The Role of Social Norms and Economic Incentives in Encouraging the Adoption of Native Gardens

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ABSTRACT *Various policy interventions can be implemented to motivate individuals to adopt pro-environmental landscaping behaviors. Here we compare the influence of economic incentives and social norms on urban landowners' adoption of native gardens. First, we model the relationship between social norms and landowners' actual land use decisions. We estimate adoption intention under different support programs with a choice experiment, also considering social norms. We find that social norms can play a significant role in the adoption of native gardens, comparable to relatively expensive financial incentives. Therefore, social norms may enhance the performance of incentives to increase rates of land conservation.* (JEL Q51, Q58)

1. Introduction

Social norms are recognized as important influences on pro-environmental behavior (Thaler and Sunstein 2008; Madrian 2014; Farrow, Grolleau, and Ibanez 2017; Grilli and Curtis 2021). These norms reflect a shared understanding of appropriate or customary behaviors in society and operate when individuals observe or receive information about the behavior of others (Dannenberg et al. 2024). There is growing evidence that norms can be effective in driving pro-environmental behaviors (Farrow, Grolleau, and Ibanez 2017). Examples can be found in the contexts of reducing household water consumption (Ferraro, Miranda, and Price 2011), conserving energy (Allcott 2011), and promoting climate-friendly food choices Griesoph et al. 2021). Still, there is uncertainty regarding the relative influence of social norms and economic incentives in motivating individuals to adopt pro-environmental behaviors.

In this article, we investigate the influence of social norms and economic incentives on urban landowners' adoption of native gardens. This form of gardening can be an important part of climate adaptation strategies in water-scarce cities. Native gardens require less water than irrigated lawns, which are common in suburban landscapes (Ligtermoet et al. 2022; Doll et al. 2024). In addition, native plant species in urban areas can provide direct biodiversity benefits and indirectly play a role in the diversity and abundance of animal species, including native birds (Ikin et al. 2013) and bats (Threlfall et al. 2016). Our research centers on native garden adoption on verges (commonly referred to as nature strips or boulevards), an area of land between streets and residential property boundaries. They are positioned at the front of properties, running along roads and walking paths, and are highly visible to other community members.

Land Economics • November 2025 • 101 (4): 482–498
DOI:10.3368/le.101.4.061524-0051R1
ISSN 0023-7639; E-ISSN 1543-8325

The positioning of verges along roads implies that they may provide ecosystem connectivity benefits. Verges are a common feature of streetscapes in North American, Australian, and South African cities, providing a considerable extent of green space in urban areas (Marshall, Grose, and Williams 2019). Because of their extent and the potential to provide diverse ecological benefits, many environmental managers are interested in increasing residents' adoption of native verge gardens.

Converting verges to native gardens includes land preparation (e.g., removing existing land covers, preparing soil, weed control) and planting. Accordingly, time, materials, labor, and transaction costs are among the relevant costs of adopting ecological landscape designs (Johnston, Ndebele, and Newburn 2022). Partially or fully covering these costs through programs offering direct payments to potential adopters may be required to motivate change from conventional land use practices toward more environmentally beneficial alternatives (Siebert, Toogood, and Knierim 2006). Using public funds for this compensation may be justified from the positive externalities (i.e., public water-saving and biodiversity-enhancement benefits) that can result from conversions to native gardens.

Whether taken in isolation or in combination with economic incentives, social norms may be relevant to native garden adoption behavior. Activating social norms can be an effective way to encourage this pro-environmental behavior at relatively low cost to governments (Savari et al. 2023). Examples of social norm–based interventions that include establishing "model" early adopters to demonstrate a socially desirable behavior change and providing information to potential adopters about the opinions and preferences of others in their network (Abrahamse and Steg 2013). These interventions motivate action through individual reactions to community expectations (Perry et al. 2021).

Where ecological landscape designs are present, the desire to conform with neighborhood norms has been found to have a positive influence on individuals' decisions to establish and maintain these landscapes (Nassauer, Wang, and Dayrell 2009; Goddard, Dougill, and Benton 2013; Ahn et al. 2024). Referred to as a mimicry effect, studies have demonstrated strong autocorrelations in spatial structures of vegetated areas, suggesting that residents are more likely to adopt pro-environmental landscape management behaviors if they are observed on nearby properties (Zmyslony and Gagnon 1998; Hunt et al. 2022). However, social norms can also be barriers to adoption when individuals mainly observe more resource-intensive land covers (i.e., lawns) in neighborhoods (Peterson et al. 2012). Social factors can therefore either benefit or impede pro-environmental behaviors, depending on the local context of what constitutes acceptable or customary behavior (Farrow, Grolleau, and Ibanez 2017).

This article builds on the existing pro-environmental behavior adoption literature by examining the influence of economic incentives and social norms in the same context (native garden adoption on residential verges). Similar comparisons have been made in agricultural settings, for example, comparing subsidies and social network effects in disease-preventing livestock vaccination decisions (Sok et al. 2018). Such comparisons are less common in urban contexts.

Our analysis is based on self-reported actual adoption of native verge gardens (by estimating an actual adoption model) and stated adoption intention based on hypothetical choices in a choice experiment (with an adoption intention model). We consider the relationships between two aspects of social norms on adoption intention and actual adoption behavior: consideration of others when making landscape management decisions, and nearby neighbors' adoption of native verge gardens. In addition, we examine interactions between the social norm measures for actual adoption and adoption intention. We investigate the influence of three economic incentives on adoption intention—rebates, discounted materials, and labor supports—and compare their effects to the potential influence of our social norm measures.

Our research helps fill a gap in the literature about adoption of pro-environmental behavior by exploring relationships between social norms and actual adoption practices and adoption intentions (Niemiec et al. 2020). Another contribution of this work is linking the influence of social norms on pro-environmental

behavioral change to estimates of monetary-equivalent values. Furthermore, our results assist in communicating to policy makers the relative influence of economic incentives and social norms in pro-environmental behavior. The results can be useful when devising future policy interventions aimed at increasing citizens' adoption of ecological landscape designs under constrained budgets.

2. Study Context

In Perth, Western Australia, our study site, verges are owned by the government but managed by the resident(s) of the adjoining property. Many local governments in the region offer incentive programs to motivate residents' adoption of native verge gardens. These programs rely on economic policy instruments and most often involve offering discounted native plant seedlings (typically 50% off, and sometimes free). (Examples of rebates and subsidies in Perth, Australia, can be found in Ligtermoet et al. [2021].) In partnership with the state water corporation, a rebate of up to AU$500, available on completion of the verge garden, can be claimed by residents in some local government areas. This rebate is given through a credit to residents' accounts with the water utility provider. Despite these incentive programs, uptake of these programs and adoption of native gardens on verges remain low. In addition, not all councils have the financial capacity to offer such programs in general or at the levels that would be required to motivate behavioral change. As a result, there is interest in investigating how social norms can be harnessed to further drive the adoption of ecological landscape designs.

Encouraging citizens' adoption of pro-environmental behaviors is highly relevant in the case study site because of ongoing concerns about biodiversity loss (Murphy and van Leeuwen 2021) and rising exposure to water scarcity (Government of Western Australia Department of Water and Environmental Regulation 2019). In Western Australia, climate change and water consumption patterns have been driving declines in groundwater levels since 1975 (Government of Western Australia Department of Water and Environmental Regulation 2021). One key driver of consumption is the use of groundwater to irrigate verges and other public open spaces. Beyond water conservation drivers, calls to encourage more native plant covers in private landscape management have been motivated by the need to provide food and habitat resources that support local biodiversity (Garbuzov and Ratnieks 2014) and enhance human well-being (Davies et al. 2009).

There have historically been widespread cultural norms to have watered lawns dominate residential land covers (Larson and Brumand 2014; Larson, Hoffman, and Ripplinger 2017). Despite a Mediterranean climate with hot, dry summers, this norm remains prevalent in Perth, where substantial water resources are used in lawn maintenance. To meet objectives for water saving and biodiversity enhancement, there is increased interest in encouraging landscape changes from lawns to more biodiverse yards and gardens featuring native plants (Doll et al. 2023a). Planting gardens with Australian native plants, which have evolved to grow in local climatic conditions, can assist in conserving water resources because once established, they often do not require regular watering (Hurd, St. Hilaire, and White 2006; Vickers 2006; Mayer, Lander, and Glenn 2015).

3. Methods

We examine the relationships between individuals' adoption of native gardens on verges, neighbors' adoption decisions, and individuals' concerns with their neighbors' opinions. This analysis is based on data collected in a household survey. We estimate relationships between native garden adoption and normative factors based on current adoption behavior (actual adoption model) and through a choice experiment investigating how policy changes could encourage nonadopters to plant a native verge garden (adoption intention model).

Choice Experiment

Choice experiments (Hanley, Wright, and Adamowicz 1998) are a stated preference approach. They allow us to investigate preferences for alternative policy interventions,

with a focus on trade-offs across policy characteristics, including compensation levels. We conducted choice experiments with the goal of understanding the program characteristics under which people may be incentivized to adopt a native garden on their verge.

Our survey included two choice experiments: one with willingness-to-pay (WTP) framing and one with willingness-to-accept (WTA) framing. Each respondent was shown both choice experiments (four WTP questions and four WTA questions). WTP and WTA questions were grouped together, but the order in which they appeared was randomized. An in-depth analysis of public preferences for different possible components of verge conversion programs (including financial and nonfinancial supports) that local governments could introduce is found in Doll et al. (2023b). Through latent class analysis, different segments of the population were found to assign different values to potential program components, including native plant seedling subsidies, landscaping support, having control over plant species selection, and reserving portions of verges for parking (Doll et al. 2023b).

We focus on the WTA framing of the choice experiment because it is better aligned with current programs and policies, and therefore more comparable with real adoption behavior. It is not currently possible for homeowners to pay their local government to convert their verge to a native garden, but governments do offer various financial, labor, and material supports to encourage native gardens as outlined in the WTA tasks. Furthermore, responses to the WTP tasks were significantly affected by the order effects, while WTA responses were not: respondents were willing to pay more to convert their verge if they saw the WTP tasks first, relative to those who saw the WTA tasks first. We change the sample considered by dropping from the stated preference sample those who have already adopted a verge garden.

We compare revealed preferences (actual verge garden adoption behavior) and stated preferences from the choice experiment with native garden adoption. Our focus is on the relationship between social norms and neighbor effects. In the revealed preference model, we are unable to measure whether an individual was the first to plant a garden on their street or whether they may have been influenced by a neighbor. Therefore, we are likely to overestimate the effects of neighbors' behavior on adoption. However, by excluding adopters from the stated preference model, we ensure that the neighbors who planted a verge garden were the initial adopters who may have influenced the potential adopters whose data are being analyzed. An overview of the attributes and levels presented in the choice experiment is shown in Table 1. Figure 1 shows an example choice card.

Before being presented with the choice experiment questions, respondents were told that some councils are encouraging residents to plant native verge gardens to support local

Table 1

Choice Experiment Attributes and Levels

Attribute	Levels
Extent of verge that must be converted	Entire; at least half (base case)
Entity responsible for preparing verge	Household; landscaper (base case)
Plant seedling discount offered	100%; 50%; none (base case)
One-time compensation level	$0; $500; $1,000; $1,500

Figure 1

Example Choice Card for Willingness-to-Accept Tasks

Note: Respondents were presented with different policy supports to facilitate planting a native verge garden.

biodiversity and conserve water. Respondents were given information about the steps involved in establishing a native verge garden and the costs that may be incurred. The full script presented to respondents before the choice experiment is in Appendix A. We implemented an experimental design with the full factorial of 48 choice sets and used Ngene (Rose and Bliemer n.d.) to create 12 blocks of four choice questions. Each respondent answered 4 of the possible 48 WTA choice cards.

Survey Development and Data Collection

An online survey was prepared for distribution to members of the public living in the Perth metropolitan region. This survey was developed between March and August 2022, in consultation with subject-matter experts from local and state governments. We tested the survey in four one-on-one interviews with members of the general public, each lasting approximately one hour. The survey collected sociodemographic information from respondents, along with information on verge use and current landscape management practices on respondents' own and neighbors' verges. We collected information on self-reported adoption of native verge gardens for our actual adoption model.

Our target for data collection was longer-established neighborhoods, which in Perth typically have larger verges and present an opportunity for greater environmental gains through native verge gardens. Given that target postal codes were underrepresented in online market research panels, survey recruitment was accomplished using a mailed-out postcard. Two postcards (an initial send-out and a reminder) inviting households to complete an online survey were sent to select neighborhoods in August 2022.

The postcard design and distribution methods followed advice by Dillman (2007) in the design, language, and use of a reminder postcard. Because of budget limitations, we could only send out a generalized invitation, rather than individually addressing the resident of each household. In addition, our incentives took the form of a draw for those who completed the survey, rather than an individual incentive with each postcard, regardless of whether the survey was completed. Across a random selection of postal runs in 13 post codes, a total of 20,583 postcards were distributed. These post codes spanned nine local government areas in the Perth metropolitan region: the City of Subiaco, City of Nedlands, Town of Claremont, Shire of Peppermint Grove, Town of Cottesloe, City of Stirling, and City of Bayswater, Town of East Fremantle, and the City of Melville (Figure 2). Most local governments in the study area are relatively small, covering only a few square kilometers with approximately 10,000 residents in each. For larger areas (Stirling and Bayswater in the north, Melville in the south), we only recruited respondents from postal runs located nearest the center of our overall study area, which covered approximately one-quarter of each of these local government areas.

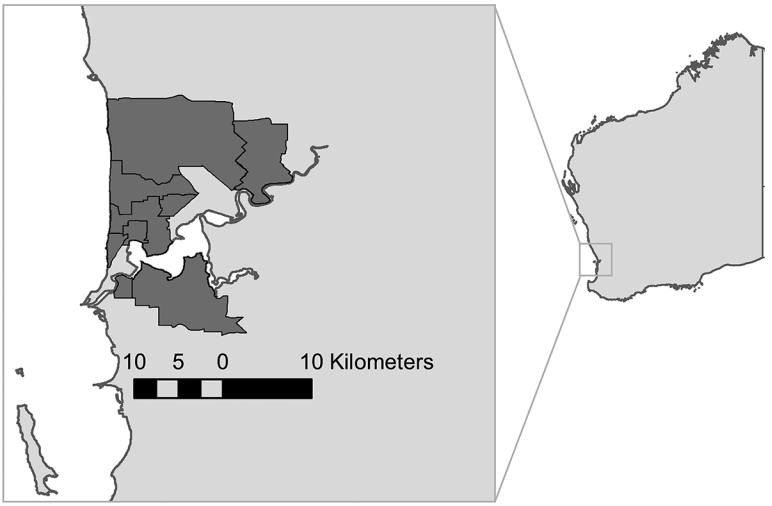
Of the 891 complete responses to the online survey, 734 came from households that were deemed to have control over decisions to plant a native garden on their verge by meeting three criteria: owning their home, living in any dwelling type except for an apartment or high-density complex, and having a verge in front of their property.

We analyze actual adoption and adoption intention with two different samples. For the actual adoption model, we include the full set of 734 households that were considered to have control over their verge. For the adoption intention model, we include only those who had not already established a native verge garden (634 respondents). This restriction allows for a clearer portrayal of the influence of social norms on adoption decisions, as it is not confounded by whether an individual was an early adopter in their neighborhood, potentially influencing the landscaping decisions of other nearby homeowners.

4. Modeling Approaches

We analyze the relationships between economic incentives and social norms with adoption decisions, considering both adoption intent and actual adoption. For our analysis, social norms are defined as care and consideration of others in decision-making.

Figure 2
Distribution of Postcards in Local Government Areas in Western Australia



The survey collected information to build a generalized measure of respondents' consideration of their neighbors when making decisions. Respondents' concern about neighborhood norms is assessed based on their agreement with the following two statements, each with five-point ordinal response scales ranging from "strongly disagree" to "disagree to strongly agree: I care what my neighbors think about my verge" to "when making decisions about my verge, I consider what my neighbors might think." Respondents indicating either "agree" or "strongly agree" to both questions are said to be concerned about neighborhood social norms and were assigned a value of one for consideration of local norms (*Concern*). This specification was chosen for the ease of interpreting the variable, because it allows us to compare concerned and unconcerned individuals. Another specification, in which *Concern* is measured as a latent construct (e.g., Walker and Ben-Akiva 2002), is in Appendix Table B4 and provides results consistent with the dummy variable specification. We did not have an initial hypothesis of how *Concern* might influence adoption of native gardens. It may lead to a lower likelihood of adoption if homeowners are worried about breaking conformity on a street with few native gardens. On the other hand, it may lead to higher adoption rates because of a wish to conform with their neighbors on a street where native gardens are present.

To assess the relationship between neighbors' decisions and the adoption of native verge gardens, respondents were asked how many of their nearby neighbors (defined as up to five properties to the left, up to five properties to the right, and up to five properties across the street) had a native verge garden. *Neighbor* is a binary variable taking a value of one for respondents who said some, most, or all their neighbors have a native verge garden and zero otherwise. We treat *Neighbor* as a binary variable because less than 3% of our sample indicated that most or all of their neighbors have a native garden. We hypothesized that homeowners with a neighboring native verge garden would be more likely to have one themselves. Finally, we include an interaction term of whether respondents were concerned about neighborhood social norms and had any neighbors with a native verge garden ($Concern \times Neighbor$). This interaction allows us to understand whether the influence of neighbors differs depending on whether a respondent states that they consider their neighbors' opinions when making decisions about their verge. Presumably, those

who stated that they are concerned with their neighbors' opinions would be influenced by their neighbors more strongly than those who did not.

Actual Adoption (Revealed Preference)

The entire sample ($n = 734$ responses) is included in the actual adoption model. Whether individuals had adopted a native verge garden—a binary choice—is modeled using a logit model, outlined in equation [1]:

$$U = \beta H + \alpha_1 Concern + \alpha_2 Neighbor + \alpha_3 Concern \times Neighbor + \varepsilon,$$
$$\text{where } y = 1 \text{ if } U > 0,$$
$$\text{and } y = 0 \text{ if } U \leq 0. \quad [1]$$

The utility (U) underlying the observed decision to adopt (y) is a function of household characteristics H, which consists of a constant; personal characteristics (age, gender, and education); verge-specific attributes (size and whether it is used for parking); and regional control variables (local government areas). Relationships between social norms and adoption are also modeled. Specifically, we include consideration of neighbors when making decisions and presence of nearby native verge gardens in respondents' neighborhoods, along with the interaction between these factors. We assume that people will adopt a native verge garden ($y = 1$) if it offers positive utility and will not adopt if it would not improve utility ($y = 0$).

Using the results from the actual adoption model, we estimate how the probability of adoption differs according to social norms. Predicted probabilities of adoption are estimated on average, and for the four combinations of the binary *Concern* and *Neighbor* variables: unconcerned with no neighboring gardens, unconcerned with neighboring gardens, concerned with no neighboring gardens, and concerned with neighboring gardens. Predicted probabilities of adoption are computed using the estimated coefficients of the actual adoption model, where all other variables are set at mean levels, and standard errors are estimated using the delta method.

Adoption Intention (Stated Preference)

We use choice experiment responses to model adoption intention, including only respondents who had not yet adopted a native verge garden ($n = 634$). We analyze the series of choices respondents made of whether they would choose to adopt a native verge garden under alternative program characteristics, which varied in the levels of the attributes presented (an overview of attributes and levels is shown in Table 1) and in their respective utility levels. Individuals are assumed to choose the alternative that maximizes their utility, and choices of whether to indicate intention to adopt a native garden are modeled as a function of the choice experiment attributes, along with the influence of social norms.

With data on repeated choices made by individuals, it is possible to capture heterogeneity in preferences for factors driving intention to adopt native verge gardens. Preference heterogeneity can be accounted for using a mixed-logit model, where, rather than assuming fixed parameters, variation in preferences between respondents are modeled using random parameters (Hensher and Greene 2003). In our model, social norm variables are interacted with the alternative-specific constant (ASC), the cost parameter is specified to be random with a log-normal distribution, and all other choice attribute parameters are specified as normally distributed random parameters. The variance-covariance matrix between all random parameters is estimated, relaxing the assumption that there is no correlation for preferences among the different policy attributes.

To compute monetary values, the adoption intention model is estimated in WTA space (Daly, Hess, and Train 2012), representing how much more or less an individual would have to be paid to be willing to convert their verge to a native garden. WTA estimates are provided for different verge conversion program attributes, along with the changes in WTA estimates that arise with changes in the social norm characteristics. Models were estimated using Stata 16 (StataCorp 2019). The model specification is outlined in equation [2], where the utility person i gets from option j (Uij) is a function of the rebate in thousands

of dollars, a parameter representing the effect of the rebate on utility (γ), the policy attributes and ASC (X_{ij}), parameters reflecting the effects of policy attributes on utility measured in thousands of dollars (ω), and a random error term (ε_{ij}):

$$U_{ij} = \gamma(rebate_{ij} + \omega X_{ij}) + \varepsilon_{ij},$$
$$\omega_{ASC} = (\mu_{ASC} + \sigma_{ASC} + \alpha_1 Concern + \alpha_2 Neighbor + \alpha_3 Concern \times Neighbor). \quad [2]$$

The distribution of preferences for the monetary rebate attribute follows a log-normal distribution to ensure the marginal utility of money is strictly positive and that moments of welfare-estimate distributions are finite (Daly, Hess, and Train 2012). A mean (μ_{rebate}) and standard deviation (σ_{rebate}) of a normally distributed variable underlying the log-normal distribution are estimated. Because the model is estimated in WTA space, means (μ_a) and standard deviations (σ_a) of WTA values for all other attributes (ω_a) are directly estimated. For the ASC representing the option of adopting a native verge garden, a mean and standard deviation of the WTA required to convert a verge are estimated. In addition, the ASC is interacted with *Concern*, *Neighbor*, and an interaction of *Concern* and *Neighbor* to estimate the dollar-equivalent values representing the relationship between social norms and native garden adoption.

5. Results

Summary Statistics

Key summary statistics are shown in Table 2, broken down between the samples used in the actual adoption model (all respondents; $n = 734$) and the adoption intention model (respondents who had not already adopted a native verge garden; $n = 634$). All variables are binary, except respondent age. For the sample in the actual adoption model, 14% of the sample had adopted a native verge garden. Regarding verge specifics, 49% of respondents in the actual adoption model sample and 51% of respondents in the adoption intention model sample used their verge for parking, either for themselves or for visitors. Most verges were medium-sized, allowing space to park one vehicle. Verges were considered small if they did not allow space to park any vehicles.

Actual Adoption Model Results (Revealed Preference)

Table 3 presents estimation results of the actual adoption model (logit model; actual adoption). Appendix B includes two more actual adoption model specifications: without the *Concern* × *Neighbor* interaction and with all social norm variables but without the other control variables. In both cases, the signs and relative influence of the social norms are consistent with the results reported in Table 3. We find that those who are concerned with their neighbors' opinions but do not have any nearby native verge gardens are significantly less likely to have a native garden themselves (parameter α_1). Those with a neighboring verge garden who are not concerned with their neighbors' opinions are more likely to adopt one themselves (parameter α_2), but only at the 10% level. The *Concern* × *Neighbor* interaction is positive and significant. This result suggests that in locations with no native verge gardens, concern for neighbors has a negative relationship with adoption. However, if a nearby neighbor adopts a native verge garden, this negative relationship is mitigated ($\alpha_1 + \alpha_2 + \alpha_3 = 0.23$; SE = 0.33), and those who are concerned are no longer less likely to be adopters themselves.

Regarding the other control variables in the model, those who use their verge for parking are less likely to have already adopted a native verge garden, while older individuals are more likely to have adopted a native garden. The series of dummy variables corresponding to different local government areas were used to control for geographic, neighborhood, and policy factors that may influence native garden adoption. Residents in Bayswater, Cambridge, and Subiaco are more likely to have a native verge garden, relative to the reference group comprising the least represented local government areas in our sample (Cottesloe,

Table 2
Summary Statistics

Variable	Description	Actual Adoption (Mean)	Adoption Intention (Mean)
Adopt	Has adopted a native verge garden	0.14	0.00
Social norms			
Concern	Is concerned about neighborhood norms	0.40	0.42
Neighbor	Has at least one neighbor with a native verge garden	0.57	0.55
Concern × Neighbor	Is concerned about norms and has a neighbor with a native garden on their verge	0.23	0.23
Verge specifics			
Parking	Uses their verge to park	0.49	0.51
Medium verge	Has a medium-sized verge (relative to small)	0.61	0.62
Large verge	Has a large-sized verge (relative to small)	0.28	0.27
Personal and house characteristics			
Woman	Gender identity of respondent	0.58	0.58
Age < 50	Younger than 50 years	0.29	0.30
Age 50–59	50–59 years	0.27	0.26
Age 60–69	60–69 years	0.25	0.26
Age 70+	70 years or older	0.19	0.18
University	Has a university education	0.80	0.80
Environmental organization	Is a member of an environmental organization	0.11	0.09
Hire gardener	Hires for most gardening jobs	0.10	0.11
Years in home: < 5	Lived in home for < 5 years	0.22	0.22
Years in home: 5–20	Lived in home for 5–20 years	0.43	0.43
Years in home: 20+	Lived in home for 20+ years	0.35	0.35
Detached	Live in detached (standalone) home	0.92	0.91
Local government area			
Bayswater	Lives in Bayswater	0.18	0.17
Cambridge	Lives in Cambridge	0.15	0.15
Melville	Lives in Melville	0.20	0.21
Subiaco	Lives in Subiaco	0.10	0.10
Stirling	Lives in Stirling	0.09	0.09
Claremont	Lives in Claremont	0.08	0.08
Nedlands	Lives in Nedlands	0.10	0.09
Peppermint Grove	Lives in Peppermint Grove	0.03	0.03
Cottesloe	Lives in Cottesloe	0.05	0.06
East Fremantle	Lives in East Fremantle	0.02	0.02

Note: n =734 for the actual adoption model; n = 634 for the adoption intention model.

Peppermint Grove, East Fremantle). These effects may be tied to the strength of their incentive programs and the marketing and communication of these programs, which center on native plant seedling discounts; by geographic factors; or by other factors relating to neighborhood-level attitudes.

Various other house- and person-specific characteristics were significant predictors of adoption. The oldest group of respondents (70+ years) were more likely to plant a native garden, relative to the youngest group (< 50 years), as were members of environmental organizations. Homeowners who hire gardeners for most gardening jobs were less likely to have adopted a native garden. Many other factors, including gender, education, verge size, whether the house was detached (vs. a

Table 3

Actual Adoption (Revealed Preference) Logit Model Results

Variable	Estimate	SE
Constant	–3.99***	0.89
Social norms		
Concern (α_1)	–1.66***	0.64
Neighbor (α_2)	0.51*	0.30
Concern × Neighbor (α_3)	1.38**	0.70
Verge specifics		
Parking	–0.53**	0.21
Medium verge	0.00	0.39
Large verge	0.45	0.42
Personal and house characteristics		
Woman	0.33	0.24
Age 50–59	0.44	0.33
Age 60–69	–0.05	0.37
Age 70+	0.86**	0.39
University	–0.09	0.30
Environmental organization	1.15***	0.31
Hire gardener	–1.09**	0.56
Years in home 5–20	–0.09	0.31
Years in home 20+	–0.07	0.37
Detached	0.91	0.57
Local government area		
Bayswater	1.45***	0.55
Cambridge	1.41**	0.57
Melville	0.58	0.58
Subiaco	1.18**	0.60
Stirling	0.50	0.68
Claremont	0.89	0.70
Nedlands	0.91	0.62

Note: n = 724. The adoption of a native garden is the dependent variable.

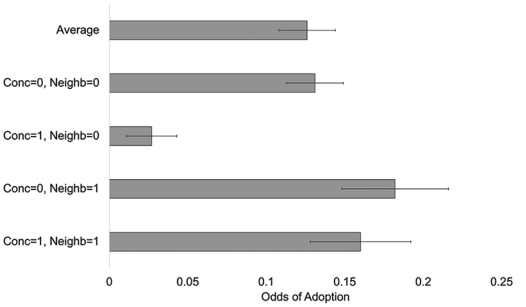
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

townhouse or villa home), and length of time in the residence were not significant determinants of adoption.

The links between normative factors and native garden adoption are illustrated in Figure 3, where predicted odds of adoption are presented based on whether respondents' neighbors have a garden (*Neighbor*) and whether they care about their neighbors' opinions (*Concern*). These predicted probabilities are derived using the actual adoption model parameter estimates and the mean levels of demographic and control variables that are not explicitly considered. The predicted likelihood of adoption for the average respondent is 13%, similar to the observed adoption rate of 14% for the whole sample (see Table 2). A similar proportion (14%) of those with no neighboring gardens and who

Figure 3

Predicted Probabilities of Native Garden Adoption for the Average Respondent



Note: Results are based on whether a respondent has a neighbor with a garden (Neighb) and whether they are concerned with their neighbors' opinion of their verge (Conc).

are unconcerned with their neighbors' opinions (*Concern* = 0 and *Neighbor* = 0) were predicted to adopt a native garden. In comparison, only 3% of homeowners who consider their neighbors' opinions but have no neighbors with a native garden (*Concern* = 1 and *Neighbor* = 0) are predicted to have one themselves. Homeowners whose neighbors have planted a native garden are more likely to have one themselves: 18% of those who are not concerned with their neighbors' opinions (*Concern* = 0 and *Neighbor* = 1) and 16% of those who are concerned with their neighbors' opinions (*Concern* = 1 and *Neighbor* = 1), are predicted to adopt one. Therefore, homeowners with a neighboring native garden are 7% (0.21 – 0.14 = 0.05; SE = 0.02; p = 0.029) more likely to adopt one if they are not concerned with their neighbors' opinions, and are 14% (0.16 – 0.03 = 0.13; SE = 0.04; $p < 0.001$) more likely to adopt one if they are concerned with their neighbors' opinions, compared to homeowners with no neighboring native gardens.

Adoption Intention Model Results (Stated Preference)

Table 4 presents estimation results of adoption intention in WTA space (mixed-logit model, the adoption intention model). The monetary variable is normalized to thousands of Australian dollars. Negative (positive) parameter estimates represent how much more (less) a

Table 4

Results of the Adoption Intention (Stated Preference Choice Experiment) Mixed-Logit Model Estimated in Willingness-to-Accept Space

	Mean		SD	
Variable	Estimate	SE	Estimate	SE
ASC	–0.73***	0.11	1.27***	0.11
Choice attributes				
Entire	–0.94***	0.09	1.09***	0.12
50% off seeds	0.59***	0.12	0.70***	0.14
Free seeds	0.86***	0.13	0.72***	0.15
You prepare	–0.86***	0.09	0.74***	0.08
Rebate ('000s)	1.12***	0.15	0.94***	0.19
Social norms				
Concern (α_1)	–0.43***	0.14	—	—
Neighbor (α_2)	0.72***	0.13	—	—
Concern × Neighbor (α_3)	0.63***	0.18	—	—
Covariance: choice attributes				
50% off seeds × Free seeds	0.21	0.15	—	—
ASC × 50% off seeds	–0.87***	0.18	—	—
ASC × Free seeds	–0.45**	0.22	—	—
ASC × Entire	–0.47***	0.15	—	—
ASC × You prepare	0.13	0.15	—	—
ASC × Rebate	0.19	0.16	—	—
Entire × 50% off seeds	0.15	0.13	—	—
Entire × Free seeds	0.54***	0.17	—	—
Entire × You prepare	0.12	0.10	—	—
Entire × Rebate	0.01	0.15	—	—
50% off seeds × You prepare	–0.13	0.09	—	—
50% off seeds × Rebate	–0.13	0.12	—	—
Free seeds × You prepare	–0.23***	0.09	—	—
Free seeds × Rebate	–0.32***	0.12	—	—
You prepare × Rebate	0.63***	0.17	—	—

Note: n = 634 (2,536 choices). Monetary values are in thousands of 2022 Australian dollars. ASC = alternative-specific constant.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

homeowner would have to be paid to convert their verge to a native garden. Positive coefficients are linked to a higher propensity to adopt a native garden, and thus a lower amount of financial support that must be provided to encourage adoption. Here the ASC represents how much governments would have to pay someone to convert at least half their verge to native vegetation and is estimated at $730 (2022 AUD; for an individual with sample-mean social norms, and all the other attributes set to zero). Relative to the baseline of converting at least half of their verge to a native garden, the average landowner would require an additional payment of $940 for the entire verge to be converted. This base case involves the government preparing the land. Where households are responsible for the labor to prepare the land, the payment required to motivate the adoption of verge gardens increases by $860. With discounts for seedlings, this required payment level decreases: by $590 with programs offering 50% off seedlings, and by $860 for programs offering free native plant seedings.

Relationships between neighboring and normative factors and native garden adoption are consistent between the adoption intention and actual adoption models. For those without any neighboring native verge gardens, being concerned with neighbors' opinions is linked with a lower likelihood of planting a native garden. For homeowners with no nearby neighbors with a garden, those who are concerned with their neighbors' opinions would need to be paid an additional $430 to plant a garden ($\alpha_1$), relative to those who do not care about their neighbors' opinions. Individuals

seem to be significantly influenced by neighboring gardens, regardless of whether they say they are concerned with their neighbors' opinions. People with at least one neighbor who planted a native garden would have to be paid \$720 less than people with no neighboring gardens. Those who are concerned with their neighbors' opinions and have a neighbor with a native garden are more open to planting a garden and would have to be paid \$920 less ($\alpha_1 + \alpha_2 + \alpha_3$; SE = \$124) than a person who is unconcerned with their neighbors' opinions and have no neighboring gardens. Understandably, the influence of neighbors' behavior is greater for those who are concerned with their neighbors' opinions. For these individuals, planting a nearby garden shifts them from being less likely to plant a native garden to being more likely. The effect equates to a \$1,350 (SE = \$140) reduction in payment required to convince them to plant a native garden ($(\alpha_1 + \alpha_2 + \alpha_3) - \alpha_1 = \alpha_2 + \alpha_3$).

As with the actual adoption model, Appendix B presents the results of the adoption intention model without the *Concern* × *Neighbor* interaction. The sign and relative influence of *Concern* and *Neighbor* are consistent with the results in Table 4.

6. Discussion and Conclusion

This study investigates how economic incentives and social norms influence actual adoption and intentions to adopt pro-environmental behavior. Our approach, which includes stated and revealed preference analyses, allows us to compare nonmarket value estimates derived from a choice experiment to the influence of social norms on actual adoption patterns.

Our work reinforces the importance of economic incentives and social norms in encouraging pro-environmental behavior. We show that individuals value seedling discounts and landscaping assistance when making decisions about whether to adopt a native verge garden. However, we also demonstrate strong spatial correlations in stated and revealed preferences for native garden adoption among neighbors. If these spatial correlations are driven by normative influences, our results suggest that social norms may have a similar effect on adoption as those gained from economic and material incentives. Through the adoption intention (stated preference) model, we were able to measure the monetary-equivalent impact of social norms and neighbor effects, and we find their value to be similar to many costly material and monetary supports that governments can offer. Furthermore, the results suggest that the influence of social norms are complex, especially in early phases of adoption. Initially, when homeowners have no neighbors with a native garden, being concerned about neighbors' opinions had a negative correlation with native garden adoption. However, this negative relationship was mitigated once one neighbor plants a native garden (revealed preference model). In the stated preference model, those who were concerned with their neighbors' opinions and had at least one neighbor who planted a native garden stated they were more willing than average to plant one themselves. Together, these findings support existing evidence that social norms for gardening may be changing from preferences for monocultured, watered lawns towards for more native, waterwise plants (Hurd, St. Hilaire, and White 2006; Larson and Brumand 2014; Larson, Hoffman, and Ripplinger 2017; Shaw, Miller, and Wescott 2017; Doll et al. 2024). We find that social norms may help encourage pro-environmental landscaping behavior, as long as an early native verge garden adopter has emerged in a neighborhood to help normalize the alternative landscape design.

Before this study, there was limited evidence of the influence of social norms, estimated as in monetary-equivalent terms, on the adoption of pro-environmental behavior. Burkhardt et al. (2022) provided one example, using hedonic pricing methods to estimate the monetary-equivalent value of deviating from neighborhood landscaping conformity. They estimated a monetary loss in average home sales prices of deviating from conformity to be US\$1,750. Our estimates (in Australian dollars) are smaller but of a similar magnitude. We estimate the influence of caring and considering neighbors' opinions in native verge adoption decisions and having a nearby neighbor who has already adopted a native garden to be approximately \$1,350, implying

potential savings to local governments interested in encouraging more pro-environmental landscaping behavior. This estimate suggests that the cost of encouraging adoption may decline over time because of normative and neighboring influences, as more homeowners have neighbors with a native garden.

In context, the values associated with social norms often exceed the cost of council and state government programs that offer more conventional supports like subsidized plant seedlings and rebates. As a comparison against the cost of governments providing financial support through conventional economic policy instruments, recall that a rebate of $500 is currently offered on the completion of a verge conversion to an ecological landscape design. When compared with the cost of councils offering discounted seedlings to residents, the value of social norms exceeds conventional council expenditure. For example, if we assume a 30 m^2 verge and planting three plants per square meter at a cost of $3 per seedling, the government cost of offering free seedlings equals $270 per verge, or $135 per verge for a discount of 50% on the cost of seedlings. These values fall below the monetary-equivalent value estimates for social norms, which range between approximately $700 and $1,350 and are similar to value estimates for the choice experiment attributes, which individually range between $590 and $860.

Furthermore, while programs centered on offering financial incentives for behavioral change may appeal to adopters, they impose high costs on local governments (Doremus 2003). In addition, these programs typically require effective communication strategies to ensure public awareness. Other alternatives to encouraging adoption of pro-environmental behaviors include information campaigns, which are not always effective (Lucas et al. 2008), and legal regulations, which require costly monitoring and enforcement (Steg and Vlek 2009) and may not be politically palatable (Banerjee., Savani, and Sreedhar 2021). Therefore, economic or regulatory policy instruments are not always the preferred tools of governments.

Governments have many options to consider when looking at ways to encourage pro-environmental landscaping behavior. The focus shifts to finding the most cost-effective ways to encourage behavioral change. We suggest using more costly policy interventions involving financial incentives to encourage early adopters of ecological landscape designs across a wide geographic spread. For example, it would be useful to more heavily incentivize early adopters on each residential street. Early adopters expose more individuals to the pro-environmental behaviors, at which point social norms can begin to take effect. This approach could be strengthened using information campaigns designed to increase individuals' care and concern about their neighbors' opinions of their verge when making landscape management decisions. Once norms are established, governments may be able to reduce investments in programs offering financial assistance and shift to the strength of social norm–based drivers of adoption that do not require ongoing financial support.

Given the importance of early adopters of native verge gardens across neighborhoods, future research could focus on gaining a better understanding of the characteristics and motivations of early adopters. Here, while we could assess whether one had a native verge garden but no neighbors with native gardens, we did not identify those who were the first in their neighborhood to establish a native verge garden, who may have encouraged their neighbors to follow in adoption. It would be helpful to learn more about the personal characteristics of these individuals, and whether they used any strategies to help their neighbors follow through with adoption, such as involvement in community organizations or direct conversations with neighbors about gardening practices. Furthermore, an in-depth understanding of the psychological and economic theories underpinning the drivers of social norms and native garden adoption could be beneficial in understanding how to best leverage these social influences in policy design. Previous research has found that social norms driving pro-environmental behavior operate through fast, intuitive, and emotional heuristics (Farrow, Grolleau, and Ibanez 2017). However, decisions to plant native verge gardens operate over longer time periods (approximately six months, including

weeding, land preparation, and planting), suggesting that alternative mechanisms are at play. Better understanding the psychological and economic mechanisms underlying social norm impacts on pro-environmental behaviors may help policy makers and environmental managers in designing program offerings.

We acknowledge some limitations to this study. First, we cannot confirm that effects of norms and neighboring effects are not driven by other unobserved spatial factors. Although our dummy variable for local government area helps control for some potential omitted variable bias (e.g., location-based characteristics and policies), we acknowledge that other factors that vary at finer geographic scales (i.e., subneighborhood heterogeneity) may partly explain the influence of neighbors' adoption decisions on an individual's likelihood of adoption. Based on the data we collected, we cannot strongly infer causation between social norms and native garden adoption. Instead, we provide evidence of spatial correlation in adoption patterns, and we believe norms are a likely driver of this correlation. Future experimental research could focus on isolating causal social norm effects in verge garden adoption. Second, we did not collect information on whether a respondent was the first to adopt a native garden on their street. Therefore, we do not know whether they may have been the person who influenced their neighbors or were influenced themselves, so it is possible that the *Neighbor* effect is overstated in the revealed preference model. However, the consistent results between revealed and stated preference data, and the robustness checks included in Appendix B, provide evidence consistent with our interpretation of the relationships between social norms, neighbors' decisions, and adoption decisions. Third, the choice experiment was nonincentivized and purely hypothetical. To mitigate issues of hypothetical bias, we worked closely with policy experts to create salient and believable choice tasks, which resulted in 94% of respondents believing the survey was at least somewhat consequential. However, it is possible that consequentiality could incentivize some homeowners to respond strategically to influence future policies or programs, which could exacerbate hypothetical bias.

Like previous work on the topic, we find that norms can play an important role in influencing the adoption of pro-environmental behaviors (Steg et al. 2014), and that normative effects may have a similar relationship with adoption as offering financial and material supports worth hundreds of dollars or more. We build on existing knowledge surrounding social norm effects by showing that these effects are consistent between actual adoption and adoption intention. Results support the notion that early adopters of native gardens encourage others to follow (Goddard, Dougill, and Benton 2013), and we find that having a diverse geographic spread of early adopters may potentially provide substantial cost savings to local governments trying to increase the adoption of native verge gardens. Based on these results, we believe governments could encourage adoption of highly visible pro-environmental behaviors by ensuring a diverse geographic spread of early adopters of native verge gardeners across different neighborhoods. This spread can be achieved through an approach that establishes early adopters as models of the pro-environmental behavior as a social norm–centered policy interventions (Abrahamse and Steg 2013). Altogether, these results reinforce the idea that policies to encourage more pro-environmental behavior, like native verge gardens, can rely on positive influences of norms (Thaler and Sunstein 2008). Building on existing interventions that rely on economic incentives and taking advantage of social norms in verge garden adoption may lead to better environmental outcomes at a lower financial cost to communities.

Acknowledgments

This article draws on research supported by the University of Western Australia Research Collaboration Award and the German Federal Ministry for Education and Research Green Talents program. Approval to conduct this research was provided by the University of Western Australia, in accordance with its ethics review and approval procedures (UWA Human Ethics Reference 2020/ET000032).

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