

Factors influencing citizens' co-production of environmental services: a multi-level analysis

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Abstract

Drawing on the literature on public service co-production, we examine the individual-level factors associated with people's pro-environmental behaviours. We also explore the role that local government-level factors play in shaping those behaviours. Multi-level analyses of data from a survey of citizens across the twenty-two local governments in Wales indicate that individuals who are more altruistic and have high levels of self-efficacy, are more likely to 'co-produce' environmental services through activities such as recycling, volunteering and 'green' consumerism. In addition, women, rural-dwellers, university graduates and middle-aged individuals exhibit more pro-environmental behaviours. Further analysis suggests that environmental co-production is more prevalent in areas with a high degree of compatibility between local public services and citizens, but poorer quality and cheaper services. Stronger backing for 'green' political representation is also important. The theoretical and practical implications of our findings are discussed.

INTRODUCTION

Citizen involvement in the production of public services is generating growing interest among public management scholars and policy makers (Brandsen, Steen and Verschuere, 2018; OECD, 2011; Osborne, Radnor and Strokosch, 2016). Defined as ‘direct and active contributions’ from citizens to the work of public organizations (Brandsen and Honingh, 2016), coproduction has the potential to help governments address the societal challenges that they now confront (Bates, 2012), such as climate change (Bremer and Reisch, 2017) and homelessness (Brown et al., 2012). Despite an explosion of scholarship on citizen involvement in delivering public services (Voorberg, Bekkers and Tummers, 2015), surprisingly little research systematically investigates the influence of individual and organizational factors on co-production.

To date, large-scale quantitative studies investigating the determinants of coproduction have largely focused on individual-level correlates of citizens’ engagement with public services (e.g. Alford and Yates, 2016; Bovaird et al., 2015). While this research has contributed greatly to our understanding of the enablers and barriers to coproduction, empirical research incorporating a wider frame of reference is needed to grasp the full range of variables that shape citizens’ contributions to the delivery of public services (Bovaird and Loeffler, 2012). In particular, theories of public service coproduction point toward the importance of organizational-level factors that facilitate or discourage citizens’ engagement with public services (Voorberg, Bekkers and Tummers, 2015). Building on those theories, we simultaneously analyse individual-level and local government-level factors that influence citizens’ pro-environment behaviours in Wales – one of the four constituent nations of the United Kingdom.

Theories of public service coproduction indicate that citizens' attitudes and demographic characteristics have a bearing on coproductive behaviours and activities, along with a host of different institutional and political factors that shape opportunities for engagement with public services (Voorberg, Bekkers and Tummers, 2015). Altruism and confidence in one's ability to effect change, or self-efficacy, seem likely to be associated with co-production (Alford, 2002; 2009), as does a higher level of education (Egerton, 2002). In addition, women are often socialised to be more other-orientated (Block, 1983) and may be more likely to coproduce than men, as might the middle-aged and rural dwellers (Parrado et al., 2013). Furthermore, citizens served by local governments with stronger participatory structures and attitudes, but poorer quality services may be motivated to engage with public services (Needham, 2008). Each of these factors seems especially likely to influence pro-environmental behaviour, which is characterised by a concern to benefit society and humanity (Berenguer et al., 2005).

To understand the relative salience of individual and organizational influences on citizens' coproduction, we analyse the pro-environmental behaviours of a sample of citizens in Wales. Environmental sustainability is seen as perhaps the paradigmatic societal challenge requiring citizens' co-productive efforts (Bremer and Reisch, 2017), and citizen involvement in the implementation of environmental policies is now a key component of the European Union's 7th Environmental Action Programme (European Union, 2014). These policies have been especially influential in Wales, where a commitment to sustainable development has been legislated for via the Well-being of Future Generations (Wales) Act 2015. Indeed, according to some estimates, municipal and household recycling rates in Wales are among the very best in the world (Eunomia, 2017). Evidence on the determinants of Welsh citizens' pro-environmental behaviour can therefore cast valuable light on the dynamics of coproduction more generally.

Drawing on a large dataset from a national survey of nearly 5,000 citizens, we employ Bayesian multi-level modelling to examine pro-environmental behaviours, such as recycling, volunteering for environmental groups and ‘green’ consumerism. Multi-level research designs are especially appropriate for understanding individual behaviour since they can estimate the effects on individuals of being nested within higher level units of analysis, such as organizations, local areas or, even, countries (Bryan and Jenkins, 2016). For the individual-level of our analysis, we draw upon survey questions measuring two personal attitudes thought to be key to coproduction: altruism and self-efficacy, along with information on demographic characteristics, such as gender, age, education and urban residence. For the upper level of analysis, we focus on local government-level factors likely to shape citizens’ engagement with public services: institutional structures for coproduction; local environmental service expenditure and performance; left-wing political control and ‘green’ political preferences.

Our analysis suggests that altruistic individuals and those with high levels of self-efficacy, are more likely to ‘co-produce’ environmental services, as are women, rural-dwellers, university graduates and the middle-aged. At the local government level, structures for coproduction are associated with more pro-environmental behaviours, as are poor quality and cheaper services, and stronger backing for ‘green’ political representation. However, residents in “producerist” local governments exhibit fewer such behaviours. These results underline the value of multi-level analysis for understanding the dynamics of coproduction.

WHY DO CITIZENS ENGAGE IN THE CO-PRODUCTION OF PUBLIC SERVICES?

High quality public services provide the essential backbone infrastructure for economic and social wellbeing from which citizens, organizations and firms benefit. In recent years, discussions about the sustainability of public services have gained salience considerably, especially in the context of post-crisis austerity policies implemented by many governments in the European Union/West (Burns, Clifton and Quaglia, 2017). These debates have also reflected multiple structural transformations in society, such as demographic changes (Wolf and Amirkhanyan, 2010) and technological revolutions (Gil-Garcia, Dawes and Pardo, forthcoming), as well as the rise of ‘wicked issues’ requiring co-ordinated government action, such as climate change (Pollitt, 2015). In response, new ideas about how to invigorate public services by promoting social innovation have emerged (see, e.g., Osborne, 2010; Osborne et al., 2013). Innovation is a crucial aspect in the quest to adapt public services to better meet the needs of citizens and to obtain value for money in service provision (Osborne and Brown, 2010). Within this setting, co-production is becoming one of the cornerstones of public service innovation, as a means for improving public service delivery and enhancing the role of public services in achieving societal ends and democratic values (Osborne et al., 2016; Pestoff, 2014).

Co-production, however, has become an umbrella term covering very different approaches to citizens’ involvement in public service delivery (Verschuere et al., 2012; Voorberg et al., 2018). Indeed, the co-production literature draws on varying, and sometimes contradictory, definitions of what is (and what is not) co-production (Brandsen and Honingh, 2016). From early definitions of co-production, based on the work of Ostrom and Ostrom (1977), such as Parks et al. (1981), to very recent works,

such as Brandsen and Honingh (2016, 2018), a considerable body of scholarship deals with the concept of co-production (see, e.g., Bovaird, 2007; Brudney and England, 1983; Brandsen and Pestoff 2006, Ostrom, 1996; Pestoff, 2006, among others). Although we do not intend to engage in this paper in the conceptual debate on the definition of co-production, to help frame our study, we draw on one of the most recent definitions, and understand co-production of public services, in a broad sense, as a relationship between citizens and public sector organizations that “requires a direct and active contribution from these citizens to the work of the organization” (Brandsen and Honingh, 2016: 431). The domain of our study, i.e. environmental co-production, constitutes an example of what Brandsen and Honingh (2016) define as *co-production in the implementation of core services*, since providing environmental services is one of the core responsibilities of local governments in Wales (see, <http://law.gov.wales/splash?orig=/constitution-government/government-in-wales>).

Over the last two decades, understanding the conditions under what kind of co-production occurs, both from the citizens’ and organizational/contextual perspectives, has been the object of considerable research efforts (e.g., Alford and Yates, 2016; Bifulco and Ladd, 2006; Bovaird and Loeffler, 2012; Bovaird et al., 2015; Marschall, 2004; Parrado et al., 2013; Voorberg et al., 2017, among others). However, despite the growing interest in explaining factors which influence citizens to co-produce, no research, to the best of our knowledge, quantitatively analyse the combined influence of individual, organizational and contextual factors on citizens’ co-production. Although there is an increasing number of studies using quantitative and even experimental approaches (see, e.g., Jakobsen, 2012; Voorberg et al., 2018), a substantial strand of the co-production literature has focused on case studies using qualitative data (Brandsen et al., 2018). Most of the limited quantitative studies exploring citizens’ co-production

behaviour and attitudes have generally tested the statistical significance and correlates of individual characteristics as part of single-level multivariate statistical models (see Alford and Yates, 2016; Bovaird et al., 2015, 2016; Parrado et al., 2013). The main contribution of this study resides, therefore, in the quantification of the relative influence of different levels on citizens' co-production behaviour. In what follows, we briefly explore individual and organizational/contextual factors that may affect citizens' engagement in the co-production of public services.

Individual factors influencing citizens' co-production.

As discussed, a growing body of empirical literature has focused recently on the determinants of citizens' co-production. Most of these studies were able to identify a number of individual characteristics that may influence citizens' co-production behaviour. First, individual attitudes and motivations seem likely to explain co-production levels. Besides straightforward material incentives to participate in public service delivery (i.e., money, vouchers, etc.), the co-production literature suggests that altruistic motives and intrinsic rewards play key roles when explaining citizens' willingness to engage in co-production of public service delivery (Alford, 2002, 2009; Sharp, 1984; van Eijk and Steen, 2014). In this sense, altruism may result in a sense of satisfaction from helping people in need (Batson and Powell, 2003), serving the interest of a community of people (Perry and Hondghem, 2008), or in a broader sense, contributing to the common well-being (Clohesy, 2000). Among the aforementioned intrinsic rewards, a self-perceived sense of efficacy or, in other words, the notion of *self-efficacy*, seems to be one of the most relevant factors influencing citizens' engagement in co-production (Parrado et al., 2013; Bovaird et al., 2015). It has been argued that citizens' self-efficacy, defined as "the extent to which they [citizens] feel

they can make a difference by influencing the service” (Alford and Yates, 2016: 162), constitutes a powerful intrinsic motivator favouring coproduction behaviour, since this factor reflects both willingness and ability to participate in the delivery of public services (Parrado, 2013; Alford and Yates, 2016).

Besides altruistic values and intrinsic motivations, the related literature has identified a number of socio-demographic factors, such as gender, age, education, and the urban/rural divide, that are likely to influence co-production behaviour (see, e.g. Parrado et al., 2012; Bovaird et al., 2015). More specifically, empirical evidence suggests that women are more likely to volunteer than men (Christensen and Laegreid, 2005), and tend to engage more in co-production activities (Parrado et al., 2013). Age seems to be another important predictor of co-production; in particular, previous research suggests that the elderly are more likely to engage in civic activities (Putnam, 2001) and individual co-production (Bovaird et al. 2015). However, the effect of age may be non-linear, since middle-agers appear to be the most proactive when volunteering (Wilson, 2012). Despite these results, other studies have found a negative correlation between age and co-production (Bovaird et al., 2016; Parrado et al., 2013). In sum, the influence of age on co-production behaviour is far from clear.

Education has also been suggested as an important predictor of citizens’ participation (Egerton, 2002), though most quantitative studies have found that education makes little (or no) difference to co-production levels (Alford and Yates, 2016; Parrado et al., 2013). Nevertheless, previous studies by sociologists and psychologists suggest that well-educated people would be more aware and concerned about environmental issues (see, e.g., Marquart-Pyatt, 2012; Ostman and Parker, 1987), which may lead citizens to actively collaborate in protecting the environment. Hence, we expect that education would be positively correlated with environmental co-

production behaviour. Finally, it has been found that living in an urban location may be negatively correlated to the willingness to co-produce, particularly as regards environmental issues (Parrado et al., 2013). This is consistent with some recent studies by environmentalists, which suggest that rural residents place a higher priority on the environment and report higher participation in pro-environmental activities (see, e.g., Berenguer et al., 2005; Huddart-Kennedy et al., 2009).

The multilevel nature of co-production

Research in public policy and public administration is increasingly taking into account the multilevel nature of governance or, in other words, the fact that outcomes and processes in public organizations may be the result of individual, organizational, and contextual characteristics operating at different levels (Miller and Moulton, 2013: 555). Hence, it is conceivable that a further set of factors that might affect citizens' co-production can be found in the organizational/contextual setting.

Voorberg et al (2015), in a recent systematic review of the co-production literature, identify three key organizational factors that might explain/influence co-production: (i) compatibility of public organizations with citizens' participation, (ii) attitude of public officials towards citizens' participation and, (iii) administrative culture. Paraphrasing Voorberg et al.'s words (1343), compatibility refers to the presence of organizational structures favouring citizens' participation. For example, the presence of community organizations, such as non-for-profit and voluntary organizations, might expose citizens to a wide range of ideas and experiences, which may lead to the development of shared values about public life and collaboration through interaction in horizontal networks (Andrews and Brewer, 2010: 578).

Second, attitudes of public officials refers to the willingness of politicians and public servants to collaborate with citizens, which has also been considered a potential predictor of co-production by citizens. For example, Coursey et al. (2012) argue that citizens' participation requires public managers who "truly value" that participation and, therefore, engage with citizens "actively and creatively" (578). In this line, public officials willing to engage with citizens would put more effort into providing tools and incentives for citizens' participation (Bryer, 2007; Handley and Howell-Moroney, 2010). The third organizational factor that might influence co-production refers to the administrative culture of public organizations. Differences in governance traditions may explain variations in co-production behaviour; for instance, inclusive administrative cultures of sharing with non-governmental stakeholders, such as civil society or private actors, may cultivate collaborative structures favouring public services co-production (Woorberg et al., 2017). On the other hand, paternalist administrative traditions that consider citizens as just service recipients instead of partners might result in a lack of collaborative structures to encourage participation (Maiello et al. 2013; Woorberg et al., 2015). For example, left-wing controlled governments that support trade unionism and in-house public service provision are often assumed to exhibit a "producerist" attitude that professionals know best (Geddes, 2001; Laffin, 2008).

A further organizational factor that might help to explain co-production behaviour is the quantity and quality of public services provided by governments. In this sense, citizens may engage more in co-production activities if they feel that the quantity and/or quality of services provided by government is poor (Alford and Yates, 2016). However, it has also been argued that poor government performance (in terms of public service delivery) might undermine citizens trust in government (van Ryzin, 2007) and, consequently, their willingness to co-produce (Alford and Yates, 2016),

hence the effect of government performance on citizens' co-production may run in both directions.

DATA AND METHODS

To explore the factors that may affect citizens' behaviour towards co-production of environmental services, we gathered individual level data from the 2016-2017 National Survey for Wales (NSW), which is conducted by the Welsh Government. The 2016-2017 NSW involved/surveyed over 10,000 people across the 22 Welsh Local Governments (LGs). This large-N survey provides evidence on people's views about different topics such as housing, health, environment, sports and recreation, democracy and government, among others. The survey results are intended to inform and shape policy decision-making by public organizations in Wales (Aumeyr et al., 2017).¹ The 2016-2017 NSW replaced the Welsh Outdoor Recreation Survey as a source of information on attitudes towards the environment. Informants answering questions related to environmental actions consisted of a survey subsample of 5,266 people. After cleaning the data, our dataset includes 4,957 individual observations across 22 LGs.

Dependent variable

The dependent variable, *environmental co-production*, is a count of the pro-environmental activities undertaken by NSW respondents, which serves as a proxy for environmental co-production behaviour. These activities/behaviours are: (1) recycling, (2) switching to a green energy supplier, (3) buying appliances which are more energy efficient, (4) reducing the amount of energy used at home, (5) purchasing eco-friendly products, (6) gardening for wildlife (7) contacting the local MP (Member of Parliament)

¹ For a comprehensive explanation of the survey methodology, sampling strategy, etc, we refer the reader to Aumeyr et al. (2017).

or AM (Assembly Member) about environmental issues, (8) signing a petition about climate change or conservation, (9) actively volunteering to help protect the environment and, (10) being a member of an environmental or climate change group.

To construct our environmental co-production indicator, we sum each activity/behaviour coded 1= respondent undertook the activity, 0=otherwise, resulting in a co-production index bounded between 0 and 10. This additive approach to constructing co-production indicators has been used in nearly all recent studies attempting to analyse factors influencing co-production behaviour using survey data (see, Parrado et al., 2013; Bovaird et al., 2015).

Individual level explanatory variables

At the individual level, we include a number of independent variables as proxies for the personal characteristics that may influence citizens' co-production behaviour. First, to evaluate the influence on altruistic values on citizens' willingness to co-produce we use as a proxy a dummy variable which takes a value of 1 if the respondent is a carer for other people, i.e., if they look after, or give any help or support to family members, friends, neighbours or others. It has been argued that one of the principal motivational bases of informal care is altruism (e.g., Abrams and Bulmer, 1985), hence this variable, though contestable as all proxy measures, should account reasonably well for people's altruistic values.

Second, we measure *self-efficacy* using a survey question assessing citizens' perceptions of their influence in local policy decisions. Informants were invited to indicate on a 5-point Likert scale from 1 (strongly agree) to 5 (strongly disagree) the extent to which they were able to influence decisions affecting their local area. To facilitate interpretation of the results we reversed the scale, so that a score of 5 stands

for "strongly agree", whereas a score of 1 reads as "strongly disagree". This proxy is similar to those measures of self-efficacy used in previous co-production research (see, Parrado et al., 2013; Bovaird et al, 2015), and is closely related to the concept of internal political efficacy from the political science literature (Balch, 1974; Madsen, 1987). The prediction is that a higher degree of perceived self-efficacy (or internal efficacy) would be associated with higher levels of citizen participation and civic engagement (Finkel, 1985; Pinkleton and Austin, 2001), hence associated with a higher number of environmental co-production behaviours,

In addition to gauging the influence of altruism and self-efficacy on environmental co-production behaviour, we include in our models a number of demographic factors that, as discussed, might affect citizens' co-production. First, we account for the respondent's gender by including a dummy variable which takes the value of 1 if the informant is a woman. Second, we include a continuous covariate measuring the respondent's age. Education level is measured through a dummy variable taking values of 1 if respondents hold a diploma, first degree, higher degree or equivalent and 0 otherwise. Finally, we include a dichotomous variable coded 1 for those respondents residing in urban areas and 0 for those living in rural areas.

Local government level explanatory variables

In addition to these indicators of individual characteristics, we include measures capturing contextual and organizational factors that might influence co-production behaviour at the local government level. Specifically, we include in our models six variables that proxy for: the existence of organizational structures favouring citizens' participation; the willingness of public officials to engage with citizens; the quantity and

quality of the services provided by each local government; and the degree of support for green politics.

First, to proxy for the presence of organizational structures which may foster citizens' participation or, in other words, the degree of organizational *compatibility* regarding co-production, we create a variable (*compatibility*) defined as the logarithm of the number of Communities First partnership members by LG (which include the community, statutory, voluntary and business sectors). The Communities First was a community program launched in 2001 by the Welsh Government to help improve local communities and address poverty issues. Given that the program was addressed to the most deprived neighbourhoods in Wales, deprivation levels and the number of Lower Super Output Areas (LSOA) within each LG may influence the number of partnership members, hence biasing our indicator. To overcome this potential problem, we weighted the indicator using the Welsh Index of Multiple Deprivation and the number of LSOAs in each LA. More specifically our compatibility indicator is computed as follows:
$$compatibility_i = \log \left[nCF_i * (1 - deprivation_i) * \left(1 - \frac{nLSOA_i}{Total\ n\ LSOAs} \right) \right]$$
, where nCF_i refers to the number of partners in LA i , $deprivation_i$ refers to the percentage of LSOAs in LG i among the top 50% most deprived in Wales, and $nLSOA_i$ refers to the number of LSOAs in LG i . Information on the number of Communities First partnership members was drawn from the annual monitoring reports that partnerships were required to produce from April 2011 to September 2012. Deprivation data and number of LSOAs were retrieved from Stats Wales (<https://statswales.gov.wales>).

Second, we measure the willingness (or reluctance) of public officials to engage with citizens via an aggregated indicator calculated by the Welsh Government using data from the 2014-2015 NSW. More specifically, our proxy measure, labelled as

attitude, consists of the percentage of informants that strongly agree that their locally elected political representative works closely with the community. We use already aggregated data instead of creating a similar measure using the 2016-2017 NSW to avoid a potential source of common method bias.

Third, to test the influence on co-production of the administrative culture of public sector organizations, we include in our model a dichotomous variable which takes a value of 1 if the Labour Party controls the local government after the 2013 Welsh local elections, and 0 otherwise. The prediction is that Labour-controlled authorities might have a more pronounced producerist ‘government knows best’ culture, which is more focused on “control” rather than citizen involvement and empowerment (Marsh, 2008: 259). Such a culture has arguably been evident at all levels of Labour-led government in post-devolution Wales (Reynolds, 2008).

To proxy for the quantity and quality of public services provided by the local government we include the following measures. As a first proxy measure for the quantity of environmental services provided by each LG, we include the logarithm of the *per capita* spending on environmental services. Financial resources expended on public services have been commonly regarded in the public administration literature as an important predictor of public service performance (see, e.g., Andrews et al., 2008). The second proxy accounting for the quantity and quality of environmental services is an aggregate indicator of citizens’ *satisfaction* with the recycling collection service provided by the local council. More specifically, our measure consists of the percentage of local residents who express they are very satisfied with such services. In line with our measure for public officials’ *attitude*, we draw on an aggregated indicator provided by the Welsh Government using data from the 2014-2015 NSW.

Finally, we argue here that, in our study case, wider public environmental concerns may help boost citizens' co-production of environmental services (Axelrod and Lehman, 1993). Hence, we use the percentage share of the vote gained by the Green Party in the 2013 local elections to capture the extent of local residents' environmental concerns. Local areas voting Green are expected to have a stronger pro-environmental disposition favouring environmental co-production behaviours. Data sources for all the variables included in our analysis are reported in Table 1, along with descriptive statistics.

Table 1. Descriptive statistics and data sources.

	Source	Mean	Std. Dev.	Min	Max
<i>Dependent variable</i>					
Co-production index	A	2.64	1.48	0	10
<i>Individual level explanatory variables</i>					
Carer	A	0.32	0.47	0	1
Self-efficacy	A	2.35	1.13	1	5
Female	A	0.55	0.5	0	1
Age	A	54.82	18.29	16	90
Higher education	A	0.37	0.48	0	1
Urban	A	0.59	0.49	0	1
<i>Local government level explanatory variables</i>					
Compatibility (log)	B	3.85	0.66	2.51	4.93
Attitude	C	28.66	10.21	11	57
Labour control	D	0.44	0.5	0	1
Environmental spending per capita (log)	E	4.84	0.17	4.51	5.11
Recycling satisfaction	C	44.78	7.21	27	56
Green party vote share	D	0.83	1.63	0	6.5

Data sources: A. Welsh Government (NSW 2016-2017); B. Communities First annual monitoring reports; C. Welsh Government (aggregated indicators based on NSW 2015-2015); D. BBC Local Elections website; E. Welsh Government.

Methodology

In order to investigate the individual, contextual and organizational factors influencing environmental co-production behaviour, we employ Bayesian multilevel modelling techniques. Multilevel models, also known as hierarchical models, are especially

appealing for our analysis since they can estimate effects both at the individual and at the local government level where individuals reside. Further, our dependent variable, i.e. the number of co-production behaviours, is a count variable. When analysing count data, using simple linear regression methods may result in inconsistent, inefficient and biased estimates due to the discrete and nonnegative nature of count variables (Long, 1997; Cameron and Trivedi, 1998). These properties of count data suggest that, in our case, a multilevel Poisson model might be helpful to account for the count nature of the dependent variable (see, e.g., Gelman and Hill, 2007).

To fit such Poisson multilevel models, we propose in this paper the use of Bayesian methods. Although there are a number of efficient Maximum Likelihood (ML)-based estimation techniques to fit multilevel models, Bayesian methods using Markov Chain Monte Carlo (MCMC) techniques have been found to perform better than ML when the number of level-2 units (Welsh local governments in our case) is relatively small (Bryan and Jenkins, 2016). Hence, we propose to use a Bayesian approach based on Metropolis-Hastings random walk sampling via MCMC simulation techniques. MCMC sampling procedures for our multilevel models are based on 1.300.000 draws with the first 100.000 draws omitted. These first draws are excluded to account for the *burn-in* period of the sampler. In addition, to decrease the autocorrelation of the simulated MCMC sample and improve the precision of the Bayesian simulations, we use a thinning factor of 4 for all chains, thus resulting in 300.000 effective MCMC draws.²

It should be highlighted that Bayesian methods involve choosing a prior probability distribution for the parameters before analysing the data, such choice being the object of substantial debate in the related literature (see, e.g., Berger, 2006; Browne

² The choice of the number of effective MCMC draws was based on chains' convergence diagnosis. The posterior plots depicted in figures 1 and 3, along with an inspection of chains' trace plots (available on request) suggest that all chains converged reasonably well.

and Draper, 2006; Efron and Morris, 1972; Gelman, 2006). Prior distributions can range from informative descriptions of previous research, to non-informative priors based on little prior knowledge about the effect under analysis (Gill and Witko, 2013). Given the few empirical studies addressing the question of what factors motivate citizens' co-production, we decided to use weakly informative priors in our MCMC simulations. In particular, we use a Normal(0, 10^4) prior for the "fixed" parameters of the model, and a half-Cauchy prior with mode at 0 and scale set to 30, for the variance hyperparameter (see, Gelman, 2006).

RESULTS

In this section, we present the estimates of our empirical models. We begin by fitting a varying-intercept³ multilevel model including only individual predictors (model 1) and we then add to this model the local government level variables (model 2). Before reporting and discussing our results, it should be noted that, from a Bayesian perspective, statistical inference can be performed through an analysis of the posterior distribution. Hence, we report in Table 2 a numerical summary of the posterior, i.e. posterior means, standard deviations, and 95% credible intervals, for the statistical models. In addition, to further facilitate results' interpretation we show in figures 1 and 3 the posterior probability densities for both multilevel models, approximated by kernel density estimation. In addition to the Bayesian approach, we also report results of estimating the same multilevel models using ML techniques (see Appendix A. Table A1). Although, as discussed, ML techniques might perform worse in our case, they offer a benchmark to check the robustness of the results to different estimation methods.

³ For a comprehensive review of different types of multilevel models, we refer the reader to Gelman and Hill (2007).

Individual factors affecting the probability of co-producing environmental services

We begin our empirical analysis by testing which citizens' characteristics might influence the probability of engaging in co-production activities. Consistent with our expectations, altruistic values and perceptions of self-efficacy are both important predictors of co-production behaviours. Conditional on the model and data, results for both models, i.e. models 1 and 2, show that there is a 95% probability that the coefficient associated with being a *carer* would be positive. Thus, in line with our theoretical expectations, altruistic values seem to be a key motivator of co-production behaviour.

Similarly, our results also suggest that intrinsic rewards such as the belief that one can positively influence local policy decisions play a key role in predicting co-production behaviours. Again, an inspection of the posterior probability densities depicted in figures 1 and 3, along with the credible intervals reported in table 2, suggest that there is a 95% probability that the parameter estimate of *self-efficacy* takes a positive value.

Moving now onto those socio-demographic characteristics predicting co-production behaviours, our results are mostly consistent with previous empirical studies; women, middle-aged citizens, the better-educated and those living in rural areas are more likely to engage in co-production activities. Among these factors, our results suggest that education and living in rural areas are particularly strong individual-level determinants of environmental co-production: the posterior means of both variables being about 0.22 and 0.11, respectively. Regarding *age*, it should be noted that the negative coefficient associated with the squared term, along with the positive coefficient

of the estimates for *age*, suggest that there is a non-linear effect of *age* on environmental co-production behaviours.

Figure 1. Posterior probabilities density. Model 1.

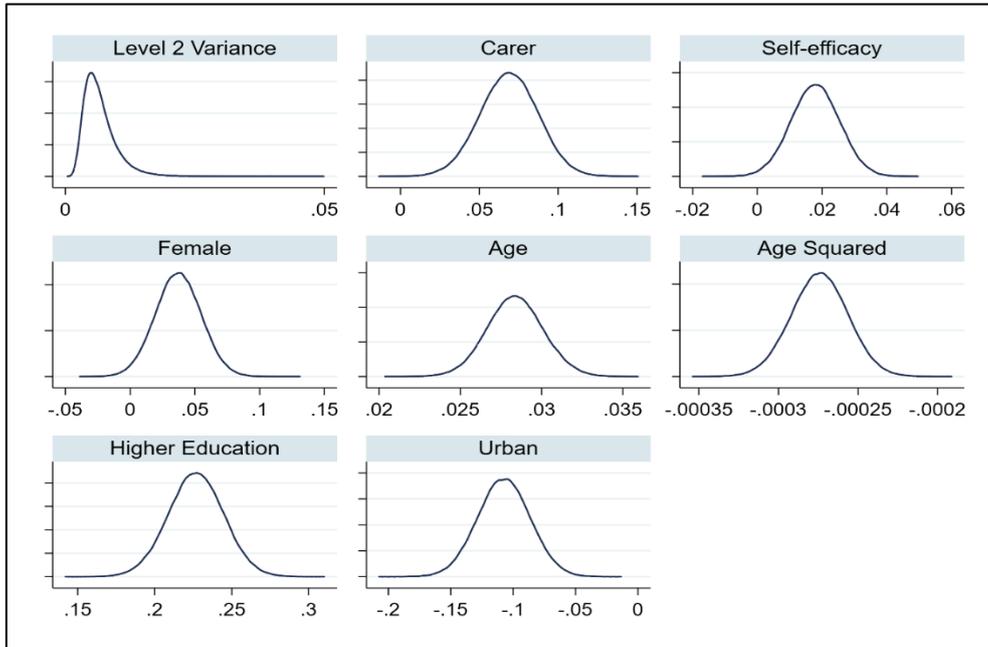


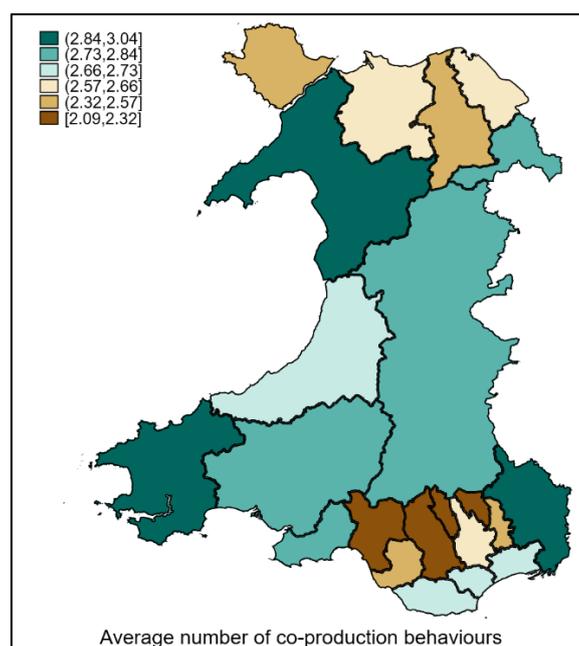
Table 2. Multilevel Poisson estimates of factors influencing environmental co-production.

	Model 1				Model 2			
	Mean	Std. Dev.	[95% Credible Interval]		Mean	Std. Dev.	[95% Credible Interval]	
<i>Individual level explanatory variables</i>								
Carer	0.0689	0.0185	0.0325	0.1048	0.0786	0.0144	0.0501	0.1065
Self-efficacy	0.0179	0.0075	0.0032	0.0326	0.0136	0.0066	0.0008	0.0267
Female	0.0372	0.0176	0.0029	0.0718	0.0372	0.0171	0.0037	0.0710
Age	0.0284	0.0017	0.0250	0.0318	0.0265	0.0027	0.0213	0.0319
Age Squared	-0.0003	0.0000	-0.0003	-0.0002	-0.0003	0.0000	-0.0003	-0.0002
Higher education	0.2268	0.0180	0.1914	0.2620	0.2257	0.0175	0.1921	0.2605
Urban	-0.1074	0.0210	-0.1485	-0.0662	-0.1106	0.0076	-0.1256	-0.0956
<i>Local government level explanatory variables</i>								
Compatibility (log)					0.0486	0.0174	0.0142	0.0826
Attitude					-0.0004	0.0013	-0.0030	0.0023
Labour control					-0.1424	0.0203	-0.1824	-0.1026
Environmental spending per capita (log)					-0.1523	0.0409	-0.2340	-0.0724
Recycling satisfaction					-0.0037	0.0012	-0.0062	-0.0013
Green party vote share					0.0157	0.0096	-0.0028	0.0353
<i>Random effects/</i>								
Level 2 Variance	0.0067	0.0032	0.0025	0.0146	0.0033	0.0021	0.0006	0.0087
N (individuals)	4957				4957			
N (local governments)	22				22			
Acceptance Rate	0.325				0.317			
MCMC Effective Sample	300.000				300.000			

Do organizational/contextual factors matter when predicting co-production behaviours?

Besides evaluating individual characteristics that may predict co-production behaviour, this analysis sought to test whether local factors could provide further explanation about the likelihood of citizens' engagement in environmental co-production activities. First, if the local context helps to explain citizen's co-production behaviours, one may expect to see a relatively wide variation in the number of co-production behaviours across Welsh local governments. This indeed seems to be the case. Figure 2 shows the spatial distribution of our co-production index by local government. Clearly, the average number of co-productive behaviours varies substantially across governments; the highest average number of co-production activities can be found in Monmouthshire, Pembrokeshire and Gwynedd, while the lowest is observed in Neath Port Talbot, Rhondda Cynon Taf, Merthyr Tydfil and Blaenau Gwent (see also the density histograms depicted in Appendix A; Figure 1A).

Figure 2. Distribution of co-production behaviours among Welsh Local Authorities

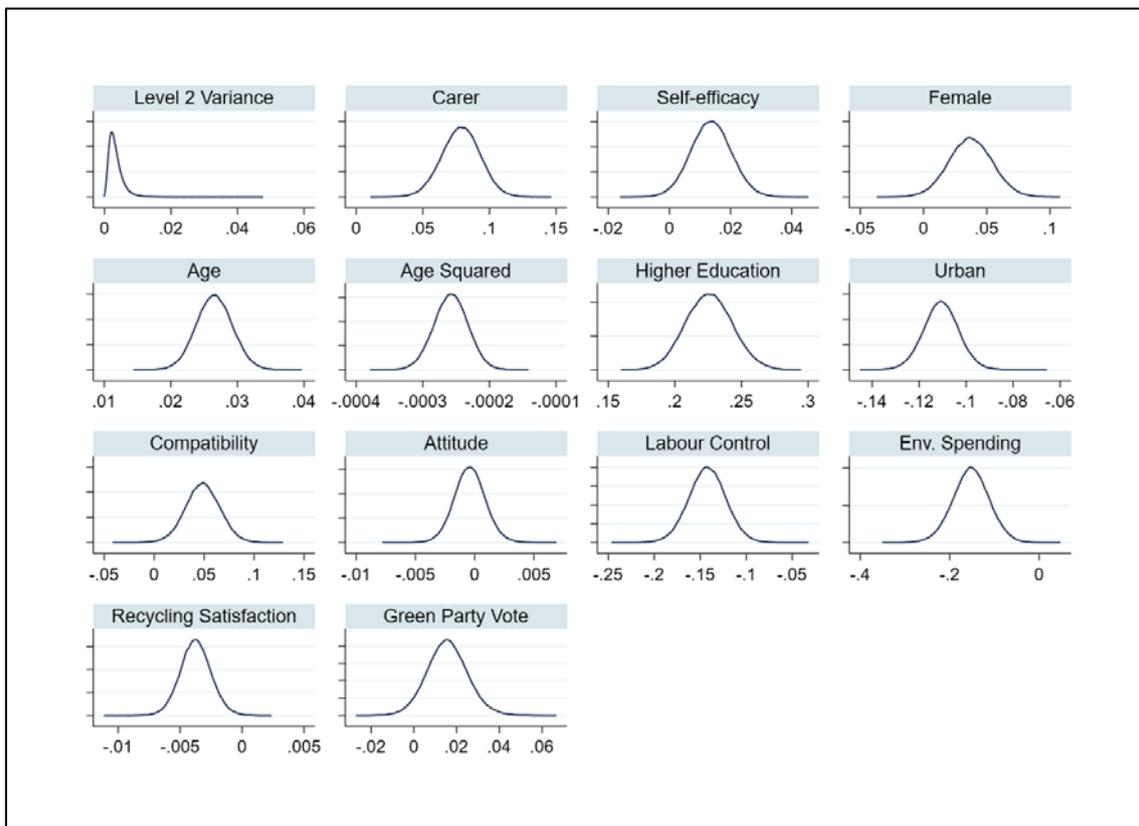


The results from our multilevel models confirm these initial exploratory findings. First, the LA-level variance in Model 1 (95%CI [0.0025, 0.0146]), along with the LR test comparing the multilevel model with one-level regression depicted in Table 1A (p-value=0.000), indicate that there is variation between Welsh LGs as regards citizens' environmental co-production behaviours. Furthermore, the LG-level variance is reduced when including those LG level contextual/organizational factors that might affect citizens' co-production (Model 2), which suggests that we were able to identify LG-level factors influencing co-production (Model 2 Variance – 95% CI[0.0006, 0.0087]).

The output of Model 2 reported in Table 2 and Figure 3 confirms most of our expectations relating to those LG organizational/contextual factors influencing citizens' co-production. First, the *compatibility* of public organizations with respect to co-production, measured as the log of the number of Communities First partnership members, seems to explain, to a certain extent, why citizens engage in environmental co-production. The posterior mean of *compatibility* is positive (about 0.06) and the posterior probability density is clearly centred away from zero (see Figure 3). In this line, our results suggest that *administrative culture* is also an important predictor of co-production: individuals living in producerist LGs exhibit fewer pro-environmental behaviours as indicated by the negative posterior mean of the Labour party control dummy (about -0.14) and the density of the posterior probability, which clearly takes negative values. By contrast, we find that, conditional on the model and data, the *attitude* of public officials towards citizens' participation does not seem to predict co-production, the posterior probability density of this parameter being centred around zero.

Turning our attention to the potential influence on co-production of the quantity and quality of public services provided by the local government, we find clear evidence that this is a key factor shaping pro-environmental behaviours. The parameter estimates for our two measures of quantity and quality of public services, i.e, environmental spending per capita and citizens' satisfaction with recycling services, point in the same direction, the posterior means of all these parameters being negative and almost the whole mass of the posterior probability densities taking negative values. Finally, we find that citizens' in local governments with higher Green Party vote shares appear to be more likely to engage in environmental co-production, which points towards the responsiveness of local residents to environmental concerns.

Figure 3. Posterior probabilities density. Model 2.



CONCLUSION

This paper illustrates the multi-level nature of coproduction: individual-level factors drive people in Wales to engage in more pro-environmental behaviours, but so too do local government-level factors. More specifically, altruism and self-efficacy appear to be personal attitudes that are critical to coproduction, while local institutional structures, priorities and performance are organizational factors that seem to make a real difference. These findings have theoretical and practical implications.

Although demographic characteristics are important determinants of coproduction, individuals' personal values also matter. From the individual-level perspective, our study provides support for theories of coproduction that emphasise the motivating force of intrinsic rewards. Altruism and self-efficacy have been found to positively influence citizens' propensity to coproduce in previous quantitative research (Parrado et al., 2013; Bovaird et al., 2015). The evidence we present here highlights that the intrinsic rewards associated with these attitudes seem to be a major influence on people's pro-environmental behaviour, underlining the value of psychological or behavioural approaches to understanding coproduction (see Voorberg, Jilke, Tummers, and Bekkers, 2018, for example). At the same time, our study confirms the role that organizations can play in facilitating or discouraging coproduction.

Much of the coproduction literature stresses the importance of organizational-level factors (Voorberg, Tummers and Bekkers, 2015), yet scant research systematically evaluates the connections between organizational behaviour and outcomes and citizens' coproductive activities. Our findings suggest that pro-environmental behaviours may substitute for the provision of poor quality environmental services and for 'producerist' public service provision. Nevertheless, they also indicate that participatory structures may be associated with positive engagement with environmental issues. This evidence

therefore offers a nuanced corrective to a straightforward zero-sum viewpoint on citizens' coproduction activities – coproduction may be a replacement for effective state-led public services, but in the right circumstances it may be a source of additional institutional capacity as well (Needham, 2008).

Practically speaking, our analysis suggests that policies intended to promote the coproduction of public services may benefit from a dual approach, focused on: i) inculcating positive attitudes among citizens; and, ii) the establishment of participatory structures for citizens' engagement with local policy-making. Civic education programmes intended to engage, educate and empower citizens may boost their self-efficacy (Andrews et al, 2008). Well-managed partnerships between public, private and non-profit organizations can potentially open up new spaces of inclusion through which citizens' influence on decision-making may be institutionalised (Bristow et al., 2008). Notwithstanding the challenges in making engagement with public policy work (Few, Brown and Tompkins, 2007), these two approaches can have positive reciprocal effects on each other. Empowered citizens may be more likely to engage with participatory structures, while involvement in participatory structures may increase a sense of empowerment.

Despite the strengths of our multi-level research design, there are limitations to our analysis that open up possibilities for further investigation. Firstly, we draw upon a cross-sectional snapshot of citizen's behaviour, meaning we are unable to offer any definitive claims regarding causality within our study. In particular, further research drawing on longitudinal or experimental data is needed to establish the extent to which coproduction is a response to poor provision or whether it is a phenomenon that prompts public organizations to under-provide key services (Percy, 1984). Secondly, although common method bias is not a serious threat to our findings at the

organizational-level, research designs that utilise different sources of data for key individual-level constructs would be valuable. Finally, the analysis presented here has examined environmental coproductive activity among a sample of citizens from a single country during a specific time period. It would be important to identify whether the relative importance of individual and organizational-level factors differs for educational, healthcare or other aspects of coproduction, as well as in other countries and in other time periods.

In conclusion, this study has examined the relationship between a series of individual and organizational level factors and the pro-environmental behaviour of a sample of Welsh citizens. In doing so, it highlights that a multi-level approach is needed to properly understand the determinants of citizens' coproductive activity: personal attitudes, demographic characteristics, organizational behaviour and outcomes all influence pro-environmental behaviour. These findings therefore represent an important contribution to theories of coproduction in the public sector and can assist in further unpacking the ways in which public managers and policy-makers can seek to boost coproduction as a vital source of social innovation.

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APPENDIX A

Table 1A. Multilevel Poisson Maximum-likelihood estimates.

	Model 1				Model 2			
	Coefficient	Std. Error.	[95% Confidence Interval]		Coefficient	Std. Error.	[95% Confidence Interval]	
<i>Individual level explanatory variables</i>								
Carer	0.0707	0.0187	0.0341	0.1074	0.0714	0.0187	0.0347	0.1081
Self-efficacy	0.0158	0.0078	0.0005	0.0311	0.0159	0.0078	0.0006	0.0312
Female	0.0367	0.0177	0.0020	0.0714	0.0366	0.0177	0.0019	0.0713
Age	0.0262	0.0029	0.0205	0.0320	0.0263	0.0029	0.0206	0.0321
Age Squared	-0.0003	0.0000	-0.0003	-0.0002	-0.0003	0.0000	0.0003	-0.0002
Higher education	0.2280	0.0182	0.1924	0.2637	0.2247	0.0182	0.1890	0.2603
Urban	-0.1133	0.0214	-0.1551	-0.0714	-0.1087	0.0217	-0.1512	-0.0661
<i>Local government level explanatory variables</i>								
Compatibility (log)					0.0511	0.0225	0.0070	0.0952
Attitude					-0.0008	0.0014	0.0036	0.0019
Labour control					-0.1407	0.0374	-0.2141	-0.0674
Environmental spending per capita (log)					-0.1757	0.0899	0.3520	0.0005
Recycling satisfaction					-0.0044	0.0018	0.0079	-0.0008
Green party vote share					0.0106	0.0095	0.0080	0.0292
<i>Random effects/</i>								
Level 2 Variance	0.0045	0.0020	0.0019	0.0107	0.0012	0.0010	0.0003	0.0059
N (individuals)	4957				4957			
N (local governments)	22				22			
Log-likelihood	-8517.93				-8510.27			
LR-test (p-value)	0.000				0.043			

Figure 1A. Density histograms of the co-production index by local authority

