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ECONOMIC VALUATION OF ECOSYSTEM SERVICES PROVIDED BY THE WILANÓW PARK: A BENEFIT TRANSFER STUDY

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Linking perceived choice complexity with scale heterogeneity in discrete choice experiments: home heating in Finland

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Abstract

The Wilanów royal residence – the palace, buildings, monuments and gardens located in the park – is a unique combination of magnificent architecture, historic tradition and nature. They provide multiple benefits to both tourists and inhabitants of Warsaw. In this study we aim at estimating the economic value of nature-related benefits of the Wilanów residence, namely the value of ecosystem services provided by the Park. We use a benefit transfer method and find the value of ecosystem services of the Wilanów Park at 500 thousand euro per year. This seems a significant amount, nevertheless it is much lower than the value of “services” provided by the non-biological assets of the residence.

Keywords:

economic valuation; ecosystem services; benefit transfer method; Wilanów Park

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1. Introduction

King Jan III Sobieski (1629-1696) has been best known as an excellent military commander who defeated the Turkish army near Vienna in 1683. However, he was also a profound nature lover. Elected for the king of Poland in 1674, he was not happy to live in the Royal Castle in the capital city. In 1677, he bought Wilanów near Warsaw, where he established his suburban residence by founding a beautiful baroque palace and planting gardens. After his death, the palace had several owners, and it was partially opened for visitors in 1805. After the World War II, the entire estate was nationalized, restored, and turned into a museum.

There are probably no trees that were planted by king Jan III Sobieski himself, but the Park is remarkable and consists of at least three types of ecosystems: woodlands, grasslands and ponds. The 45 ha of the Wilanów Park comprise gardens in a number of styles: a two-level baroque garden, a neo-Renaissance rose garden, an English landscape park, and an English-Chinese landscape park, as well as the forest complex Morysin, which is a nature reserve with valuable habitats of flood meadows and of woodlands that have exceptionally high amounts of dead wood in various stages of decomposition.

Tourists, as well as Warsaw inhabitants appreciate the nature of the gardens and the Morysin nature reserve which both constitute the Wilanów Park. In addition to its unquestioned historical, cultural and recreational value, the Park ecosystems provide multiple environmental benefits. In this paper, we set estimate the economic value of these ecosystem services.

2. Ecosystem services

Economic assessments of ecosystem services have been carried out for at least two decades. Costanza *et al.* (1997) is often referred to as an early example of a global valuation exercise. The study was revisited by Costanza *et al.* (2014) to conclude that the value reported in the previous study was largely underestimated. Costanza and his team are to be credited for grouping ecosystem services into three general categories that are analysed routinely: provision of raw materials (to be consumed or used in production), regulation of natural processes, and societal functions (such as recreation).

The original 1997 study identifies 17 types of ecosystem services. The list has been amended, although such endeavours are not always purposeful because specifying narrower types does not necessarily imply greater accuracy of measurement. Currently, many assessments available in the literature rely on the *Common International Classification of Ecosystem Services* (CICES 2015). The recent CICES list (version 4.3) includes 46 items, of which 15 refer to the provision of raw materials; 20 – to the regulation of natural processes; and 11 – to societal functions, including recreation.

3. Benefit transfer technique

While estimating the value of services provided by an ecosystem, the first-best approach is conducting a *primary* empirical study at the location of interest. However, in many cases it is not possible because of time and cost constraints. Fortunately, an alternative exists – extrapolating results from another study, similar in relevant aspects to the site that is analysed. This method is called “benefit transfer” (Johnston *et al.* 2015).

In the literature, two major approaches exist to using values or coefficients that do not originate from a study of a particular site. One splits a good G into separate components $g_1, g_2, \dots, g_n$, and then identifies a value of each component on the basis of another assessment exercise. Formally, the approach can be represented by the following formulae (TEV stands for “Total Economic Value”):

$$G = (g_1, g_2, \dots, g_n), \text{ and } TEV(G) = TEV(g_1) + TEV(g_2) + \dots + TEV(g_n), \quad (1)$$

This has been routinely used in assessing gains from projects that provide multiple benefits in terms of avoided externalities. For instance, if switching from using a car to a bus reduces air emissions, noise and road accidents, then the overall gain from the change in the mode of transport can be decomposed into gains from the separate elements, each of which is estimated on the basis of earlier assessments. Of course, the lack of exact equivalence between the original circumstances and the project under analysis implies possible errors, but they may be considered minor compared to the effort required by conducting a new study (which, actually, would also be subject to uncertainty; Johnston and Rosenberger 2010, Kaul *et al.* 2013).

The second approach is based on interpreting results of a valuation study carried out for one site from the point of view of another site (e.g., Ahtiainen *et al.* 2015, Czajkowski and Ščasný 2010). If, for instance, good G was evaluated at site s (the empirical “study” site), and its value was calculated as $TEV_s(G)$, then the question is how to estimate $TEV_p(G)$, that is, the value of the same good at site p (the “policy” site).

The simplest way would be to assume that $TEV_p(G) = TEV_s(G)$. Nevertheless, for many practical purposes, particularly with international benefit transfers, this is not a satisfactory solution, since it results in relatively high transfer errors (Londoño and Johnston 2012, Bateman *et al.* 2011, Lindhjem and Navru 2008). There are two main reasons why the total economic values of good G at site p and at site s could be different. One reason is that the people whose preferences are taken into account have different incomes in both sites, given by Y_p and Y_s , respectively. If we further assume that the value they attach to the good depends on their incomes with constant elasticity of ε (that is, $TEV_p(G)/TEV_s(G) = (Y_p/Y_s)^\varepsilon$), then

$$TEV_p(G) = TEV_s(G)(Y_p/Y_s)^\varepsilon, \quad (2)$$

This is a benefit transfer statement that is, perhaps, the most frequently used. The elasticity ε has to be determined using some additional information. If there is no convincing argument about the level of elasticity, analysts may assume that it is equal to one (Lindhjem and Navrud 2015). Then, the formula simplifies to $TEV_p(G) = TEV_s(G)(Y_p/Y_s)$.

Another way of extrapolation is to observe that not only people’s incomes, but also other characteristics observed at site s determine $TEV_s(G)$. Analysts assume that $TEV_s(G) = f(x_s, y_s, \dots, z_s)$, where $x_s, y_s, \dots, z_s$ are variables observed at s such that $TEV_s(G)$ depends on them. The function f is called a benefit function. The result of a benefit transfer exercise is then summarised by the formula

$$TEV_p(G) = f(x_p, y_p, \dots, z_p). \quad (3)$$

Formula (2) turns out to be a special case of (3), with income Y playing the role of the single relevant variable, and $f(Y_p)$ defined as $TEV_s(G)(Y_p/Y_s)^\varepsilon$.

Some researchers assume that the more parameters included in the benefit function f , the better (cf. Bateman *et al.* 2011). Indeed, increasing the number of explanatory variables in the definition of f improves the estimation fit at site p . This, however, does not necessarily imply that the accuracy of the transfer will be better. The more variables are taken into account at site s , the more likely it is that some of them are specific for the data set at s , and not necessarily for site p . As a result, the benefit transfer using such a complicated function f may result in a higher error than a simple alternative based, for example, only on income differentials between the two sites (e.g., Ahtainen *et al.* 2015).

Existing research, as well as theoretical arguments, suggest that benefit transfer functions f should have firm foundations in economic theory (Bateman *et al.* 2011). Parsimony is a useful guide for analysts who want to transfer results from an empirical study to a site possessing apparently similar characteristics. Income is an example of a variable that economic theory heavily relies on, while neither age nor attained education seem to play a similarly strong role. Consequently, including income in benefit transfer functions is inevitable. At the same time, using functions that include social and demographic characteristics of stakeholders improves statistical fit to the empirical data sets at site s , but it may appear very misleading when transferred to site p (Bateman *et al.* 2009).

Sometimes policy analysts combine formula (1) with *in-situ* valuation studies. For this purpose, they assume that $G = (g_1, g_2, \dots, g_n)$, and $I(G) = I(g_1) + I(g_2) + \dots + I(g_n)$, where G stands for a good, say, pollution neutralization, and $g_1, g_2, \dots, g_n$ denote specific pollutants. I is the impact function: policy analysts assume that the total impact of, say, pollution reduction is the sum of partial impacts of its components, say, pollutant reductions. Consequently, the value of the total impact is the sum of values of the partial impacts:

$$TEV(I(G)) = TEV(I(g_1)) + TEV(I(g_2)) + \dots + TEV(I(g_n)) \quad (4)$$

The impact function I can be derived from biological or engineering research, while the valuation function TEV can be derived from economic research, and both sources can be separate.

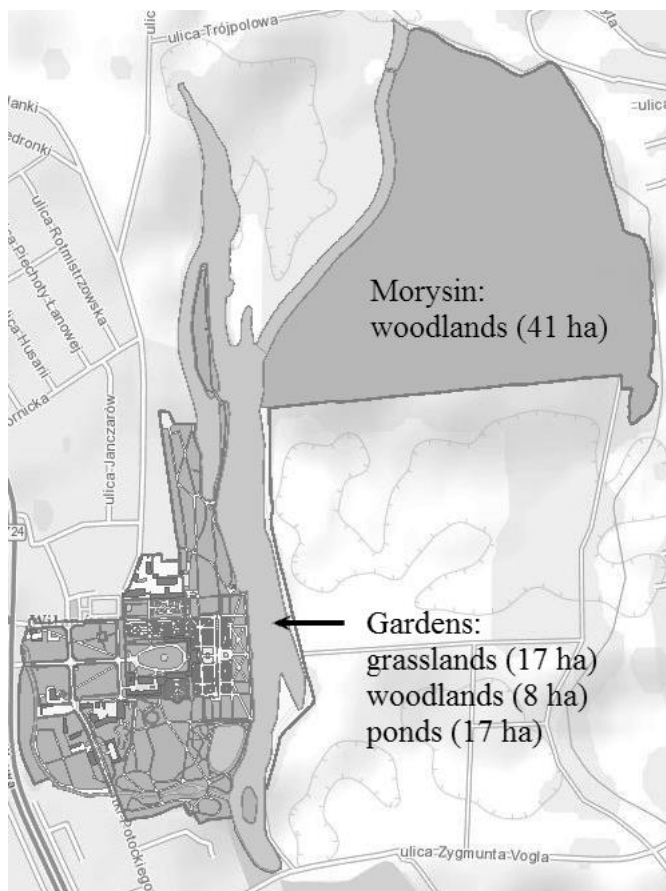
4. Study of Wilanów Park

We now turn to applying the benefit transfer technique, described in Section 2, to estimate the economic value of ecosystem services provided by the Wilanów Park.

The first ecosystem services included in the CICES 2015 encompass provision of raw materials. The Park in Wilanów could, for example, harvest carps in its ponds, produce hay from its grass, and sell timber from its woodlands, but it is not involved in such activities. According to the information provided by the Museum in Wilanów, there is only one product of that sort – compost made out of grass and other organic residues. The annual production of compost in the Wilanów Park in Wilanów is 625 m³, that is, 350 tonnes. Assuming that the market price of compost is 15 euro per tonne, it corresponds to the annual value of 5,250 euro.

The second category of ecosystem services, as proposed in the classification of Costanza *et al.* (1997), covers regulation of natural processes (items 16-35 in the CICES 2015 list), and is evaluated on the basis of various types of benefit transfer techniques. Our study area is composed of three principal biotopes: grasslands, woodlands, and ponds. Their surface is 17 ha, 8 ha, and 17 ha, respectively, with an additional 41 ha of woodlands in the adjacent nature reserve of Morysin. Figure 1 presents the study area.

Figure 1. A map of the study area



Our benefit transfer analysis suggests that ecosystem services corresponding to regulation of natural processes provided by the three biotopes of the Park in Wilanów can be evaluated at 3,100 euro per hectare of grasslands, 3,200 euro per hectare of woodlands, and 8,900 euro per hectare of ponds, annually. Taking the areas of these biotopes into account, the total value of regulation services provided by the Park in Wilanów is 320,000 euro annually. If the Morysin nature reserve is included, the total annual value increases by 135,000 euro.

The value estimates provided in the preceding paragraph are based on the extensive literature survey (Barreiro *et al.* 2005, Bjørner 2004a, Bjørner 2004b, Chau *et al.* 2010, Chen and Jim 2008, Day *et al.* 2007, De Groot *et al.* 2012, Fosgerau and Bjørner 2006, Jim and Chen 2009, Kroeger 2005, MacMullan and Reich 2009, Martín-López *et al.* 2011, Millward and Sabir 2011, Navrud 2000, Navrud 2010, Noel *et al.* 2009, Olewiler 2004, Pimentel *et al.* 1997, Troy and Bagstad 2009, Wilson 2008a, Wilson 2008b, Wilson 2010, Wilson 2012, Xu *et al.* 2003, and

Xue and Tisdell 2001). Only studies carried out in objects similar in terms of biotopes to the Park in Wilanów were used to derive the value estimates.

Relative to other biotope types in the Park in Wilanów, ponds provide ecosystem services of a fairly high value. This high value estimate results from that empirical studies emphasize the important role of aquifers in regulating the water cycle and neutralizing contamination. Although, at first glance, this may seem an overstatement, ponds in the Park in Wilanów indeed play a significant environmental role, in particular, given that water pollution from southern Warsaw – instead of reaching the Vistula river directly – flows before through the Wilanów ponds.

In evaluating the ecosystem services provided by the Park in Wilanów, we also took an alternative approach, based on a detailed inventory of more than 3,000 trees in the Park. Empirical studies from different parts of the world show that urban trees provide several types of benefits, which include stabilising the temperature and removal of toxic substances (Pauleit *et al.* 2000, Dawe 1996, Rosenzweig *et al.* 2006, Peper *et al.* 2007, Nowak 1994). In our analysis, we focus on the latter, since removal of toxic substances is the main service that the trees in the Wilanów Park provide. Various tree species, their physical characteristics, and their ability to decrease the concentration in the air of toxic substances such as sulphur dioxide (SO₂), nitrogen dioxide (NO₂), particulate matter (PM₁₀), and volatile organic compounds (VOCs) are identified as in the study of McPherson *et al.* (2007). Based on this information, we estimate the total pollution removal per annum by the trees in the Wilanów Park at the following levels: 1.82 tonne of sulphur dioxide, 1.16 tonne of nitrogen dioxide, 1.65 tonne of particulate matter, and 0.1 tonne of volatile organic compounds. Next, we use the estimates of external cost of pollutants developed in the EU research project NEEDS (2008) to express the value of the pollution removal service in monetary terms. Table 1 shows the external yearly costs of each of the considered air pollutants (that is, SO₂, NO₂, PM₁₀, and VOCs) for Poland in euro per tonne of the pollutant, as estimated by the project NEEDS.

Table 1. The estimates of the external cost of pollutants (in euro per tonne of the pollutant) based on NEEDS (2008)

	SO ₂	NO ₂	PM ₁₀	VOC
Damages to human health	7,232	4,287	667	499
Damages to biodiversity	-36	1173	0	-59
Damages to crops	-8	155	0	126
Damages to materials	579	145	0	0
Total	7,767	5,760	667	566

Taking into account the estimates of both the total annual pollution removal by the trees in the Wilanów Park and of the external costs of the pollutants, the total value of the ecosystem services provided by the trees is equal to 22,000 euro per year. Given the number of trees in the Wilanów Park, which exceeds 3,000, an average annual benefit provided by a tree is estimated at 7 euro. The value of the ecosystem services calculated on the basis of the tree inventory is lower than the estimate obtained in the benefit transfer approach because the former does not take into account the value provided by other elements of the Park ecosystems than trees and does not include benefits from avoiding damages related to other aspects than those enumerated in Table 1 (that is, beyond damages to human health, biodiversity, crops, and materials).

A precise value estimation of the third group of ecosystem services, that is, societal functions including recreational benefits, provided by the Wilanów Park would ideally be based on primary surveys conducted on an adequate number of (both actual and potential) visitors to the Park, as well as people living in the vicinity of the Park. Surveys are a widely applied tool which allows researchers to collect information about people's preferences. The existing methodology of preference modelling distinguishes two main approaches: either respondents state their preferences in a specially designed surveys which enables for subsequent estimation of values of the considered good, or information is gathered on consumption behaviour of respondents. The latter approach could allow to conduct a so-called travel cost analysis: based on people's choices, the demand for visits to Wilanów could be estimated, which, in turn, would reflect the value of the societal functions fulfilled by the Park. However, we do not have specific data which could allow for conducting such an analysis, and providing accurate value estimates.

Without the data such surveys would provide, one can only refer to the value estimates reported in other assessments, carried out elsewhere. Because the Park in Wilanów is unique and uniquely located, a direct transfer of benefits identified in other objects (as done above, in evaluating regulatory ecosystem services) would be associated with a very large uncertainty. Therefore, we only state that the value estimates found in the existing empirical literature range from 200 euro per ha for open space (Troy and Bagstad 2009, De Groot *et al.* 2012) to 2,000 euro per ha for urban forests (Chen and Jim 2008). On this basis, we can provide a rough estimate that a hectare of the Wilanów Park provides recreational benefits of 1,000 euro. Thus, the Park provides benefits of 42,000 euro per annum. Including the Morysin nature reserve doubles this number.

The summary of the benefits corresponding to each category of the ecosystem services considered is presented in Table 2. In terms of annual flows, the gardens in Wilanów supply services: of provision of raw materials valued at the level of 5,250 euro, of regulation of natural processes at the level of 320,000 euro, and of societal functions at the level of 42,000 euro. When the Morysin nature reserve is included, the annual values increase: to 455,000 euro for the regulating services and to 83,000 euro for the societal functions. Summing the numbers up reveals the total economic value of the services provided by the gardens in Wilanów is equal to 365,250 euro annually, and to 543,250 euro annually when the Morysin reserve is included.

Table 2. Annual values of ecosystem services provided by the Wilanów Park (in euro per year)

	Gardens	Gardens and Morysin
Provision of raw materials	5,250	5,250
Regulation of natural processes	320,000	455,000
Societal functions	42,000	83,000
Total	365,250	543,250

In order to account for uncertainty and much divergence in the estimates reported in the existing studies, we estimated that the total value of the ecosystem services provided annually by the Park (with the mean of 365,250 euro) would be 41,000 euro if lower bounds for the relevant values were adopted, or 546,000 euro if upper bounds for the relevant values were adopted. As

we did not have any hints regarding the income elasticity of any of these services, we applied the benefit transfer approach summarized by formula (1).

The total economic value of the services provided by the Wilanów Park is a large number, but it yields to the historical value of the place. In 2013, the allocation from the state budget for the Museum in Wilanów was 5.75 million euro. If a non-market good – like the Palace surrounded by the Park – does not have a well-established economic value, economists refer to this case as an *implicit value*. The latter is what the society pays in order to secure the supply of the good. A budgetary subsidy serves as a reference. In addition, revenues from selling tickets indicate what individual tourists are willing to pay in order to enjoy this supply.

5. Conclusion

The total *implicit value* of the Park in Wilanów is obviously much higher than the value of ecosystem services provided by its natural environment. This does not indicate that the local ecosystems are of little value. It only implies that the value of historical assets of the Park is so high that ecosystem services do not dominate over it. It further implies that protecting the local nature is certainly called for, but it cannot be used as the main argument for an adequate financing of the royal estate. Neither can one expect that “commercialisation” of ecosystem services – by, for example, raising the prices of visitors’ tickets or of local souvenirs – could provide the Museum with significantly higher revenues.

The Park appears as a unique combination of magnificent architecture and nature. Both ingredients are very valuable, but the uniqueness of the architecture and historical tradition linked to the King's presence is probably more important. Indeed, the local natural resources are precious and provide users (both Warsaw inhabitants and tourists) with tangent benefits. Nevertheless, losing the natural assets – however painful – would imply a lower economic damage to the society than a hypothetical loss of the Palace. Subsidies from the state budget reflect these proportions. Protection of the natural assets in Wilanów can and should be a purpose of the financing, but other objectives may be dominant ones.

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