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Evaluating policy changes on council waste generation and diversion: Evidence from South Australia

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Abstract

Australia, like most countries worldwide, faces increasing issues with burgeoning waste generation and its appropriate disposal. Hence, effective policies and programmes are needed to change household waste generation and recycling behaviour, thereby reducing waste into landfill. To date, however, there has been little academic research on the potential effects of various policies on waste generation. We employ a rare data set and the fixed-effects linear regression model with autoregressive disturbances to investigate how a variety of public policies (namely education campaigns, roll-out of food diversion systems and provision of food caddies) influence monthly waste generation and diversion in Adelaide, South Australia, from 2006 to 2020. The results show that the introduction of food waste caddies and diversion systems was associated with increased diversion rates, saving local councils the gross equivalent of AUD$4.67 million in reduced solid waste landfill levies. However, education campaigns regarding food waste and recycling alone were found to have no significant association with reduced waste or increased recycling.

KEYWORDS

diversion, policies, South Australia, time-series regression, waste generation

JEL CLASSIFICATION

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1 | INTRODUCTION

Waste generation has become a major global environmental issue—with waste diversion receiving increasing attention over the last decade (United Nations Statistics Division, 2018). Food and materials that are not recycled or repurposed often end up in landfill, which is not only a waste of economic resources but also environmentally degrading—given this leads to the production and release of greenhouse gases (Danthurebandara et al., 2012). Waste generation is particularly an issue in developed countries (e.g. the United States, the UK and Australia) given they generate far more waste per capita per day than developing countries (Mmereki et al., 2016). However, many developing counties are experiencing a rapid growth in landfill waste, causing significant environmental and administrative challenges (Tai et al., 2011; Xiao et al., 2015).

Reducing waste by 2030 across the world is one of the fundamental Sustainable Development Goals (SDG 12) (United Nations Statistics Division, 2018). Specifically, SDG12.3 aims to halve global per capita food waste, while SDG 12.5 aims to substantially reduce waste generation. Such a reduction in waste has many potential benefits, including the following: a more effective distribution of food (and an associated reduction in hunger); a lower demand for raw materials through recycled products; reduced energy costs in manufacturing; lower landfill dumping costs; and reduced environmental impacts (Arıkan et al., 2017; Ferrara & Missios, 2005; Fiorillo, 2013; Monavari et al., 2012; Xu et al., 2016). Therefore, the focus of waste management in many countries is increasingly on reducing waste production, promoting waste recycling and minimising waste sent to landfills (Ferrara & Missios, 2005; Lee & Paik, 2011). The US Environmental Protection Agency (EPA) listed source reduction as the most preferred waste management method, followed by recycling and composting—with disposal in combustion facilities and landfills as the least preferred method (Lee & Paik, 2011; Mazzanti & Zoboli, 2008).

Australia provides a salient example of a developed country facing significant waste management problems. Australia's average amount of waste per capita per day is 7.40 kg, while its waste generation ranks in the top 10 in OECD countries (He et al., 2020; OECD, 2023). In 2016–2017, Australia generated around 67 million tonnes of waste, with this volume forecast to increase by approximately 60% by 2050 (Big Australia, 2018). Hence, the development of the *National Waste Policy Action Plan* aims to reduce waste by 10% per person by 2030, compared with the 2019 baseline (Australian Government Department of the Environment and Energy, 2019).

Organic waste is one of the main waste types sent to landfill (The Food and Agribusiness Growth Centre, 2021). Halving the amount of organic waste sent to landfill for disposal by 2030 is another target under the *National Waste Policy Action Plan* (Australian Government Department of the Environment and Energy, 2019). Over 500 local governments across Australia are also taking steps to develop a variety of programmes and interventions to reduce waste into landfill (i.e. information and education on food storing and home composting; grants, subsidies and rebates for households to purchase food caddies, which are hard containers used to collect food scraps to add directly to the green organics bin; food diversion systems; compost bags, which can be placed into the organic bin to produce materials for compost; worm farms; and bottle deposits) (Australian Government Department of the Environment and Energy, 2017).

Among Australian states, South Australia (SA) is often argued to be at the forefront of innovation in waste, recycling and resource recovery. South Australia has reduced its waste into landfill by one-third since 2003 and leads Australia in organic recycling (Department of Agriculture, Water and the Environment Australian Government, 2020). In SA, food waste is also one of the largest components of household waste sent to landfill. The current aim of the state government is to aim for zero avoidable waste sent to landfill by 2030 (Green Industries, 2020). Several food waste policies and programmes have been implemented across various locations in Adelaide—the capital of SA—in an effort to reduce food waste and increase diversion from landfill (more detail regarding these initiatives can be found in the case study section). These policies have been implemented at differing times across various council locations over the past two decades in SA (and indeed across Australia). However, although food waste remains one of the largest components of household waste, how food waste policies contribute to waste reduction and diversion behaviour has not been directly quantified to date.

This study aims to narrow these knowledge gaps. To do this, it employs aggregated monthly data from eight councils in the Adelaide Metropolitan Area of SA, from July 2006 to June 2020, to investigate the impacts of three key food waste policies (e.g. education campaigns, provision of food waste caddies and the roll-out of food diversion systems under which food waste is allowed to put into the green bin). The outbreak of Coronavirus (COVID-19) is also examined, along with other socio-economic influences on waste generation, recycling weights and diversion rates. The study makes a twofold contribution to the current literature. First, we use a rare information data set of waste volumes and diversion rates across eight South Australian councils, to identify the effectiveness of various food waste policies—and apply a fixed-effects linear model with an AR(1) disturbance to categorise the data and verify the results. Secondly, we examine unobservable regional time-invariant heterogeneity across waste volumes and quantitatively explore the role of heterogeneity in waste recycling and diversion—thereby extending the scope of existing knowledge and providing robust evidence around policy effectiveness.

2 | BACKGROUND

Given the growing social costs of waste generation, it has been receiving increasing scholarly attention (e.g. Alacevich et al., 2021; Johnstone & Labonne, 2004; Kirakozian, 2016). The majority of the literature has focussed upon understanding individual drivers of waste, usually through stated personal views regarding household waste (Cecere et al., 2014; Monavari et al., 2012; Nainggolan et al., 2019; Pirani et al., 2015; Xiao et al., 2015), with less emphasis on analysing actual bin waste patterns. Due to difficulties and confidentiality in obtaining local waste collection data, to date, there has been a limited focus on the analysis of waste patterns over time, along with potential policy influences on waste diversion patterns.

2.1 | Waste policy literature

Waste management policies can be generally categorised as: (a) *structural changes* to waste collection (e.g. providing increased collection services for different types of waste/recyclables); (b) *economic instruments* (e.g. ‘Pay-as-you-throw’ PAYT schemes, incentive fees and landfill tax); and (c) *information and education* campaigns. Regarding the impact of policy structural changes on waste collection, various findings have been found. Several studies have identified that source separation and kerbside collection increased household recycling—Barr and Gilg (2005), Cole et al. (2014) (UK); Dahlén and Lagerkvist (2010) (Sweden); and Jenkins et al. (2003) (US). Furthermore, reducing the collection of residual waste from weekly to fortnightly resulted in more recycling in the UK (LGA, 2007; WRAP, 2009). Others have questioned the positive structural impact of separating waste, given the need to rely on the participation of households (Barr & Gilg, 2005; Watson & Bulkeley, 2005); while Oom do Valle et al. (2009) found an increased variety of collection services resulted in lower participation rates in Portugal, due to greater confusion among households.

Regarding economic policy instruments, many studies have found that the introduction of user fees or incentive pricing (based on weight, volume, bag or subscription) reduced waste and increased recycling (Dijkgraaf & Gradus, 2004; Ferrara & Missios, 2012; Fullerton & Kinnaman, 1996; Lakhan, 2015; Linderhof et al., 2001; Miranda et al., 1994). However, other studies have highlighted that individuals who are taxed according to the amount of waste they produce are more likely to dump their waste illegally to avoid payment—and the reduction in collected waste might result from antisocial behaviour (Bartelings et al., 2004; Kirakozian, 2016).

Information and education policy campaigns aim to educate people and change their behaviours (Kirakozian, 2016). Some have highlighted the success of such campaigns in improving recycling and separation (e.g. Saladié & Santos-Lacueva, 2016 [Spain]). Lee et al. (2017) revealed that pro-environmental behaviours such as waste sorting are not widely practised, due to high inconvenience costs, and that education programmes should be considered for people who report high inconvenience costs. However, others have argued that information and education campaigns are not effective if other strategies are not implemented at the same time (Knussen et al., 2004).

2.2 | Socio-economic, demographics, location and seasonal influences on waste generation

There is considerable evidence that household waste generation is strongly influenced by socio-economic and demographic attributes such as household income, household size, family structure, age and education level (Abdallah et al., 2020; Lebersorger & Beigl, 2011; Monavari et al., 2012; Pirani et al., 2015; Torrente-Velásquez et al., 2020). Household income has often been found to be positively associated with increased waste generation (Monavari et al., 2012; Pirani et al., 2015), although Bruvoll (2001) found that income did not influence total municipal waste.

Age has also often been identified to be significantly associated with waste generation (Bandara et al., 2007; Bartelings & Sterner, 1999; Beigl et al., 2008; Jenkins, 1993), although other studies have found inconclusive findings (Lebersorger & Beigl, 2011; Mazzanti & Zoboli, 2008). Bandara et al. (2007) found that education level was significantly associated with household solid waste generation, and Fiorillo (2013) suggested that being female increased the likelihood to recycle for all materials in Italy.

Other locational variables such as temperature, precipitation and humidity have also been shown to play a role in household waste generation (Abdoli et al., 2011; Azadi & Karimi-Jashni, 2016; Chung, 2010; Cubillos, 2020; Dayal et al., 1993; Gómez et al., 2009; Thanh et al., 2010; Vu et al., 2019). Household waste generation in Vietnam was higher during wet seasons than dry seasons (Thanh et al., 2010), while Gómez et al. (2009) found less waste was generated in Mexico during the winter season.

To the best of our knowledge, there have only been a few studies examining seasonal and time impacts on waste generation. Cole et al. (2014) used a time-series intervention model to analyse monthly recyclable and residual waste volumes, while other studies have used time-series analysis to predict future waste (e.g. Chang & Lin, 1997; Matsuto & Tanaka, 1993). More recently, authors have started investigating the impact of COVID-19 on waste generation (e.g. Burlea-Schiopoiu et al., 2021; Vu et al., 2021) and have found varying effects on different waste streams. Movement restrictions are linked with an increase in the global plastic waste footprint (Benson et al., 2021), along with increased household waste (Leal Filho et al., 2021). Kasim et al. (2021) found that 61% of respondents in Nigeria and 63% of respondents in Guyana noticed increased general waste during the COVID-19 pandemic. Laila et al. (2021) found that the total per capita unavoidable food waste significantly increased during the COVID-19 pandemic in Canada. Alacevich et al. (2021) used a household-level data-set on residential waste from a Swedish municipality and found that the introduction of organic waste sorting bins induced a reduction in generated waste by up to 9%, an effect that vanished over time.

Previous research has concentrated mainly on cross-sectional household survey analysis (Abdallah et al., 2020; Xiao et al., 2015), with little analysis of policy drivers or seasonal/time factors. Indeed, the number of studies attempting to disentangle policy drivers from actual waste patterns is limited (e.g. Alacevich et al., 2021; Cole et al., 2014; Kirakozian, 2016). These knowledge gaps, together with the policy importance of waste recycling in Australia and around the world, jointly motivate this current research. We aim to better understand the determinants of waste generation and recycling through a fixed-effects linear model with an AR(1) disturbance, using a unique panel data-set of actual monthly waste across eight SA councils, from July 2006 to June 2020.

3 | DATA AND METHODS

3.1 | Case study area and data

In SA, most households have three council bins, which as at 2020 included: (1) a red (landfill) bin for general waste; (2) a green (organics) bin for food scraps, paper towel and tissues and garden cuttings etc; and (3) a yellow (recycle) bin for recyclables. Our study covers eight out of 19 metropolitan councils in SA, including Prospect, Walkerville, Campbelltown, Burnside, Unley, Mitcham, Adelaide Hills and Norwood, Payneham and St Peters. This study uses consolidated data obtained from multiple sources. The main data-set of monthly volumes of waste by three bin streams—organics (green), recycling (yellow) and general (red) waste—was provided by the Eastern Waste Management Authority (East Waste), which provides waste removal services to eight councils in the Adelaide Metropolitan Area. Monthly data were available from July 2006 to June 2020, and included weight information from the three bin streams, and the diversion rate, which was defined as the rate of monthly waste diverted from landfill (i.e. [monthly waste in green bin + monthly waste in recycle bin]/[monthly total waste in three bins]). The diversion rate measures the level of diversion of both organic and recyclable waste. The monthly waste volumes in the three bins and the diversion rate were used as our four dependant variables within the modelling. For each model, 1144 observations were available during this time period.

The eight councils in question have implemented different food waste and recycling policies over the study time period. Some of the policies included the following: roll-out of food diversion systems—allowing food waste to go directly into the organics bin (differing times from 2008 onwards); distributing opt-in food waste caddies under which households can request kitchen caddies for free through their councils, and roll-out of food waste caddies under which the council sent caddies for free to all households in their area (from various times from 2010 onwards); and implementing large educational campaigns (from 2019 onwards). The education campaigns aimed to increase awareness and knowledge about waste disposal (e.g. knowledge about which bin should be used for disposal of common contaminants and how items should be prepared for recycling). Information on the extent and dates of various policy implementations were provided by East Waste, Green Industries SA (GISA) and private waste consultants (Rawtec) in SA. All council areas faced the same economic incentives, in that: waste was levied the same way through all councils; disposal waste into landfill cost the same; and all faced similar deposit schemes for recycling. These policies were similar over time. Hence, unfortunately, no economic incentive waste policies could be assessed from our data.

Other data employed include the council-level data set from the Australian Population Census by the Agriculture Bureau of Statistics (ABS), collected every 5 years. For the study time period, there were three waves (2006, 2011 and 2016) available at council levels. The variables from the Population Census include total council population, average household size, average total household income, average age, percentage of people married, percentage of people born in Australia and the index of Relative Socio-economic Advantage and Disadvantage (IRSAD)—where higher scores indicate higher incidence of advantage and lower scores imply lower incidence of disadvantage. The IRSAD scores are constructed from a wide range of socio-economic dimensions: variables of income, education, occupation, housing and others (e.g. cars, Internet and disability). The five-year census data were transferred into monthly data from 2006 to 2016, using linear interpolation.

Furthermore, climate data including monthly average maximum temperature and monthly total rainfall were collected from the Australian Bureau of Meteorology (BOM). The vegetation density of council areas was measured according to the Normalised Difference Vegetation Index (NDVI)—obtained from Copernicus Global Land service. The NDVI is an indicator of the greenness of the biomes, which measures green space coverage in various councils. It was hypothesised that higher green space coverage would increase green organic bin volumes.

A dummy variable for the impact of COVID-19 on waste volumes (from April 2020 onwards) was also included to test for the presence of widespread working-from-home changes on council household waste volumes. Table S1 in Appendix S1 reports the descriptive statistics and variable definitions.

3.2 | Empirical specification

We consider the following fixed-effects linear model with AR(1) disturbances:

$$W_{it} = a + P_{it}\delta + X^{'}_{it}B + v_i + \lambda_t + \epsilon_{it}\ i = 1, \ldots, N; t = 1, \ldots, T$$

$$\text{where } \epsilon_{it} = \rho\epsilon_{i,t-1} + \eta_{it}, i = 1, \ldots, N; t = 1, \ldots, T \quad (1)$$

where W_{it} represents the natural logarithmic of the waste variable (e.g. weight of waste in three bins and diversion rate) in council i at time t; P_{it} is the presence of waste policies (including the Recycle Right education campaign, opt-in or roll-out of food waste caddies and roll-out of food diversion systems) of council i at time t; $X\prime_{it}$ is a vector of time-variant covariates (e.g. post-COVID-19, IRSAD, average household size in council, average resident age in council, monthly average daily maximum temperature and monthly total rainfall); ϵ_{it} is the error term, which is assumed to follow a first-order autoregressive process; v_i and λ_t are council and time fixed effects (FE), respectively; and finally, a, δ, B and ρ are unknown parameters to be estimated. The parameter δ captures the policy effect on the dependent variable. The AR(1) structure of the errors is important to account for as the presence of serial correlation will bias the parameter estimates if standard panel data estimation techniques are applied. In this perspective, we implement the method proposed by Baltagi and Wu (1999) for unequally spaced panel data regression models with AR(1) error structure. This model is applied because unit-root test showed that our data are stationary (Table S4 in Appendix S2) and the optimal dependence memory the time-series choosen by BIC is one, which indicates that AR(1) model is sufficient.

In the empirical analysis, the Hausman test was conducted to choose the appropriate specification between the fixed-effects and random-effects models. The result indicated that the fixed-effects specification was more efficient. As such, the fixed-effects results are reported here. Several alternative specifications were generated to check the robustness of results. These specifications included controlling for seasonal variation and region fixed-effects in the baseline fixed-effects model.

4 | RESULTS

The descriptive statistics under Table S1 in Appendix S1 illustrate that waste in general bins is greatest among the three bins. On average, 52% of waste was recycled via the organics or recycle bin, and hence diverted from landfill. Figure 1 provides an overview of the total monthly waste across general, organic and recycle bins for eight SA councils, from 2006 to 2020. Although there is volatility in monthly waste across the three bins, monthly waste in the general bins slightly decreased over time—while organic bin volumes increased. No significant change in recycle bin volumes can be discerned.

Table 1 presents the empirical results with region, year and seasonal fixed effects (FE). The effects of policies are of our primary interest—therefore, policy variables are displayed first, followed by the impact of the other covariates.

4.1 | Effects of various waste policies on waste diversion

Our studied waste policies were found to have various associations with waste generation and diversion (Figure S2 in Appendix S1 and Table 1). Providing food waste caddies by councils (by either opt-in food waste caddies or area-wide roll-out) was significantly associated with a reduction in general landfill waste bin volumes. In addition, providing food waste caddies was significantly associated with the increase in diversion rates (Column 5 in Table 1).

Specifically, caddy provision was associated with a 5.1% reduction in the amount of monthly waste in general bins and an increase in household waste diversion rates by 0.018 (Figure 2).

The roll-out of food waste diversion systems (e.g. food waste diversion allowed in organic/green bins) was also found to be significantly associated with the increase in the household diversion rate, and the monthly green bin volumes. Specifically, the roll-out of food waste diversion systems was associated with a 79% increase in the amount of monthly waste in organic bins and a slightly higher diversion rate as food caddies—a 0.021 difference. However, the association between education campaigns and monthly waste volumes

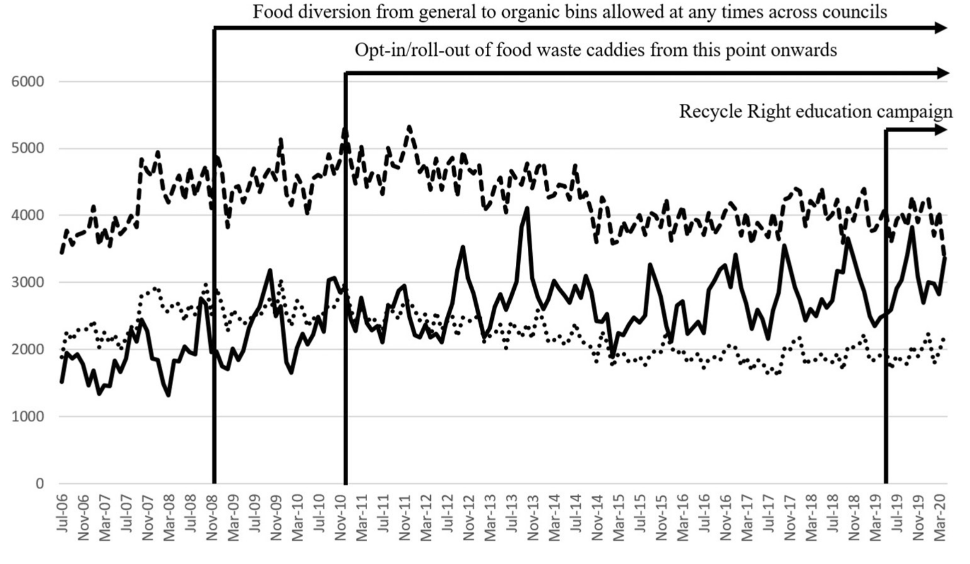

FIGURE 1 Total monthly waste in general, organic and recycle bin (tonnes) in eight councils in South Australia, July 2006–June 2016. *Source*: East Waste Monthly Tonnage Data (July 2006–June 2020). Authors' estimates and mapping.

TABLE 1 Determinants of councils' diversion rates and waste volumes (Xtregar, region, year and seasonal fixed effects).

Variable definition	General bin waste (in tonnes logged)	Organic bin volumes (in tonnes logged)	Recycle bin volumes (in tonnes logged)	Diversion rate
Policy variables				
Recycle Right education campaign	0.02 (0.03)	0.03 (0.08)	0.04 (0.04)	0 (0.01)
Opt-in or roll-out of food waste caddies	−0.05***(0.01)	0.01 (0.07)	0.02 (0.02)	0.018*** (0.01)
Roll-out of food diversion systems	0.02 (0.02)	0.58*** (0.07)	0.01 (0.02)	0.021*** (0.01)
Climate variables				
Monthly average daily maximum temperature	0.00** (0.00)	−0.01***(0.00)	0.00** (0.00)	−0.00** (0.00)
Monthly total rainfall (mm)	0.00*** (0.00)	−0.00*** (0.00)	0.00 (0.00)	−0.00*** (0.00)
Community sociodemographics variables				
Monthly total population in council (thousand people)	0.04*** (0.00)	0.05*** (0.00)	0.03*** (0.00)	0.00* (0.00)
Average household size in council	0.64*** (0.15)	1.10 (0.73)	0.82*** (0.20)	0.08 (0.06)
Average resident age in council	0.05*** (0.01)	0.29*** (0.03)	0.05*** (0.01)	0.02*** (0.00)
Percentage of people married in council	−0.01 (0.01)	−0.10*** (0.02)	−0.01 (0.01)	−0.01*** (0.00)
Percentage of people born in Australia in council	0.01 (0.01)	−0.01 (0.01)	−0.00 (0.01)	0.00 (0.00)
IRSAD	0.00*** (0.00)	−0.00*** (0.00)	0.00*** (0.00)	0.00 (0.00)
Other variables				
NDVI	0.06* (0.03)	0.18*** (0.06)	0.02 (0.04)	0.79 (0.75)
Post-COVID-19	0.06** (0.03)	0.19** (0.08)	0.06 (0.04)	1.45 (0.89)
Rho	0.31	0.85	0.32	0.65
Overall R^2	0.80	0.75	0.80	0.55
Observation	1144	1108	1144	1144

Note: Robust standard errors are reported in parentheses. *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively.

Abbreviations: IRSAD, index of Relative Socio-economic Advantage and Disadvantage; NDVI, Normalised Difference Vegetation Index.

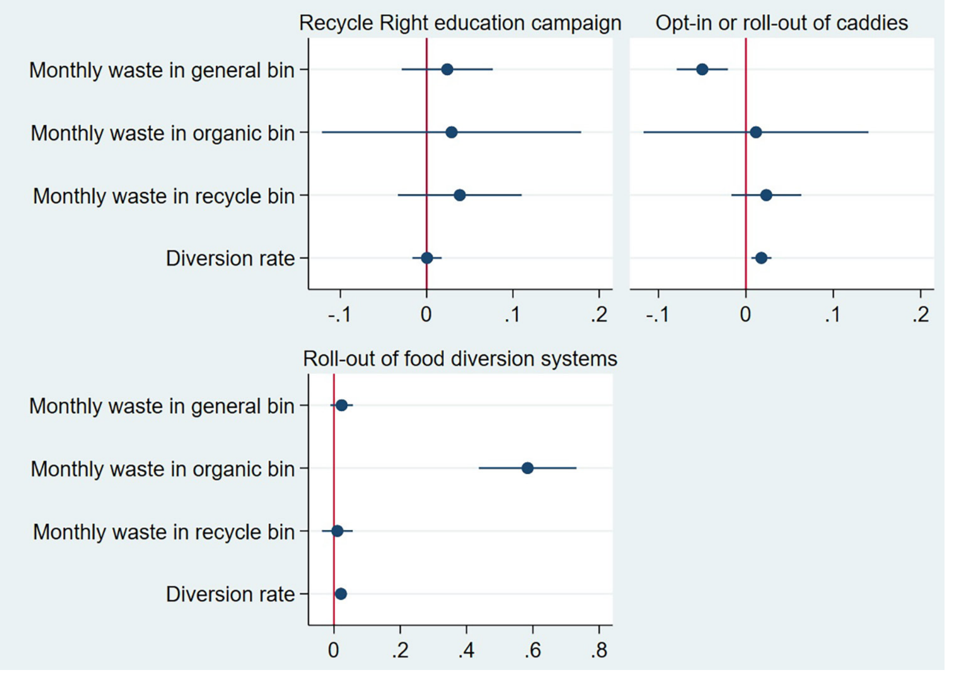

FIGURE 2 Effects of policies on councils' waste generation and diversion rates. Note: The dots are point estimates of the effects of different variables on monthly waste in three bins and the diversion rate. The lines are 95% CIs. Xtregar with region, year and seasonal fixed effects are used. [Colour figure can be viewed at wileyonlinelibrary.com]

in any of the three bins or indeed the overall diversion rate was insignificant (Figure S2 in Appendix S1 and Table 1).

4.2 | Effects of COVID-19 and other covariates on waste generation and diversion

On average, the period after the outbreak of COVID-19 (which signalled more time spent working from home) was associated with a 6.2% increase in household monthly general waste—and a 20.9% increase in organic waste volumes. However, recyclable waste volumes and the overall diversion rate were not significantly associated with the COVID-19 outbreak.

Climate conditions and green space coverage were also found to be significantly associated with waste generation and diversion. Increased monthly average daily maximum temperature was associated with decreased diversion rate, due to significantly decreased organic waste volumes. Similarly, increases in monthly total rainfall was also associated with the reduction of the overall diversion rate and decreased organic waste volumes. However, an increase in monthly average daily maximum temperature was also significantly associated with the increased general waste and recycle waste volumes. Green space coverage, as measured by the NDVI, significantly increased green organic waste volumes. These results illustrate that both the middle of summer (namely Australia's Christmas holiday period) and middle of winter were associated with increased general waste volumes and decreased organic waste volumes, while periods of higher vegetation growth were associated with increased organic waste volumes.

4.2.1 | Socio-economic and demographic features

As expected, an increase in the council area population within our time period was associated with higher waste volumes across all three bins. Similarly, a council resident population that was older on average was also related to increased waste volumes across general, organic and recycle bins—as well a higher diversion rate. This positive role of age on diversion rates was consistent with previous findings (Saphores et al., 2006; Zhang & Wen, 2014). Another expected result was that an increase in a council's average household size was associated with increased general and recycle waste volumes. Many previous studies have also identified the significant effect of household size on household waste generation (Abdallah et al., 2020; Beigl et al., 2008; Benítez et al., 2008; Lebersorger & Beigl, 2011; Miller et al., 2009; Monavari et al., 2012), while further studies have found that families with more members generate a larger quantity of solid waste (Monavari et al., 2012).

Finally, the increased percentage of people married within a council area was significantly associated with the reduced organic waste volumes and therefore observed negative association with overall diversion rates. This result is consistent with Katajajuuri et al. (2014) and Koivupuro et al. (2012).

4.3 | Council-level time-invariant heterogeneity

Our study includes eight councils, which may manifest varying features that could have influenced waste recycling outcomes. In addition to the controlled factors, there could also be unobserved council-level characteristics that may systematically be associated with aggregate waste recycling behaviour at this level. For example, certain features, such as public awareness of environmental protection and recycling facility accessibility, may manifest regional patterns. Also, neighbourhood peer-effects in pro-environmental behaviour may occur, potentially associated with aggregate-level waste recycling behavioural changes. Admittedly, while these features cannot be precisely measured, their consistent estimates can be obtained within the fixed-effects specification setting, provided that the time dimension is reasonable large. In our application, monthly data covering the period 2006–2016, provides 120 data points to estimate the FE after the within estimation. While this time-series dimension may still be considered moderately large, it represents a unique setting within a panel data context, where the time dimension is often small (2–10 years). The estimated FE help to uncover the extent to which regional time-invariant regularities that are intrinsic to councils influence the waste generation and recycling in SA.

To investigate these potential heterogeneities, council-level FE were predicted and plotted in Figure 3. It can be observed that inner-city suburbs typically have higher estimated FE—suggesting households in urban areas (left of the map, except for Burnside) generally have higher diversion rates, once the observed covariates are controlled for. Conversely, outlying councils such as Burnside and Adelaide Hills have the lowest estimated FE, where people divert less waste. This may be because of other socio-economic or geographical locational factors that have not been controlled for (such as more opportunities for composting in larger properties, accessibility of council resources to support people or the ability of council staff to implement policies).

4.4 | Robustness checks

Several alternative specifications were run to check the robustness of results. This included employing various year and seasonal FE and using a variety of variables. First, models with

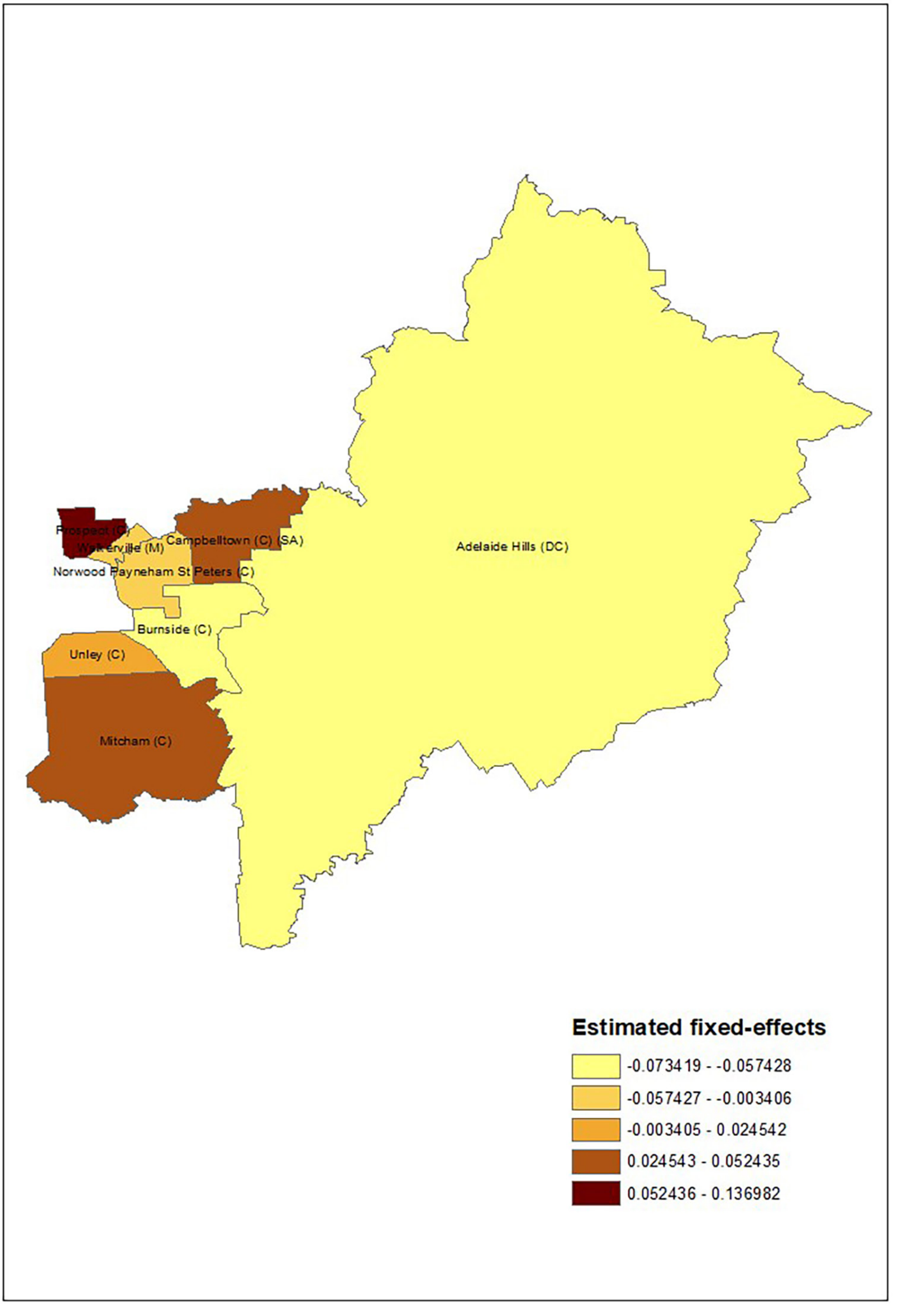

FIGURE 3 Estimated council fixed effects. *Source*: Authors' estimates and mapping. [Colour figure can be viewed at wileyonlinelibrary.com]

less-restrictive FE (regional and year FE) were used for robustness checks. Our results showed that changes in model specifications, using less-restrictive FE, did not significantly alter the significance or magnitude of key policy variables and the COVID-19 pandemic on waste generation (Figure S1 and Table S2 in Appendix S1). Nor did the specification changes impact the overall diversion rate (Figure S1 and Table S3 in Appendix S1). When applying standard fixed-effects specification, the significance and magnitude of most variables did not change—other than the impact of deploying food kitchen caddies on monthly waste in the organic bin. This result indicates that when serial autocorrelation exists, the standard fixed-effects model is liable to lead to biased estimation.

Second, models with only policy and climate variables, excluding sociodemographic variables, were also estimated. The results indicated the policy associations were quite robust, while only the significance of opt-in or roll-out of caddies policy on diversion rate changed. These results suggested the estimations were subject to potential omitted variable bias due to the missing socio-economic and demographic variables (Figure S2 in Appendix S1).

5 | DISCUSSION

How best to address the environmental and economic challenges presented by increasing waste volumes, and to encourage household behaviour to adapt towards a more circular economy, are pressing issues faced by many countries. Our study has provided quantitative findings on the association between various structural and educational waste policies with reduced waste volumes and increased diversion rates in SA. Estimates of the fixed-effects linear model with an AR(1) disturbance show that food waste policies such as opt-in and roll-out of food waste caddies, and roll-out of food diversion systems, were associated with increases in the total waste diverted from landfill. Specifically, the implementation of opt-in and roll-out of food waste caddies was associated with an additional 23.86 monthly tonnes of waste diverted from landfill for each council—saving on average $3484 dollars per council per month.

Similarly, the implementation of the roll-out of food waste diversion systems was associated with 28.43 tonnes diverted monthly from landfill for each council—saving on average $4151 per council per month. Between 2006 and 2020, we estimate that 32,014 tonnes of solid waste was diverted across eight SA councils, saving those councils over $4.67 million dollars in reduced landfill levies.[1] Similar associations from roll-out of food diversion systems have been demonstrated in other locations, including Italy, Germany and San Francisco (Green Industries, 2021). It is important to note that these dollar values do not include any estimation of reduced carbon emissions or other circular economy benefits, hence they should be considered a conservative estimate of social benefits.

However, no significant benefits were found from the widespread education campaign that was conducted during studied time period, which aimed to improve awareness and knowledge of waste diversion. Such lack of impact from an education programme does accord with previous studies, which find awareness campaigns are ineffective when implemented alone (Quested et al., 2013; Secondi et al., 2015). In our study setting, the same null finding occurred, even when the Recycle Right campaign was implemented along with other food waste reducing policies—although it is entirely possible that if the information had not been available, people may not have diverted as effectively. Other studies have proposed strategies to improve educational food waste and recycling campaigns, by using information-education tools combined with other strategies (Bernstad et al., 2013; Dai et al., 2016).

Another interesting finding from this study was the continuing impact of COVID-19 on disrupting work and household patterns, and changing the way households live. Enforced

[1]This is a proxy estimate only of gross savings. Currently, the solid waste levy for metropolitan Adelaide is $146 a tonne in landfill (EPA, 2022). Therefore, the total saving is calculated by multiplying annual savings of opt-in/roll-out of food waste caddies and food diversion system by the number of councils and number of years in which the interventions were operating. This does not include the costs of caddies to councils, or any other associated costs.

lockdown and more working at home were associated with 6.2% and 20.9% increases in household general and organic waste, respectively, consistent with international studies (Kasim et al., 2021; Laila et al., 2021). Cooking more often at home, shopping less frequently and purchasing more per trip have all probably contributed to an increase in household food waste (Laila et al., 2021).

One limitation of this study is that, while a significantly long time period at the monthly level allowed us to capture seasonal variations and changes that many other studies were unable to, it included only eight councils within SA in urban areas. As the waste policies and settings in rural areas might be entirely dissimilar, the impacts of policies in rural areas need further investigation in future studies. It would also be beneficial in future to include: (a) more councils across SA and Australia in general; and (b) model individual bin weights by households over time. A larger data set across different jurisdictions may also allow for the assessment of various economic policies on waste diversion (such as deposit schemes, landfill tonne charges and differing council charges on household waste collection). There is also a need to employ household-level data, given its future availability within systems such as RFID collecting (Radio Frequency Identification Device—to accurately track and report on individual kerbside bin collections), which could allow for greater understanding of household-level behaviour (e.g. gardening and food waste activities). Finally, having access to individual bin volumes would allow future research to investigate the effectiveness of various waste policies on the exact measure of household waste.

6 | CONCLUSION

Given the goal of SA to achieve zero avoidable waste sent to landfill by 2030, understanding the relationship of various policies and influences with diversion and food waste behaviour is critical in ensuring the implementation of effective and efficient policies. Using a rare comprehensive monthly data set covering eight councils in SA, we employed a fixed-effects linear model with an AR(1) disturbance to examine the influence of structural food waste diversion and education campaigns on waste generation and diversion.

The main findings are threefold. First, food waste structural policies (e.g. opt-in or roll-out of food waste caddies and roll-out of food diversion systems) were highly associated with increased total waste diverting from landfill. We estimated that over 32,000 tonnes of waste was potentially diverted during the study time period, saving the councils in question over $4.67 million dollars. On the contrary, a widespread education campaign was found to neither be associated with reduction of monthly waste volumes across the three bins nor be associated with the diversion rate. Furthermore, the outbreak of Coronavirus in SA is linked with increases in monthly waste in the general and organic bins in our area of study, signifying the ongoing impact of COVID-19 on everyday household lives. Given these findings, and the desire to increase diversion rates around the world, understanding the effectiveness of various recycling and food waste intervention policies is essential. Although we found that some food waste policies were signficantly associated with increasing in waste diversion, there is clearly a need for better-targeted interventions and policies going forward.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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REFERENCES

Abdallah, M., Arab, M., Shabib, A., El-Sherbiny, R. & El-Sheltawy, S. (2020) Characterization and sustainable management strategies of municipal solid waste in Egypt. *Clean Technologies and Environmental Policy*, 22(6), 1371–1383.

Abdoli, M.A., Falahnezhad, M. & Behboudian, S. (2011) Multivariate econometric approach for solid waste generation modeling: impact of climate factors. *Environmental Engineering Science*, 28(9), 627–633.

Alacevich, C., Bonev, P. & Söderberg, M. (2021) Pro-environmental interventions and behavioral spillovers: evidence from organic waste sorting in Sweden. *Journal of Environmental Economics and Management*, 108, 102470.

Arıkan, E., Şimşit-Kalender, Z.T. & Vayvay, Ö. (2017) Solid waste disposal methodology selection using multi-criteria decision making methods and an application in Turkey. *Journal of Cleaner Production*, 142, 403–412.

Australian Government Department of the Environment and Energy. (2017) *National food waste strategy: halving Australia's food waste by 2030*. Available from: https://www.environment.gov.au/protection/waste-resource-recovery/publications/national-food-waste-strategy [Accessed 15th July 2023].

Australian Government Department of the Environment and Energy. (2019) *National Waste Policy Action Plan 2019*. Available from: https://www.awe.gov.au/environment/protection/waste/publications/national-waste-policy-action-plan [Accessed 15th July 2023].

Azadi, S. & Karimi-Jashni, A. (2016) Verifying the performance of artificial neural network and multiple linear regression in predicting the mean seasonal municipal solid waste generation rate: a case study of Fars province, Iran. *Waste Management*, 48, 14–23.

Baltagi, B.H. & Wu, P.X. (1999) Unequally spaced panel data regressions with AR (1) disturbances. *Econometric Theory*, 15(6), 814–823.

Bandara, N.J., Hettiaratchi, J.P.A., Wirasinghe, S.C. & Pilapiiya, S. (2007) Relation of waste generation and composition to socio-economic factors: a case study. *Environmental Monitoring and Assessment*, 135(1), 31–39.

Barr, S. & Gilg, A.W. (2005) Conceptualising and analysing household attitudes and actions to a growing environmental problem: development and application of a framework to guide local waste policy. *Applied Geography*, 25(3), 226–247.

Bartelings, H., Dellink, R.B. & van Ierland, E.C. (2004) Modeling market distortions in an applied general equilibrium framework: the case of flat-fee pricing. In: van den Bergh, J.C. & Janssen, M. (Eds.) *Economics of industrial ecology: materials, structural change, and spatial scales*. Cambridge, MA: MIT Press, pp. 255–286.

Bartelings, H. & Sterner, T. (1999) Household waste management in a Swedish municipality: determinants of waste disposal, recycling and composting. *Environmental and Resource Economics*, 13(4), 473–491.

Beigl, P., Lebersorger, S. & Salhofer, S. (2008) Modelling municipal solid waste generation: a review. *Waste Management*, 28(1), 200–214.

Benítez, S.O., Lozano-Olvera, G., Morelos, R.A. & de Vega, C.A. (2008) Mathematical modeling to predict residential solid waste generation. *Waste Management*, 28, S7–S13.

Benson, N.U., Bassey, D.E. & Palanisami, T. (2021) COVID pollution: impact of COVID-19 pandemic on global plastic waste footprint. *Heliyon*, 7(2), e06343.

Bernstad, A., la Cour Jansen, J. & Aspegren, A. (2013) Door-stepping as a strategy for improved food waste recycling behaviour–Evaluation of a full-scale experiment. *Resources, Conservation and Recycling*, 73, 94–103.

Big Australia. (2018) *Big Australia's rubbish future does not have to go to waste*. Available from: https://www.abc.net.au/news/2018-03-17/wastecould-become-fuel-source-in-big-australias-future/9550082 [Accessed 15th July 2023].

Bruvoll, A. (2001) Factors influence solid waste generation and management. *Journal of Solid Waste Technology and Management*, 27(3), 156–162.

Burlea-Schiopoiu, A., Ogarca, R.F., Barbu, C.M., Craciun, L., Baloi, I.C. & Mihai, L.S. (2021) The impact of COVID-19 pandemic on food waste behaviour of young people. *Journal of Cleaner Production*, 294, 126333.

Cecere, G., Mancinelli, S. & Mazzanti, M. (2014) Waste prevention and social preferences: the role of intrinsic and extrinsic motivations. *Ecological Economics*, 107, 163–176.

Chang, N.B. & Lin, Y.T. (1997) An analysis of recycling impacts on solid waste generation by time series intervention modeling. *Resources, Conservation and Recycling*, 19(3), 165–186.

Chung, S.S. (2010) Projection of trends in solid waste generation: the case of domestic waste in Hong Kong Special Administrative Region. *Environmental Engineering Science*, 27(1), 13–20.

Cole, C., Quddus, M., Wheatley, A., Osmani, M. & Kay, K. (2014) The impact of local authorities' interventions on household waste collection: a case study approach using time series modelling. *Waste Management*, 34(2), 266–272.

Cubillos, M. (2020) Multi-site household waste generation forecasting using a deep learning approach. *Waste Management*, 115, 8–14.

Dahlén, L. & Lagerkvist, A. (2010) Evaluation of recycling programmes in household waste collection systems. *Waste Management & Research*, 28(7), 577–586.

Dai, Y.C., Lin, Z.Y., Li, C.J., Xu, D.Y., Huang, W.F. & Harder, M.K. (2016) Information strategy failure: personal interaction success, in urban residential food waste segregation. *Journal of Cleaner Production*, 134, 298–309.

Danthurebandara, M., Van Passel, S., Nelen, D., Tielemans, Y. & Van Acker, K. (2012) Environmental and socio-economic impacts of landfills. *Linnaeus Eco-Tech*, 2012, 40–52.

Dayal, G., Yadav, A., Singh, R.P. & Upadhyay, R. (1993) Impact of climatic conditions and socio-economic status on solid waste characteristics: a case study. *Science of the Total Environment*, 136(1–2), 143–153.

Department of Agriculture, Water and the Environment Australian Government. (2020) *National Waste Report*. 2020. Available from: https://www.awe.gov.au/sites/default/files/env/pages/5a160ae2-d3a9-480e-9344-4eac42ef9001/files/national-waste-report-2020.pdf [Accessed 21st March 2022].

Dijkgraaf, E. & Gradus, R.H. (2004) Cost savings in unit-based pricing of household waste: the case of The Netherlands. *Resource and Energy Economics*, 26(4), 353–371.

EPA. (2022) *Waste levy*. Available from: https://www.epa.sa.gov.au/business_and_industry/waste-levy#:~:text=The%20waste%20levy%20is%20paid%20to%20the%20EPA,paid%20on%20the%20recovered%20material%20%28see%20diagram%20below%29 [Accessed 15th July 2023].

Ferrara, I. & Missios, P. (2005) Recycling and waste diversion effectiveness: evidence from Canada. *Environmental and Resource Economics*, 30(2), 221–238.

Ferrara, I. & Missios, P. (2012) A cross-country study of household waste prevention and recycling: assessing the effectiveness of policy instruments. *Land Economics*, 88(4), 710–744.

Fiorillo, D. (2013) Household waste recycling: national survey evidence from Italy. *Journal of Environmental Planning and Management*, 56(8), 1125–1151.

Fullerton, D. & Kinnaman, T.C. (1996) Household responses to pricing garbage by the bag. *American Economic Review*, 86(4), 971–984.

Gómez, G., Meneses, M., Ballinas, L. & Castells, F. (2009) Seasonal characterization of municipal solid waste (MSW) in the city of Chihuahua, Mexico. *Waste Management*, 29(7), 2018–2024.

Green Industries SA. (2020) *Supporting the circular economy: South Australia's waste strategy 2020–2025*. Available from: https://www.greenindustries.sa.gov.au/resources/sa-waste-strategy-2020-2025 [Accessed 15th July 2023].

Green Industries SA. (2021) *Valuing our food waste: South Australia's strategy to reduce and divert household and business food waste 2020–2025*. Available from: https://www.greenindustries.sa.gov.au/Green%20Industries%20SA_Food%20Waste%20Strategy_final_web.pdf?downloadable=1 [Accessed 15th July 2023].

He, H., Reynolds, C.J., Hadjikakou, M., Holyoak, N. & Boland, J. (2020) Quantification of indirect waste generation and treatment arising from Australian household consumption: a waste input-output analysis. *Journal of Cleaner Production*, 258, 120935.

Jenkins, R.R. (1993) *The economics of solid waste reduction: the impact of user fees*. Aldershot: Edward Elgar Publishing Limited.

Jenkins, R.R., Martinez, S.A., Palmer, K. & Podolsky, M.J. (2003) The determinants of household recycling: a material-specific analysis of recycling program features and unit pricing. *Journal of Environmental Economics and Management*, 45(2), 294–318.

Johnstone, N. & Labonne, J. (2004) Generation of household solid waste in OECD countries: an empirical analysis using macroeconomic data. *Land Economics*, 80(4), 529–538.

Kasim, O.F., Oyedotun, T.D., Famewo, A., Oyedotun, T.D., Moonsammy, S., Ally, N. et al. (2021) Household waste generation, change in waste composition and the exposure to COVID-19 in Guyana and Nigeria. *Scientific African*, 14, e01060.

Katajajuuri, J.M., Silvennoinen, K., Hartikainen, H., Heikkilä, L. & Reinikainen, A. (2014) Food waste in the Finnish food chain. *Journal of Cleaner Production*, 73, 322–329.

Kirakozian, A. (2016) The determinants of household recycling: social influence, public policies and environmental preferences. *Applied Economics*, 48(16), 1481–1503.
Knussen, C., Yule, F., MacKenzie, J. & Wells, M. (2004) An analysis of intentions to recycle household waste: the roles of past behaviour, perceived habit, and perceived lack of facilities. *Journal of Environmental Psychology*, 24(2), 237–246.
Koivupuro, H.K., Hartikainen, H., Silvennoinen, K., Katajajuuri, J.M., Heikintalo, N., Reinikainen, A. et al. (2012) Influence of socio-demographical, behavioural and attitudinal factors on the amount of avoidable food waste generated in Finnish households. *International Journal of Consumer Studies*, 36(2), 183–191.
Laila, A., von Massow, M., Bain, M., Parizeau, K. & Haines, J. (2021) Impact of COVID-19 on food waste behaviour of families: results from household waste composition audits. *Socio-Economic Planning Sciences*, 30, 101188.
Lakhan, C. (2015) Evaluating the effects of unit based waste disposal schemes on the collection of household recyclables in Ontario, Canada. *Resources, Conservation and Recycling*, 95, 38–45.
Leal Filho, W., Voronova, V., Kloga, M., Paço, A., Minhas, A., Salvia, A.L. et al. (2021) COVID-19 and waste production in households: a trend analysis. *Science of the Total Environment*, 777, 145997.
Lebersorger, S. & Beigl, P. (2011) Municipal solid waste generation in municipalities: quantifying impacts of household structure, commercial waste and domestic fuel. *Waste Management*, 31(9–10), 1907–1915.
Lee, M., Choi, H. & Koo, Y. (2017) Inconvenience cost of waste disposal behavior in South Korea. *Ecological Economics*, 140, 58–65.
Lee, S. & Paik, H.S. (2011) Korean household waste management and recycling behavior. *Building and Environment*, 46(5), 1159–1166.
Linderhof, V., Kooreman, P., Allers, M. & Wiersma, D. (2001) Weight-based pricing in the collection of household waste: the Oostzaan case. *Resource and Energy Econonomics*, 23(4), 359–371.
Local Government Association. (2007) *Recycling rates rocket by 30% when councils switch to alternate weekly collection*. Available from: http://www.lga.gov.uk/lga/core/page.do?pageId=41797 [Accessed 12th January 2022].
Matsuto, T. & Tanaka, N. (1993) Data analysis of daily collection tonnage of residential solid waste in Japan. *Waste Management & Research*, 11(4), 333–343.
Mazzanti, M. & Zoboli, R. (2008) Waste generation, waste disposal and policy effectiveness: evidence on decoupling from the European Union. *Resources, Conservation and Recycling*, 52(10), 1221–1234.
Miller, I., Lauzon, A., Wattle, B., Ritter, M. & Hood, J. (2009) Determinants of municipal solid waste generation and recycling in western New York communities. *The Journal of Solid Waste Technology and Management*, 35(4), 209–236.
Miranda, M.L., Everett, J.W., Blume, D. & Roy, B.A., Jr. (1994) Market-based incentives and residential municipal solid waste. *Journal of Policy Analysis and Management*, 13(4), 681–698.
Mmereki, D., Baldwin, A. & Li, B. (2016) A comparative analysis of solid waste management in developed, developing and lesser developed countries. *Environmental Technology Reviews*, 5(1), 120–141.
Monavari, S.M., Omrani, G.A., Karbassi, A. & Raof, F.F. (2012) The effects of socioeconomic parameters on household solid-waste generation and composition in developing countries (a case study: Ahvaz, Iran). *Environmental Monitoring and Assessment*, 184(4), 1841–1846.
Nainggolan, D., Pedersen, A.B., Smed, S., Zemo, K.H., Hasler, B. & Termansen, M. (2019) Consumers in a circular economy: economic analysis of household waste sorting behaviour. *Ecological Economics*, 166, 106402.
OECD. (2023) *Municipal waste, generation and treatment*. Available from: https://stats.oecd.org/index.aspx?DataSetCode=MUNW [Accessed 15th July 2023].
Oom do Valle, P., Menezes, J., Reis, E. & Rebelo, E. (2009) Reverse logistics for recycling: the customer service determinants. *International Journal of Business Science and Applied Management*, 4(1), 1–17.
Pirani, S.I., Al-Khatib, I.A., Halaweh, R., Arafat, M.A. & Arafat, H.A. (2015) Household-level determinants of residential solid waste generation rates: a study from Nablus-Palestine. *Journal of Material Cycles and Waste Management*, 17(4), 725–735.
Quested, T.E., Marsh, E., Stunell, D. & Parry, A.D. (2013) Spaghetti soup: the complex world of food waste behaviours. *Resources, Conservation and Recycling*, 79, 43–51.
Saladié, Ò. & Santos-Lacueva, R. (2016) The role of awareness campaigns in the improvement of separate collection rates of municipal waste among university students: a causal chain approach. *Waste Management*, 48, 48–55.
Saphores, J.D.M., Nixon, H., Ogunseitan, O.A. & Shapiro, A.A. (2006) Household willingness to recycle electronic waste: an application to California. *Environment and Behavior*, 38(2), 183–208.
Secondi, L., Principato, L. & Laureti, T. (2015) Household food waste behaviour in EU-27 countries: a multilevel analysis. *Food Policy*, 56, 25–40.
Tai, J., Zhang, W., Che, Y. & Feng, D. (2011) Municipal solid waste source-separated collection in China: a comparative analysis. *Waste Management*, 31(8), 1673–1682.

Thanh, N.P., Matsui, Y. & Fujiwara, T. (2010) Household solid waste generation and characteristic in a Mekong Delta city, Vietnam. *Journal of Environmental Management*, 91(11), 2307–2321.

The Food and Agribusiness Growth Centre (FIAL). (2021) National Food Waste Strategy Feasibility Study. NSW, Australia. Available from: https://workdrive.zohopublic.com.au/external/06152b9ff5971843391f39fc4d32a847e56fb907c167a4a645887b0a4bc43000 [Accessed 15th July 2023].

Torrente-Velásquez, J.M., Chifari, R., Ripa, M. & Giampietro, M. (2020) Robust information for effective municipal solid waste policies: identifying behaviour of waste generation across spatial levels of organization. *Waste Management*, 103, 208–217.

United Nations Statistics Division. (2018) Sustainable development goal 12: ensure sustainable consumption and production patterns. Available from: https://sdg-tracker.org [Accessed 15th July 2023].

Vu, H.L., Ng, K.T.W. & Bolingbroke, D. (2019) Time-lagged effects of weekly climatic and socio-economic factors on ANN municipal yard waste prediction models. *Waste Management*, 84, 129–140.

Vu, H.L., Ng, K.T.W., Richter, A., Karimi, N. & Kabir, G. (2021) Modeling of municipal waste disposal rates during COVID-19 using separated waste fraction models. *Science of the Total Environment*, 789, 148024.

Watson, M. & Bulkeley, H. (2005) Just waste? Municipal waste management and the politics of environmental justice. *Local Environment*, 10(4), 411–426.

WRAP. (2009) *Analysis of kerbside dry recycling performance in England 2007/08*. Oxon: WRAP.

Xiao, L., Lin, T., Chen, S., Zhang, G., Ye, Z. & Yu, Z. (2015) Characterizing urban household waste generation and metabolism considering community stratification in a rapid urbanizing area of China. *PLoS One*, 10(12), e0145405.

Xu, L., Lin, T., Xu, Y., Xiao, L., Ye, Z. & Cui, S. (2016) Path analysis of factors influencing household solid waste generation: a case study of Xiamen Island, China. *Journal of Material Cycles and Waste Management*, 18(2), 377–384.

Zhang, H. & Wen, Z.G. (2014) Residents' household solid waste (HSW) source separation activity: a case study of Suzhou, China. *Sustainability*, 6(9), 6446–6466.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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