on biodiversity is reached (Vickery et al., 2009). Finally, cover crops are crops planted in the fallow period and are not harvested with the aim of fixating nitrogen and making it available in the soil thereby reducing nitrogen leaching and water contamination. Constantin *et al.* (2010) show that planting cover crops may reduce nitrogen leaching by between 30% and 60% of the leaching level in the absence of cover crops.

Organic farming and fast growing trees plantations are implemented only marginally in the periurban area of Milan, while biodiversity-strips creation and cover crops are not adopted at all. The reasons for such a low level of adoption for the four AEMs analysed in this study may be twofold. First, as already stated, the compensating payment may be insufficient to cover the lost farm income. This may be especially the case for organic farming and biodiversity-strips, where the income lost is likely to be higher compared to the other two practices. Second, although planting fast growing trees and cover crops implies limited additional costs or lost income, it is likely that their low level of adoption is mainly linked to a lack of information of farmers or to an inertia in the adoption. Farmers in this case may perceive the payment as insufficient to cover the additional time and effort needed to carry out the bureaucratic paper work for the application and the setting up of the measures.

Given the low level of adoption of these four practices it is worth assessing how much Milan city-dwellers, who are the main beneficiaries, value the ecological benefits associated to each of these measures. This evaluation informs on the additional welfare that may be generated by improving the adoption of the four AEMs in the periurban area, which can be achieved by developing agricultural programmes specifically targeted to this area.

2. Methodology

In the last two decades there has been a sharp increase in the application of discrete choice experiments (DCE) for the economic evaluation of environmental goods. Environmental goods are often multi-attribute goods and subjects may prefer more provision of some attributes than others. DCE allows disentangling the preference towards each attribute as the approach is rooted in Lancaster's theory (Lancaster, 1966), which states that the utility an individual derives from a packaged good depends on the utility he derives from each of the good's attributes. In a DCE survey respondents are asked to repeatedly choose the alternatives they prefer among experimentally designed sets, where each alternative represents a specific combination of attribute levels of the good. In each set the individual is expected to choose the alternative that gives him the highest utility among all the alternatives in the set. DCE is suitable for our purpose as we assess four agri-environmental practices which can be thought of as the attributes of an agri-environmental good. The information retrieved by DCE is analysed according to the Random Utility Theory (McFadden, 1974). Random Utility Theory states that the individual utility can be decomposed into a deterministic part (V_{nj}) which depends on the attributes of the good to be evaluated and on individual characteristics and a random part (ε_{nj}), not observed by the researcher:

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

Where, n indicates the individual and j the alternative.

Assuming ε_{nj} is extreme value Gumbel distributed, the conditional logit model (CL) is obtained. The CL model dominated the discrete choice modelling (DCM) literature for decades as its close-form solution makes the parameter estimation easy and requires a limited amount of data. Despite these advantages, the CL model carries some limitations. First, it can represent systematic taste variation (by the inclusion of socio-economic variables) but not random taste variation (taste heterogeneity that cannot be linked to observed characteristics). Second, it relies on the Independence from Irrelevant Alternatives (IAA), which implies a rigid substitution pattern among alternatives. Third, it is unable to deal with correlation over time in the random part of the utility. In order to overcome these drawbacks, mixed logit (MXL) models have been introduced and have progressively grown in popularity. MXL encompasses a wide range of different models, whose probabilities of a sequence of choice is the integral of the logit probability over parameters density function. The random parameter logit (RPL) model is a type of MXL where the utility of individual n from alternative j is :

$$U_{nj} = \beta' x_{nj} + \eta_n' x_{nj} + \varepsilon_{nj} \qquad (2)$$

Where, x_{nj} is the vector of attributes levels in alternative j for the good in question, β is the vector of expected values of the parameters associated to each attribute, η_n is the vector of individual specific deviations from the expected values β, and ε_{nj} is the random component that has an extreme value Gumbel distribution with variance $(\frac{\pi^2}{\lambda^2 6})$ where λ is the scale parameter. In many applications λ is set equal to 1. Thus each individual has a specific value for each parameter, $\beta_n = \beta + \eta_n$, and the unconditional choice probability of individual n for the observed sequence of t choices is the integral of the product of the logit probabilities over all possible values of β_n (Train, 2009) :

$$P_{nj} = \int \prod_t \left(\frac{e^{\beta_n' x_{nj}}}{\sum_i e^{\beta_n' x_{ni}}} \right) f(\beta, \delta^2) d\beta \quad , \qquad (3)$$

where, j is the alternative chosen in the choice occasion t, $f(\beta, \delta^2)$ is the probability density function (normal in our case) for the preference parameters β_n with standard deviation δ. In order to estimate a RPL model it is necessary to make an assumption about the distribution of the β_n parameters in the population. Equation (3) does not have a closed form, but the solution is approximated by simulations (Train, 2009). The RPL model allows accounting for taste heterogeneity not linked to observed variables and introduces flexible substitution patterns among alternatives. However, in order to account for the potential correlation among utilities for different alternatives an error component must be introduced. Error component (EC) model (Scarpa et al, 2005) decomposes the random part of utility into two parts:

$$U_{nj} = \beta' x_{nj} + \mu_n' z_{nj} + \varepsilon_{nj} \qquad (4)$$

Where, μ_n is a vector of random terms with zero mean and whose variance must be estimated, z_{nj} is a vector of observed variables related to alternative j and ε_{nj} is the extreme-value Gumbel distributed part of the error term. According to the values set for z_{nj} a correlation among alternatives is introduced and the variance of μ_n measures the magnitude of the correlation.

The combination of RPL and EC results in a probability of individual n choosing the sequence of choices t :

$$P_n = \int_\beta \int_\mu \prod_t \frac{e^{\beta_n' x_{nj} + \mu'_{nj} z_{nj}}}{\sum_i e^{\beta_n' x_{ni} + \mu'_{ni} z_{ni}}} f(\beta, \delta^2) \phi(0, \sigma^2) d\beta d\mu \tag{5}$$

Where, $\phi(0,\sigma^2)$ is the probability density function for the error component parameter, β, δ^2 and σ^2 are the parameters to be estimated.

One of the most suitable applications of an EC model is to analyse data from a DCE where in each choice set the status quo alternative is included. The status quo is an alternative which displays for each attribute the attribute's level that is currently observed. Indeed, it has been shown that the attitude people have towards the status quo is different from the attitude towards hypothetical designed alternatives (Kahneman et al., 1991). While people are familiar with the status quo the other alternatives are just hypothetical changes. As such they are conjectured in an idiosyncratic manner rather than in a systematic one (Marsh et al. 2011). This real versus hypothetical alternative likely implies a larger variance of the error term for the hypothetical alternatives compared to the status quo and introduces a correlation in the error structure among hypothetical alternatives. An EC model allows accounting for that by setting $z_{nj} = 1$ if j is the non status quo alternative and $z_{nj} = 0$ if j is the status quo alternative. Scarpa et al. (2005, 2007) have shown that the error component model with alternative specific constant (ASC) for the status quo outperforms a CL model with ASC. Indeed, an EC model with an ASC allows capturing both systematic status quo effects (through the inclusion of ASC) and a correlation structure among the random part of utility (through the error component).

As the preferences of Milan's city-dwellers towards the ecological benefits generated by sustainable agricultural practices are likely to be heterogeneous across the population a RPL is adopted for analysing the data of our DCE. In addition, the status quo alternative enters the choice sets in our DCE, thus we opt for introducing an error component in the RPL model to account for the potential difference in the perception between an observed alternative (status quo) and the experimentally designed alternatives.

In most environmental economics studies the main interest is to estimate the willingness to pay (WTP) of the individuals for marginal improvements in each attribute. This is carried out by taking the ratio of each 'non-cost' attribute estimated coefficient by the cost coefficient. When the model setting is a RPL, WTP must be approximated by simulations, i.e. randomly drawing R-times from the distribution of the non-cost attribute and from the distribution of the cost attribute and computing the ratio of the R-pairs. However, the ratio between two distributions may lead to unrealistic values and to overly large variance of the WTP implying that a share of people is willing to pay an extremely large amount of money to have a marginal improvement in an attribute (Thiene and Scarpa, 2009). Daly et al. (2012) outline the importance of choosing a proper distribution for the cost attribute coefficient as many distributions lead to a WTP distribution with infinite moments. The authors provide a theorem that allows checking for each possible distribution of the cost coefficient whether the resulting WTP distribution has finite moments. The theorem allows stating that while the lognormal and Johnson's Sb distribution always have inverse moments, the existence of the inverse moments for all the other distributions can be assured only by setting bounds to prevent non-zero density around zero.

In order to avoid the drawbacks from the ratio between two distributions and when the main interest is to derive the WTP estimates, Train and Weeks (2005) propose re-parametrizing the utility model such that the WTP for each attribute is directly estimated. This re-parametrisation leads to a model specified in WTP-space and avoids the problems related to the ratio between two distributions. A model specified in WTP space is:

$$U_{nj} = -\alpha_n + (\alpha_n w_n)' x_{nj} + \varepsilon_{nj} \qquad (6)$$

Where, α_n is the cost attribute coefficient divided by the scale parameter ($\alpha_n = \frac{\theta_n^{cost}}{\lambda_n}$), w_n is the vector of marginal WTP (henceforth mWTP) parameters ($w_n = \frac{\theta_n}{\theta_n^{cost}}$) directly estimated in the model and ε_{nj} is the extreme value Gumbel distribution with variance $\frac{\pi^2}{6}$.

In a RPL framework a model specified in WTP-space requires the researcher to specify the distribution of the WTP for each attribute rather than the distribution of each coefficient of the linear preference-space model. Train and Weeks compare a model in preference-space (i.e. a model where the parameters are the marginal utilities for each attribute and the WTP are derived taking the ratio) with a model in WTP-space and find that the model in preference-space fits the data better than the model in WTP-space. However, opposite to the model in WTP-space the model in preference-space estimates displays an unreasonably large variance for the WTP. Scarpa et al. (2008) compare the performance of a preference-space model and a WTP-space model to analyse the choice for outdoor activities destinations in the Alps by using revealed preferences data. The study shows that WTP-space model outperforms preference-space model both in terms of fitting the data and in terms of avoiding an unreasonably large variance for WTP estimates. The study is also the first application of the simulated maximum likelihood estimator to a WTP-space model. By using this estimator and utility specification Thiene and Scarpa (2009) show how hypotheses on the size of the variance of random mWTP can be directly tested in estimation.

Despite its interesting features, applications of the WTP-space model for economic evaluation of environmental goods are still rather scant. As the main goal of our study is to assess the WTP of Milan's city-dwellers for improvement in the adoption of environmentally-friendly agricultural practices in the periurban area, the WTP-space model represents the most suitable model specification. Thus, our model framework is a RPL-EC model estimated in WTP-space where all the attributes and the error component are assumed to be normally distributed.

3. Experimental Design and Data

The four environmentally-friendly practices analysed represent the four attributes of the CE. The status quo level of adoption for each practice in the periurban area of the municipality of Milan together with the analysed improvements and the consequent ecological benefits are listed in Table 1. For organic farming, besides the current level of adoption (3% of the UAA), we considered a level of 10% and of 20% of the UAA. Currently the percentage of periurban UAA covered by fast growing trees is 0.5% and we introduced the possibility to increase it to 2% and 5%. No farmer in the peri-urban area of Milan plants biodiversity-strips, thus the status quo level was their absence. In the experiment we considered the option of having strips between the main crop and the field border which are either planted with the main crop, but a reduced amount of pesticides and fertilisers is applied, or are planted with wildflowers beneficial for pollinators and wildlife in general. The two levels associated to the cover crop attribute were cover crop adoption or not (status quo level).

The levels of each practice were defined after a focus group with local farmers whose farms are located in the periurban area of the municipality of Milan and after consultations with agronomists. The focus group and the consultations guaranteed to consider attribute levels that are reasonable and implementable in the area. In the survey each of the four environmentally-friendly practices were described along with the ecological benefits they bring according to each level. In order to estimate the WTP an economic attribute was added to the CE. The economic attribute took the form of a new local yearly tax that each citizen older than 18 years of the municipality of Milan has to pay for at least seven years to implement attribute improvements. The levels of tax attribute were tested by a pilot study on a sample of Milan's city-dwellers and are 5, 15, 30, 50, 70 euro/person/year. The pilot study also allowed checking for wording, length and coverage of the survey.

In the CE each respondent was asked to choose his preferred alternative in each choice set. A choice set consists of two experimentally designed alternatives and the status quo. The alternatives represent a trade-off between the no-economic attribute levels (the four environmentally friendly practices and related ecological benefits) and the tax attribute the respondent has to pay to have those attribute levels. If the status quo option is chosen no additional tax has to be paid.

Table 1. Attributes, related ecological benefits and attribute levels

Attributes	Ecological benefits	Attribute levels
Organic farming (% of the UAA)	Reduction in nitrogen leaching in the soil and reduction in the nitrous oxide emissions (greenhouse effect 298 times higher than carbon dioxide)	3% (status quo) 10% 20%
Fast growing trees plantation (% of the UAA)	Carbon sequestration, refreshing, shadowing	0.5% (status quo) 2% 5%
Biodiversity-strips	Effects on the farmland bird population and on pollinators	Absent (status quo) strips sown with the main crop but treated with a reduced amount of fertilisers and pesticides strips sown with wildflowers beneficial for the farmland birds and pollinators
Cover crops	Reduction in the nitrogen leaching in the soil	Not adopted (status quo) adopted
Tax on each citizen older than 18 years (euro/person/year)		5 15 30 50 70

The questionnaire started with a short introduction of the agriculture in the periurban area of the municipality of Milan together with a map indicating the periurban area. Then, a detailed description of the four agri-environmental practices, their status quo and experimentally designed levels together with their ecological benefits was provided. It was made clear that an improvement over the current level of the practices was conditional to the introduction of a new local tax. Such a tax would be used exclusively to compensate periurban farmers for the income foregone due to the adoption of four sustainable agricultural practices.

In the second part of the questionnaire respondents were asked socio-demographic information and questions to test the respondent's sensitivity to environmental issues, their familiarity with the area under study and their idea on the role of agriculture in the periurban area. Before showing the choice sets, an honesty priming task was introduced in order to reduce the hypothetical bias issue in our hypothetical CE. Indeed, it has been shown that in a hypothetical setting individuals overstate their WTP. The application of honesty priming in CE was first introduced by De-Magistris et al. (2013), who borrowed it from social psychological literature. Honesty priming aims at automatically activating some mental processes which unconsciously influence people's perception and evaluation. In order to do so, before administering the choice sets respondents were exposed to a scrambled sentence exercise. In this test, the respondents were asked to compose grammatically-correct sentences out of sentences with a random order of the words. The grammatically-correct sentences refer to honesty, sincerity, fairness, truth. De-Magistris et al. showed that honesty priming outperforms other strategies (cheap talk and neutral priming) in terms of reducing the bias in the estimation of the WTP in a hypothetical DCE. We checked the easiness and the number of the sentences of our scramble test by a pilot study and finally we included 8 sentences in the final questionnaire.

In our case a full factorial design implies 72,900 combinations $(3^3 \cdot 2 \cdot 5)^2$ of the attribute levels, we used a fraction of the full factorial using the criterion of minimizing the expected D-error, a so-called Bayesian efficient design. Efficient designs aim at obtaining a fraction of the full factorial with a high probability of generating parameter estimates with low asymptotic variance (Henser et al., 2015). Constructing an efficient design requires minimising some measure of the variance-covariance matrix of the estimators conditional on some prior knowledge of the values of the parameters being estimated. Ferrini and Scarpa (2007) show that, in the context of error component specifications, efficient designs outperform other common designs in terms of efficiency of the marginal WTP estimates. In our case estimates were obtained from a pilot study and used to generate the efficient design[1]. Of course, the priors represent just a highly uncertain indication of the true parameter values, which remain the final goal of the choice survey. In order to account for the uncertainty of the priors around the true parameter values we specified the priors in terms of distributions (Scarpa and Rose, 2008). As we finally estimated a RPL model, in the design generation process we specified priors for both the expected value and the variance of each parameter.

The final number of choice sets in our survey is 30 that have been divided into 5 blocks with 6 choice sets each. A randomisation of the order with which the choice sets were presented in each

[1] The experimental design of the pilot study is an optimal orthogonal in the difference (OOD) design, which aims at maximising the differences in the attribute levels across alternatives. OOD design are orthogonal within an alternative but there often exists a negative correlation across alternatives.

block was performed during the survey, such that two respondents facing the same block faced the 6 choice sets of that block in a different order.

The online questionnaire was administered by a market research company that achieved 600 complete questionnaires. The sample is representative of the population of Milan dwellers over 18 years of age in terms of age sex and city district. Table 2 shows descriptive statistics for some socio-economic variables. Around half of the respondents are men, 46% hold a degree and 71% are employed. The average number of family members is around 3. We identify three income classes according to the ratio between family income and family size: in 45% of the respondents the ratio is between 700 and 1,400 euro/month (Medium Income Class), while in 21% the ratio is greater than 1,400 euro/month (High Income Class). The remaining 34% of the population has an income per family member lower than 700 euro/month (Low Income Class). Note that 13% of the respondents are members of an environmental association, denoting the sensitivity of the target population towards environmental issues. The share of respondents that does not live in the periurban area of Milan and visits the area for leisure is 66% and the average number of leisure visits in the last twelve months was 8. The share that transits through the area subject of study is 60% and the average number of transits in a year is 12 times. 37% of respondents indicated also other reasons for going into the area.

Table 2. Descriptive statistics

		Mean	standard deviation
Age		42.2	14.6
Male		0.52	0.50
Degree		0.46	0.50
Middle Income Class (family income/family size 700 -1,400 euro/month)		0.45	0.50
High Income Class (family income/family size > 1,400 euro/month)		0.21	0.40
Employed		0.71	0.45
Family Size		2.9	1.2
Environmental Association Membership		0.13	0.34
Number of Visits in the area	For leisure	8.3	37.9
	For transit	12.2	54.6
	For other reasons	5.5	34.6

The closing question of the questionnaire asked respondents to evaluate their perceived difficulty in answering it and in choosing the preferred alternative in each choice set using a Likert scale from 1 (easy) to 5 (difficult). The average evaluation was 2.78 indicating that respondents on average did not have big difficulties in understanding and compiling the questionnaire.

4. Results

Table 3 presents the results for the RPL-EC model estimated in WTP space (Model 1). The socio-economic variables are interacted with the status quo and thus the parameters for these variables indicate changes in the utility when choosing the status quo alternative compared to the other two alternatives. Respondents who belong to the Medium and High Income Class and members of an environmental association experience an increase in the utility from higher level of sustainable agricultural practices compared to the status quo level. The same happens for men and for those with larger family size. More educated and older respondents are negatively affected by departing from the status quo. On average the utility of citizens decreases by departing from the status quo (ASC parameter is -22.5 and it is statistically significant).

All the attribute levels were coded as dummy variables in order to depict a potential non-linear relationship between utility and attribute levels. As the model is specified in the WTP-space the estimated coefficients can be directly interpreted as the annual marginal WTP for the ecological benefits generated by improvement in each attribute compared to the status quo situation. The WTP for these improvements is heterogeneous across respondents for all the attributes but cover crops, as the standard deviation of the WTP is statistically significant. This confirms the suitability of a RPL model, which captures heterogeneity in WTP unaccounted for by socio-economic variables (unobserved heterogeneity). The standard deviation of the error component is also significant at 1% statistical level indicating higher utility variance and a correlation across utilities from non status quo alternatives. The respondents perceive the experimentally designed alternatives and the status quo differently, and this variation in perception concerns both the deterministic (the ASC is statistically different from zero) and the random part of utility (the standard deviation of the error component is statistically different from zero).

The average annual WTP is positive and significant at a 1% confidence level for each attribute, indicating that on average Milan dwellers are interested in improving the ecological benefits derived from an increase in the adoption of environmentally-friendly agricultural practices in the periurban area of Milan. On average Milan dwellers display a WTP for marginal improvement ranging between 5.6 euro/person/year (for having strips between main crop and field border with a reduced application of chemicals) to 16.3 euro/person/year (for having strips on the field border sown with wildflowers to support biodiversity). In addition, for the quantitative attributes that have three levels (organic farming and fast growing trees), the average WTP is higher when referred to

Table 3. Model coefficients in WTP-space

	Model 1		Model 2	
	Estimate	Std. Error		
ASC (status quo)	-22.5	7.2***	25.42	8.89***

Age	0.2	0.1***	-0.37	0.09***
Degree	13.8	2.4***	8.88	2.60***
Occupied	2.2	2.6	-1.39	2.83
Family Size	-6.4	1.5***	-9.30	1.60***
Middle Income Class	-14.4	2.9***	-30.53	5.50***
High Income Class	-26.6	3.8***	-31.51	7.32***
Male	-21.1	2.5***	-15.17	2.34***
Number of Visits	0.0	0.0	-0.01	0.01
Env. Assoc. membership	-19.0	3.3***	-21.49	4.52***
Expected values of the coefficients for the attributes				
10% UAA organic	13.5	1.5***	11.45	2.83***
20% UAA organic	15.8	1.4***	26.17	2.51***
2% UAA forest	9.0	1.5***	4.21	2.76
5% UAA forest	13.2	1.6***	10.93	2.89***
Biodiversity strips- reduced chemicals	5.6	1.5***	7.39	2.80***
Biodiversity strips- wildflowers	16.3	1.4***	18.59	2.88***
Cover crops	11.6	1.2***	16.08	2.26***
Interaction terms with the dummy for the Middle Income Class				
10% UAA organic			-0.03	3.64
20% UAA organic			-11.83	3.00***
2% UAA forest			5.64	3.56
5% UAA forest			8.12	3.56**
Biodiversity strips- reduced chemicals			2.83	3.58
Biodiversity strips- wildflowers			-6.62	3.77*
Cover crops			-1.31	2.80
Interaction terms with the dummy for the High Income Class				
10% UAA organic			2.09	4.34
20% UAA organic			-7.86	4.58*
2% UAA forest			16.59	4.86***
5% UAA forest			7.44	4.89
Biodiversity strips- reduced chemicals			-2.91	4.64
Biodiversity strips- wildflowers			-1.74	4.62
Cover crops			-1.30	3.64
Standard deviation of the coefficients for the attributes				
10% UAA organic	3.7	2.0*	16.02	1.54***
20% UAA organic	19.8	1.6***	22.03	1.65***
2% UAA forest	3.2	1.9*	1.98	1.72
5% UAA forest	17.5	1.6***	16.10	1.15***
Biodiversity strips- reduced chemicals	4.2	1.8**	12.74	1.74
Biodiversity strips- wildflowers	20.7	1.6***	23.46	1.60***
Cover crops	2.4	1.5	0.51	1.34
error component	74.1	4.7***	91.07	4.72***
Number of observations	*600*		*600*	
Log Likelihood	*-3019*		*-3007*	

***,**,* indicate 1%, 5% and 10% confidence level respectively

the highest level of the attribute compared to the medium level and this is in accordance with the theory of increasing utility. Additionally, according to the law of decreasing marginal utility, the average WTP for improvement from the status quo level to the medium level of each attribute is larger than the WTP for raising from the medium to the highest level.

In order to compare the welfare changes associated to simulated policy programmes we use the compensating surplus formula:

$$CV = V^1 - V^0$$

Where, V^0 and V^1 are the deterministic part of the utility before and after the policy programme implementation respectively. Each policy programme is represented by a different combination of the attribute levels. The average WTP (compensating surplus) to move simultaneously from the current level to the ecological benefits derived from the medium level of all the attributes is 39.8 euro/person/year. If we consider the WTP to simultaneously move from the current level to the highest level of all the environmentally-friendly practices we obtain 56.9 euro/person/year.

These numbers show that on average Milan dwellers derive rather high satisfaction from the adoption of sustainable agricultural practices in the periurban area of the municipality. Despite the difference in the magnitude, an increase of all the four practices analysed over the current level generates ecological gains which represent benefits for society.

Although the average WTP for each attribute is positive and rather high, there are variations across respondents (the standard deviations are statistically significant for all the attributes but cover crops). If we look at the share of population with a positive WTP (Table 4), we notice that more than 99.9% of the respondents is willing to pay for reducing nitrogen leaching, either by supporting an increase in the organic farming area up to 10% of the UAA or by supporting the cover crop adoption. The share of population showing a positive marginal WTP for expanding the fast growing trees plantation to 2% of the UAA is 99.8% and the share in favour of promoting biodiversity strips by reducing the applied amount of chemicals is 91%. The other 3 attributes (20% of UAA under organic farming, 5% of UAA under fast growing trees, biodiversity strips with wildflowers) are supported by a share of population between 77% and 79%. It can be observed that for the quantitative attributes with three levels (organic farming and fast growing trees), while almost all Milan dwellers have a positive marginal WTP to improve up to the medium level, around 20%-22% of them does not want improvement up to the highest level. In both cases, this may be associated to the fear that converting 20% of UAA to organic agriculture and 5% to fast growing trees may imply a drop in the production and thus less availability of locally-grown products. This hypothesis may also explain why 21% of the population is unwilling to pay for biodiversity strips sown by wildflowers. The presence of cover crops does not compete with production and thus more than 99.9% of population indicate a positive mWTP.

Table 4. Share of population with a positive WTP

	Model 1	**Model 2**		
		Low Income Class	*Medium Income Class*	*High Income Class*
10% UAA organic	>99.9	76.1	76.1	79.93
20% UAA organic	78.7	88.27	74.2	79.65
2% UAA forest	99.8	98.27	>99.9	>99.9
5% UAA forest	77.4	75.169	88.07	87.26
Biodiversity strips-reduced chemicals	91	71.89	78.8	63.67
Biodiversity strips-wildflowers	78.5	78.5	69.49	76.1
Cover crops	>99.9	>99.9	>99.9	>99.9

We have re-estimated the model in WTP-space by including interaction terms between each attribute WTP coefficient and the dummies for the income classes. The goal in this case is to check whether income per family member (calculated as the ratio between family income and family size) affects the average mWTP for each attribute, while assuming the same standard deviation across the income classes.

Results of this model (hereafter Model 2) are reported in Table 3. Most of the socio-economic variables show the same sign, statistical significance and order of magnitude of Model 1. The only exception is represented by age, whose negative sign, opposite to Model 1, indicates that older respondents experience lower utility when the status quo is unchanged. The first seven coefficients for the attributes in the Table indicate the mWTP of Low Income respondents. The WTP of the other two classes are obtained by adding to these seven coefficients the corresponding average deviation of WTP reported under the headings “Interaction terms with the dummy for the Middle Income Class” and “Interaction terms with the dummy for the High Income Class”. The unobserved preferences heterogeneity is assumed to be the same across the three income classes. Thus, there is only one set of standard deviation coefficients. The variance of the error component is assumed to be the same across the classes too. The WTP of the Low Income Class is positive and significant for all the attributes with the exception of 2% of UAA under fast growing trees which is not statistically significantly different from zero. The highest WTP is for the two attributes already depicted in Model 1: 10% of UAA under organic farming and biodiversity strips with wildflowers. The range of WTP is between 4.2 euro/person/year (fast growing trees) and 26.2 euro/person/year (20% of UAA under organic farming).

Middle Income respondents do not have the same preference rank as Low Income ones. Indeed, for the two most preferred agri-environmental practices of the latter, the former are willing to pay an average of almost 12 euro/year less (45% less) for raising organic farming up to 20% of the UAA and 6.6 euro/year (35% less) less for biodiversity strips with wildflowers. On the other hand, this group seems to be more interested in the ecological benefits provided by the fast growing trees area as its mWTP for increasing to 5% the UAA under fast growing trees is 74% higher than that of Low Income respondents.

The High Income group also shows a lower interest towards organic farming compared to the Low Income one, as its mWTP for the ecological benefits of raising the UAA under organic farming to 20% is nearly 8 euro/person/year lower. Compared to the Low Income, the High and Middle Income respondents exhibit a larger increase in utility for fast growing trees. Opposite to Model 1, in Model 2 the standard deviations of the coefficients for the 2% of UAA planted with fast growing trees and for biodiversity strips without chemicals are insignificant. This suggests that the unobserved heterogeneity in WTP for these two attributes detected in Model 1 vanishes when allowing for a different average mWTP according to the income size.The standard deviation of the error component is still significant.

In all the three income groups more than 99.9% of the population has a positive WTP for the ecological benefits provided by cover crops (Table 4). 98.3% of the Low Income population shows a positive mWTP for extending the UAA with fast growing trees up to 2% and nearly 90% is in favour of having 20% of UAA under organic agricultural practices. More than 99.9% of Milan dwellers in the Middle and in the High Income Classes are mWTP for 2% of UAA under fast growing trees and just below 90% for increasing the UAA under fast growing trees to 5%. For all other attributes the percentage of population with positive mWTP is between 70% and 80% in the two income groups. The only exception is represented by the High Income group, which has a positive mWTP for biodiversity strips with a reduced chemicals application in 64% of the population only.

5. Discussion and Conclusions

Most of the studies in environmental economics focus on the economic valuation of goods and services that people can directly experience (e.g. the view of a landscape, participating in recreational activities). Our study aims at evaluating the marginal WTP of urban dwellers in Milan for ecological benefits generated by four environmentally-friendly agricultural practices in the periurban area. The ecological benefits generated by agriculture may be perceived as a somewhat abstract concept by survey respondents, who may be unaware of the link between agriculture and the environment. In order to deal with this issue, in the questionnaire we have always presented the sustainable agricultural practices and the consequent ecological benefits together. In addition, we have tried to focus on ecological benefits that most of the citizens should already be familiar with from public debates (N leaching, carbon sequestration, biodiversity).

The four agricultural practices analysed in our study are AEMs belonging to the RDPs of the Lombardy Region. The choice of considering agri-environmental practices already included in the current regional policy programme is grounded in the interest to evaluate the need to support the adoption of already implementable practices in the periurban area of the municipality of Milan. Indeed, despite their availability as an option in the policy programme, the four sustainable agricultural measures considered are adopted only marginally in the areas investigated. This may be due to the high costs of compliance with AEMs in this area, which are likely to be incompletely covered by the per hectare compensating payment. Our results, however, suggest that most Milan dwellers benefit from the ecological consequences of the four practices and most of them has a positive mWTP for supporting the adoption of those practices. The average WTP ranges between 5.6 euro/person/year (for biodiversity strips with a reduced chemicals application) to 16.3 euro/person/year (for biodiversity strips with wildflowers). The mWTP is heterogeneous across the population and the respondents have different perceptions of the status quo alternative and the experimentally designed alternatives. Thus, the use of a RPL-EC model was found to be a suitable specification to analyse the observed choice data obtained from the DCE. In addition, our focus on mWTP motivates the estimation of a model with utility in WTP-space.

The positive and statistically significant mWTP estimates for all four AEMs suggest the existence of a misalignment between their current very low level of adoption in the periurban area of Milan and the satisfaction the population would derive from a rise in their uptake. This misalignment sheds light on the unsuitability of current agri-environmental programmes to target the needs of periurban agriculture. It is likely that the agri-environmental policies designed for the general agriculture do not match the requirements of the periurban agriculture. Policy makers should find tools (e.g. increasing the per hectare compensating payment for AEMs) specifically targeted to the characteristics of periurban agriculture in order to promote the adoption of environmentally-friendly practices in these areas which have large positive welfare effects on society.

If the costs of adopting sustainable agricultural practices in the periurban area of Milan were available, it would be possible to calculate the optimal level of the per hectare compensating payment required to guarantee for each practice a level of adoption equal to those used in our study. We could then compare the public expenditure needed to support our experimentally designed practices levels with the aggregate WTP of the population in Milan.

Finally, if we consider the mWTP of the urban dwellers according to their income class, we see that low income respondents are WTP more for the highest level of organic farming and for biodiversity strips with wildflowers, while middle and high income respondents are more interested in promoting fast growing trees plantation. This heterogeneity ought to be taken into account when designing policy options to improve the uptake of AEMs in the periurban area of Milan.

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