United States Consumers' Landscaping Expenditures: A Case of Garden and Lawn Care Services and Equipment

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ABSTRACT. The economic downturns of 2007–09 and the COVID-19 pandemic affected most industries in the United States, including landscape services and equipment sales, and provoked both short-term disruptions and long-term changes. To understand how the landscaping industry has responded, we investigated patterns of consumer expenditures on landscape services and equipment from 2009 through 2021 using a representative sample of 76,895 US households. We categorized US households as detached single-family residents and townhouse residents to more fully articulate the factors that turned potential consumers into purchasers and the factors that affected purchasers' expenditures. We used a double-hurdle model to identify key factors that drive consumer demand for landscape services and equipment over time, including social-demographics, geographic characteristics, housing conditions, year and seasonal trends, and the COVID-19 pandemic. We found that during the studied period, the demand for landscape services declined in terms of both the percentage of consumers purchasing the services and the purchasers' average expenditures, while the demand for do-it-yourself (DIY) equipment remained relatively unchanged. In response to the COVID-19 pandemic, the percentage of consumers who purchased landscape services increased, while the expenditures on landscape services decreased in 2020 and then began to rebound in 2021, but not enough to reverse the overall downward trend. In contrast, purchases of DIY equipment were relatively stable in response to the COVID-19 pandemic and mainly relied on current consumers.

R ecreational activities and aesthetic pleasure motivate US homeowners to purchase landscape products and services (Ambrose et al. 2020; Chalmin-Pui et al. 2021). Many homeowners invest significant money and time in improving their gardens, yards, and lawns; furthermore, numerous kinds of tools and equipment have become necessities for people who choose DIY landscaping and gardening. Other homeowners take advantage of landscaping service companies that design, install, and maintain yards and other landscapes as needed and through maintenance contracts. Many service companies also provide value-added services such as pest control, fertilization, snow removal, and irrigation system installation (IBIS World 2021).

In general, green landscapes have grown in popularity in the United States as part of efforts to beautify residential, commercial, and public spaces and to benefit from associated improvements in water quality and reductions in flood damage. According to Milesi et al. (2009), ~68% of the total turfgrass area in the United States was devoted to residential lawns, thus making residential households the largest group of consumers of landscaping services and equipment in the United States. New technologies that save time, energy, and money, such as robotic lawn mower and in-ground irrigation systems, also present opportunities for growth in the landscaping industry in years to come.

However, similar to other industries, the US landscaping industry, consisting of service companies and sellers and renters of tools and equipment, was strongly negatively affected by the 2007–09 economic downturn (Brown 2009; Goldblatt and Lee 2012).

Other economic events likely affect the landscaping industry as well. Onset of the COVID-19 pandemic, for example, restricted many residents to their own house and yards and required many to spend much more time at home. Thus, the pandemic has unsurprisingly increased household spending on landscaping and home renovations (Behe et al. 2022; Campbell et al. 2021; National Gardening Association 2021; San Fratello et al. 2022). In 2020, the market for lawn and garden equipment was worth a substantial $32.4 billion (Global Market Insights 2021). Although onset of the COVID-19 pandemic potentially increased demand for DIY tools and equipment, it decreased demand for landscape services because of mandatory stay-at home orders (Centers for Disease Control and Prevention 2020). The landscape service industry was valued at $105.1 billion in 2021 according to IBIS World (2021), and its value had grown 4.2% per year between 2017 and 2021, faster than the growth of the overall economy.

Consequently, there is no clear understanding of the impacts on the landscaping industry of economic downturns and documented changes in consumer spending in response to the pandemic. Previous studies have shown that landscaping expenditures were significantly associated with income, education level, owner-occupied houses, ages of houses, and family size (Zhao et al. 2016; Zhou et al. 2009). Few studies have specifically examined the factors that drive people to purchase landscape services and equipment following the 2007–09 economic downturns and onset of the COVID-19 pandemic. The National Gardening Survey (National Gardening Association 2020) found that the wealthiest US households were most likely to purchase landscape services, and lower-income households were most likely to purchase DIY lawn and gardening equipment. Campbell et al. (2021) compared southeastern US consumers' expenditures on plants and landscape items, and they concluded that the expenditures grew by 3.4% in

2019 and 4.6% in 2020. Meanwhile, San Fratello et al. (2022) found that household decisions about participating in gardening changed in response to the COVID-19 pandemic.

We examined developments in US consumers' expenditures for landscape services and equipment following the 2007–09 economic downturns and onset of the COVID-19 pandemic, using a longitudinal representative dataset of 76,895 US consumers for 2009 through 2021. The models identified associations between households' purchasing decisions and subsequent expenditures and participants' sociodemographic characteristics, geographic factors, housing conditions, year and seasonal trends, and onset of the COVID-19 pandemic. These results expand our understanding of factors that drive US households to purchase landscape services and equipment during critical economic periods and identified expenditure patterns over the past 13 years.

Methods

DATA. The dataset used in the study was obtained from the US Bureau of Labor Statistics' nationwide consumer expenditure (CE) survey. The survey collected data on participants' reported expenditures for a wide range of categories of goods and services, as well as most types of income and demographic background.

We extracted data on two types of landscaping expenditures: landscape services and tools/equipment (hereafter referred to simply as DIY equipment). Landscaping services are transitory goods, whereas many DIY equipment purchases are long-term investments. Purchased equipment can be used for many years if consumers want to maintain their gardens and lawns by themselves. However, those consumers who do not want to invest in equipment and tools can hire landscape services. In the CE survey, "gardening or lawn care services" includes fertilizing, lawn cutting, plowing, tree pruning, hedge trimming, planting, tilling, and tree removal provided by companies via service contracts. "Lawn and garden equipment" includes lawn mowers and other yard equipment such as edgers, electric lawn trimmers, garden hoses, rakes, shovels, snow blowers, spreaders, tillers, tractors (farm, garden, etc.), weed diggers, and wheelbarrows. We also included household expenditures on "repairing/rental of lawn and garden equipment" in DIY equipment purchases.

To maintain the representativeness of the sample, we restricted it to participants who may have a need for landscape services and DIY equipment; that is, those who have a yard, an area surrounding their home that may include mulch beds, a pool, a garden, or a lawn/grass area. Thus, we limited our analysis to participants who lived in single-family detached (SFD) houses and in townhouses because those were most likely to have yards and/or lawns that created demand for landscape services and DIY equipment.

The CE survey has been administered quarterly to ~6000 households on their monthly expenditures in the preceding 3 months. And each household participant was surveyed for four consecutive quarters. After applying our sample restriction, the resulting sample consisted of data on 76,895 US households for the first quarter (Q1) of 2009 through the second quarter (Q2) of 2021. Expenditures for landscape services and DIY equipment during that period were aggregated into quarterly measures for each household, resulting in a final dataset of 270,195 observations. Then, the aggregated expenditures were adjusted for inflation based on the 2009 Consumer Price Index. Using these data, we identified factors, such as geographic location and age, that made consumers more or less likely to purchase landscaping services and DIY equipment and affected how much they spend. We also compared likelihood of purchasing and amounts spent by residents of SFD houses vs. residents of townhouses.

MODEL SPECIFICATION. Many sampled households reported zero purchases of landscape services and DIY equipment intermittently during the study period. These zero observations can arise from nonpurchasers, infrequent purchases in the short run, and corner solutions (Dong et al. 2004). Tobit models have been commonly used when the dependent variable is censored, such as when a substantial proportion of the observations fall at the lower limit of zero expenditures, and it treats observations with zero expenditures as nonpurchasers (Tobin 1958). The models assume that the process that generated a zero observation was identical to the process that generated strictly positive values. Consequently, such models fail to differentiate between consumers who would be potential purchasers at some point in the future and consumers who would never choose to purchase.

Tobit models can be improved by assuming the existence of a group of nonpurchasers who would never purchase under any circumstances. This double-hurdle model, introduced by Cragg (1971), incorporated the idea that an individual's decision of participation was the result of two processes: the first hurdle determined whether an individual consumed the good—in our case, whether an individual made a landscaping purchase; the second hurdle determined the extent to which the individual participated—in our case, how much the individual spent on landscaping services and/or equipment.

A key feature of this model is specifying two types of zero observations. In one, the individual is a nonparticipant and the outcome will always be zero regardless of the circumstances at the time of the decision (e.g., resources, prices); that is, in our case, as some SFD and most townhouse consumers have their landscapes maintained by their homeowner associations, they do not purchase landscaping services or equipment. In the second, the individual is a potential participant and the outcome, which can be zero or positive, depending on the circumstances when the decision was made. Thus, the double-hurdle model naturally incorporates nonparticipants and allows one to estimate the probability that an individual will be a participant and the extent of participation based on the individual's characteristics.

This model has been used to study various issues. Jones (1989), for example, applied it to consumers' consumption of cigarettes based on the assumption that some proportion of a population would never smoke cigarettes regardless of their circumstances. Burton et al. (1994) applied the model to meat consumption to incorporate individuals who were vegetarians and thus never consumed meat. In the literature on ornamental horticulture, Torres et al. (2021) used the model to study the factors that influence a firm's adoption of and spending on online advertising. Saz-Salazar and Rausell-Köster (2008) used the model to identify residents'

willingness to pay for access to urban green area.

In this study, we used the double-hurdle model to examine decisions regarding consumption of landscape services and DIY equipment in which household sociodemographic characteristics, geographic factors, housing status, year and season, and onset of the COVID-19 pandemic were potential explanatory variables for decisions to purchase and amount to expend. In the first hurdle, we estimated the decision to purchase using a probit model in which the dependent variable d_i measured the probability of household i being a potential purchaser based on the latent variable d_i^*, which is greater than zero for potential purchasers, and zero or less for never-purchasers.

$$d_i = \begin{cases} d_i^* & if \ d_i^* > 0 \\ 0 & if \ d_i^* \leq 0 \end{cases} \quad [1]$$

$$d_i^* = z_i'\alpha + \varepsilon_i; \ \varepsilon_i \sim N(0,1) \quad [2]$$

In the second hurdle, we measured expenditures using maximum likelihood estimation

$$y_i^* = x_i'\beta + \varphi_i; \ \varphi_i \sim N(0,\sigma^2). \quad [3]$$

Following Engel and Moffatt (2014), the log-likelihood function was given by

$$Log \ L = \Sigma_0 \ ln\left\{1 - \phi(z_i'\alpha)\phi\left(\frac{x_i'\beta}{\sigma}\right)\right\} + \Sigma_+ \ ln\left\{\phi(z_i'\alpha)\frac{1}{\sigma}\phi\left(\frac{y - x_i'\beta}{\sigma}\right)\right\}. \quad [4]$$

In the empirical application, we used the same set of explanatory variables for participation and expenditures:

$$d_i^* = \alpha + \alpha_0 COVID + \alpha_1 s_i + \alpha_2 g_i + \alpha_3 h_i + \alpha_4 yt_i + \varepsilon_i \quad [5]$$

$$y_i^* = \beta + \beta_0 COVID + \beta_1 s_i + \beta_2 g_i + \beta_3 h_i + \beta_4 yt_i + \varphi_i \quad [6]$$

where d_i^* was the estimated probability of household i being a purchaser for landscape services or DIY equipment based on if household i had positive expenditure values. Zero and negative estimates indicated that household i was a nonpurchaser under all circumstances, y_i^* represented the logarithm of a positive landscape service or DIY equipment expenditure, as expenditures on landscape services and DIY equipment were highly skewed, and we therefore took the natural logarithms to fit expenditure data to a normal distribution, COVID equaled 1 for after Q1 2020 and 0 otherwise, s_i represented a set of variables of participants' sociodemographic characteristics, g_i represented geographic factors, h_i denoted housing status, and yt_i denoted years and seasons.

Results

Summary statistics for participants' sociodemographic characteristics

Table 1 presents summary statistics of the 76,895 sampled households for Q1 2009 through Q2 2021. The households were distributed evenly over years and quarters. In terms of the age of participants, ~27% were younger than 40 years, 29% were between 40 and 54 years of age, and 44% were 55 years or older. Approximately 48% of the participants were male, 83% were Caucasian, and 59% were married. The average household size was 2.62 people and every household had at least one wage earner. The average number of household members aged 64 years or older was 0.4, and the average age of the oldest child was 6 to 11 years. The average education level was high school or equivalent (less than a bachelor's degree), and the average household income was $36,900.

Most participants (93%) were in urban areas because metropolitan statistical areas were included in the sample design of the CE survey as primary sampling units. The largest share of households (38%) resided in southern US states and the smallest share (17%) resided in northeastern US states. The average population of participants' cities exceeded 1 million. In terms of housing status, 91% of participants resided in SFD houses, 9% resided in townhouses; overall, 78% of those sampled owned their homes. The average number of rooms per home was 3.12, and 70% of participants had a porch, terrace, patio, or balcony.

Landscaping expenditures by region

Table 2 shows summary statistics for the sample's annual expenditures on landscape services and DIY equipment by US regions—West, Midwest, South, and Northeast—for 2009 through 2021. Figure 1 presents the percentage of participants who purchased landscape services and DIY equipment by region. The latest CE data captured expenditures only through Q2 2021, so we calculated projected expenditures and percentages of purchasers for the third and fourth quarters (Q3 and Q4) of 2021 using the average four-quarter expenditure ratios and purchasing percentage ratios from prior years.

Note that, in the original dataset, the maximum expenditure on DIY equipment was $53,036 and presumably represented agricultural rather than residential purchases. We thus defined outliers as expenditures that exceeded the 99th percentile and deleted those expenditures from the analysis. In the final dataset, the maximum expenditure by a household for DIY equipment was $5800.

We found that ~28% of participants purchased landscape services and that the average annual household expenditure for landscape services during the study period was ~$371. Most households' expenditures for services were moderate: the median was ~$190, 25% of households spent less than $54, and 25% spent more than $496.

We also found that expenditures for landscape services varied by region. Those in western US states consistently rated highest with an average of 32%, followed by northeastern, southern, and midwestern US states. In terms of expenditures, purchasers in western US states had the highest annual average ($413), and purchasers in northeastern US states had the highest median with half paying more than $229. Purchasers in the midwestern US, on the other hand, had the lowest annual average ($289) and the lowest median ($148). On average, purchasers in southern US states spent more on landscape services than those in midwestern US states.

For DIY equipment, we found that ~13% of participants chose to purchase during the study period. Of particular interest is the fact that the households' expenditure patterns on DIY equipment were similar to that of landscape services. Once again, most households' expenditures were moderate. For DIY equipment, the average annual expenditure was $329, the median was $143, 25% of purchasers spent less than $60 per year, and 25% spent more than $320 per year.

Purchases and expenditures on DIY equipment also varied by region. In

Table 1. Summary statistics of the 76,895 sampled households in the consumer expenditure survey collected by the US Bureau of Labor Statistics during the first quarter of 2009 to the second quarter of 2021.

Variable	Description	Survey participants	
		Mean	SD
Sociodemographic characteristics			
Age1	1 if participant younger than 40 years; 0 otherwise	0.27	0.44
Age2	1 if participant 40 to 54 years; 0 otherwise	0.29	0.46
Age3	1 if participant 55 years and older; 0 otherwise	0.44	0.50
Gender	1 if male participant; 0 if female participant	0.48	0.50
Caucasian	1 if participant race identified as Caucasian; 0 otherwise	0.83	0.37
Married	1 if participant married, 0 otherwise	0.59	0.49
Household size	Number of household members	2.62	1.50
Earners	Number of earners in household	1.34	0.98
Person64	Number of household members older than 64 years	0.40	0.68
Child age	Age of participants' children (in years)	1.90	2.62
	0 = No children		
	1 = All children younger than 6		
	2 = Oldest child between 6 and 11, at least one child younger than 6		
	3 = All children between 6 and 11		
	4 = Oldest child between 12 and 17, at least one child younger than 12		
	5 = All children between 12 and 17		
	6 = Oldest child greater than 17, at least one child younger than 17		
	7 = All children older than 17		
Education	Highest educational level completed	2.26	0.63
	1 = Did not complete high school		
	2 = High school diploma or equivalent		
	3 = Bachelor's degree or above		
Income	Income class pre-tax	3.74	2.08
	1 = Less than $15,000		
	2 = $15,000 to $29,999		
	3 = $30,000 to $39,999		
	4 = $40,000 to $49,999		
	5 = $50,000 to $69,999		
	6 = $70,000 and above		
Geographic factors			
Urban	1 if urban area; 0 if rural	0.93	0.25
Northeast	1 if in northeastern US; 0 otherwise	0.17	0.37
Midwest	1 if in midwestern US; 0 otherwise	0.22	0.42
South	1 if in southern US; 0 otherwise	0.38	0.48
West	1 if in western US; 0 otherwise	0.23	0.42
Population[i]	Population of residence city	2.62	1.37
	1 = More than 5 million		
	2 = 1 to 5 million		
	3 = 0.5 to 0.99 million		
	4 = 100 to 500 thousand		
	5 = Less than 100 thousand		
Housing status			
House owned	1 if participant owned house	0.78	0.42
Rooms	Number of rooms in the house	3.12	0.98
Porch	1 if house had a porch, terrace, patio, or balcony; 0 otherwise	0.70	0.46
Single-family detached house	1 if the house was single-family detached (detached structure with only one primary residence); 0 otherwise	0.91	0.28
Townhouse	1 if the house was a townhouse; 0 otherwise	0.09	0.28
Year and seasonal trends			
Year trend (YT)	Trend variable: 1 = year 2009 through 13 = year 2021	6.28	3.70
YT × Age1	Interactive term for year and age younger than 40 years	1.64	3.32
YT × Age2	Interactive term for year and age 40 to 54 years	1.75	3.38
YT × Age3	Interactive term for year and age older than 55 years	2.89	4.08
COVID	1 if after Q1 2020, the onset of COVID-19 pandemic	0.11	0.31

Table 1. (*Continued*)

Variable	Description	Survey participants	
		Mean	*SD*
Quarter 1	1 if recorded in January, February, or March; 0 otherwise	0.26	0.44
Quarter 2	1 if recorded in April, May, or June; 0 otherwise	0.26	0.44
Quarter 3	1 if recorded in July, August, or September; 0 otherwise	0.24	0.43
Quarter 4	1 if recorded in October, November, or December; 0 otherwise	0.24	0.42

[i] Population was coded in inverse order.

terms of the average annual percentages of households that made purchases, midwestern US households ranked highest at 15% and southern and western US households ranked lowest and below the national average at 13%. In terms of expenditures, purchasers in the midwestern United States had the highest annual average ($378), those in the northeastern United States had the highest median ($170), and western purchasers had the lowest annual average ($217) and median ($108).

Landscaping expenditure by age group

Consumer age was an important factor affecting expenditures on landscape services and DIY equipment. We analyzed reported expenditures for three age cohorts of participants—younger than 40 years, between 40 and 54 years, and 55 years or older—and calculated the percentage of annual purchases attributable to each cohort for 2009 through 2021 (including projected data for Q3 and Q4 of 2021). Those ratios are depicted in Figs. 2 and 3.

Of the three age cohorts, purchasers 55 years or older accounted for the greatest annual average shares of expenditures for landscape services (more than 50%) and DIY equipment (more than 40%) each year. This oldest age cohort also increasingly directed their expenditures to landscape services before the COVID-19 pandemic. Their share of purchases of services rose from ∼56% in 2009 to 67% in 2019 and their share of equipment purchases dropped from 53% in 2009 to 44% in 2019. During the pandemic, their share of expenditures for landscape services declined 8% and their share of DIY expenditures rose 11%, figures that are roughly equivalent to their shares in 2009.

The percentages of purchases of landscape services made by the youngest cohort (younger than 40 years) varied little over time. Their shares of expenditures for DIY equipment rose and fell during the period in a pattern that did not correlate with the economic downturns or with the pandemic.

Overall, we found that participants in the oldest cohort (55 years or older) steadily spent more on both landscape services and DIY equipment with a shift toward DIY equipment during the pandemic. Participants in the youngest cohort (younger than 40 years) did not change their expenditures on landscape services very much but showed increasing purchase of DIY equipment over time.

Landscaping expenditures before and during the COVID-19 pandemic

To further explore potential shifts in expenditure patterns in response to the COVID-19 pandemic, we examined average quarterly expenditures on landscape services and DIY equipment before (2009–19) and during the pandemic (quarterly for 2020 and 2021). Table 3 reports these average expenditures before and during the pandemic, and Fig. 4 presents the average percentage of participants who made purchases in the same periods.

The data in Table 3 show that average expenditures on landscape services fell somewhat in 2020 and then increased considerably beginning in 2021. Average expenditures per quarter on services in 2021 exceeded average expenditures in the same quarters for 2009 through 2019. Post-pandemic expenditures per quarter on DIY equipment, on the other hand, increased moderately in the first half of 2020 and then increased significantly in 2021. Moreover, as shown in Fig. 4, percentages of participants who purchased landscape services and/or DIY equipment increased after onset of the COVID-19 pandemic.

In addition, we found that 40% of purchasers annually made repeated (at least two) purchases of landscape services before the pandemic. After onset of the COVID-19 pandemic, the shares of purchasers making repeated purchases of landscape services rose to ∼48% in 2020 and 50% in 2021. Before the COVID-19 pandemic, ∼4% of purchasers made repeated purchases of DIY equipment: after onset of the pandemic, the share of repeat purchases rose to 6% in 2020 and 7% in 2021.

Results of the double-hurdle model

As previously noted, we adopted the double-hurdle model to examine the effects of sociodemographic characteristics, geographic factors, housing status, years and seasons, and onset of the COVID-19 pandemic on participants' decisions to purchase (participation, or hurdle 1) and expenditures by purchasers (hurdle 2) on landscape services and DIY equipment. We present those results for Q1 2009 through Q2 2021 in Table 4 for landscape services and Table 5 for DIY equipment. In Tables 4 and 5, columns 1 and 3 show the estimation results of the participation equation for participants who lived in SFD houses and those who lived in townhouses, respectively, and columns 2 and 4 present the corresponding estimation results of the expenditure equations.

Our initial estimations, reported in Table 2, showed that expenditures on landscape services and DIY equipment were highly skewed, and most expenditures were moderate. We therefore took the natural logarithms of positive expenditures to fit expenditure data to a normal distribution. Figure 5 presents histograms of the transformed positive expenditures and indicates that the natural logarithms were more likely to be normally distributed. We also conducted the Kolmogorov-Smirnoff test for normality
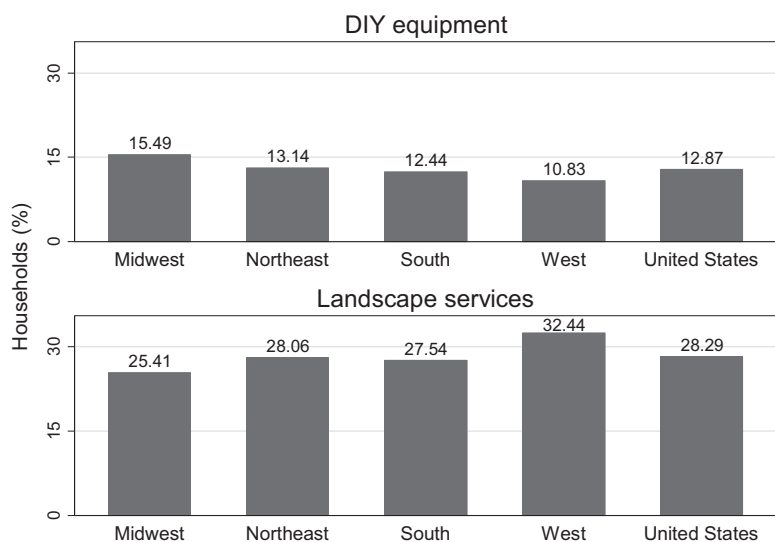
Fig. 1. Percentage of households that made purchases of landscape services and do-it-yourself (DIY) equipment by region using the consumer expenditure survey data collected by the US Bureau of Labor Statistics during 2009–21. Because the latest consumer expenditure data captured expenditures only through the second quarter of 2021, we calculated projected percentages of purchasers for the third and fourth quarters of 2021 using the average four-quarter purchasing percentage ratios from prior years.

and found the residuals followed a normal distribution.

LANDSCAPE SERVICE EXPENDITURES. Table 4 presents the results of the double-hurdle model for landscape service purchases and expenditures for Q1 2009 through Q2 2021. It also provides a comparison of purchases and expenditures by SFD participants vs. townhouse participants.

Our analysis of sociodemographic factors revealed numerous associations with choosing to purchase and expenditures on landscape services. Three factors—age, education, and income—affected SFD and townhouse participants similarly. Participants in the oldest age cohort (55 years and older), which served as the base group, were significantly more likely to purchase landscape services and spent more on those services than participants in the two younger cohorts. The coefficients of the two younger age cohorts are negative and statistically significant at the 1% significant level. Those results were in line with our initial estimates, which are shown in Fig. 3. Greater education and household income were associated with a greater probability of purchasing landscape services and spending more on those services relative to the other education and income levels. Coefficients were positive and statistically significant at the 1% significance level for both SFD and townhouse participants.

Several other sociodemographic factors that affected landscape service participation and expenditures varied based on type of house. Participants from SFD houses were less likely to be purchasers and spent less on landscape services when they were male, married, and in a larger household size, and had a greater number of income earners and older children. Caucasian participants were less likely to be purchasers of landscape services but spent significantly more when they did buy than participants of other races. Households that included a relatively large number of members older than 64 years were more likely to be purchasers of services and spent more than households with fewer older members.

In contrast, townhouse participants were more likely to be purchasers of landscape services when the participants were female and participants were Caucasian and when the household size was relatively small

Table 2. Purchasers' average annual expenditures on landscape services and do-it-yourself (DIY) equipment by US region using the consumer expenditure survey data collected by the US Bureau of Labor Statistics during 2009–21.

	Survey participants (no.)	Avg expenditure ($/yr)[i]				
		Mean	SD	25%[ii]	50%	75%
Landscape services						
United States	21,754	370.95	509.81	53.63	190.30	495.63
Northeast	3,588	410.52	510.49	68.86	228.60	573.68
Midwest	4,366	288.80	378.96	48.01	147.52	380.07
South	7,994	367.30	479.82	58.00	206.53	491.56
West	5,806	413.31	616.49	46.71	190.43	544.23
DIY equipment						
United States	9,893	328.76	610.20	59.79	143.14	320.39
Northeast	1,680	359.77	622.12	68.15	169.90	362.54
Midwest	2,662	377.89	696.19	59.80	154.77	362.03
South	3,612	338.05	635.31	65.41	148.32	314.79
West	1,939	217.16	361.86	46.03	107.75	250.00

[i] Because the latest consumer expenditure data captured expenditures only through the second quarter of 2021, we calculated projected expenditures on landscape services and DIY equipment for the third and fourth quarters of 2021 using the average four-quarter expenditure ratios from prior years.
[ii] Because expenditures on landscape services and DIY equipment were highly skewed and most expenditures were moderate, we therefore reported expenditures at the 25th percentile, the 50th percentile (the median), and the 75th percentile.

and included a greater number of members older than 64 years. Interestingly, however, those factors had no effect on expenditures for landscape services. The presence of older children significantly negatively affected expenditures. Marital status and number of income earners had no significant effect on likelihood of purchasing or on expenditures among townhouse participants.

Our geographic analysis indicated that urban SFD participants were more likely than rural SFD participants to purchase landscape services. In terms of expenditures, however, urban SFD and townhouse participants spent significantly less than rural SFD and townhouse participants. Moreover, participants in relatively large cities were more likely to purchase landscape services and spent more money on those services than participants in smaller cities.

Our double-hurdle analysis also confirmed the presence of regional disparities observed in the initial estimates (see Table 2 and Fig. 1) for likelihood of purchasing and expenditures on landscape services. SFD participants in the western US states (the base group) were most likely to purchase landscape services, followed by participants in the southern, northeastern, and midwestern US states. Among SFD participants who purchased services, northeastern US participants spent the most on landscape services and midwestern US participants spent the least. The expenditure difference between southern and western US participants was significant.

Among townhouse participants, those from midwestern and western US states were most likely to purchase landscape services and northeastern and southern US participants were least likely. Townhouse purchasers in the northeast US states spent significantly more and townhouse purchasers in the southern US states spent significantly less on landscape services than purchasers in the western and midwestern US states, where expenditures were similar.

House ownership and conditions also significantly influenced expenditures on landscape services. As shown in Table 4, participants who owned their houses and participants whose houses had porches (indicative of having yards) were more likely to
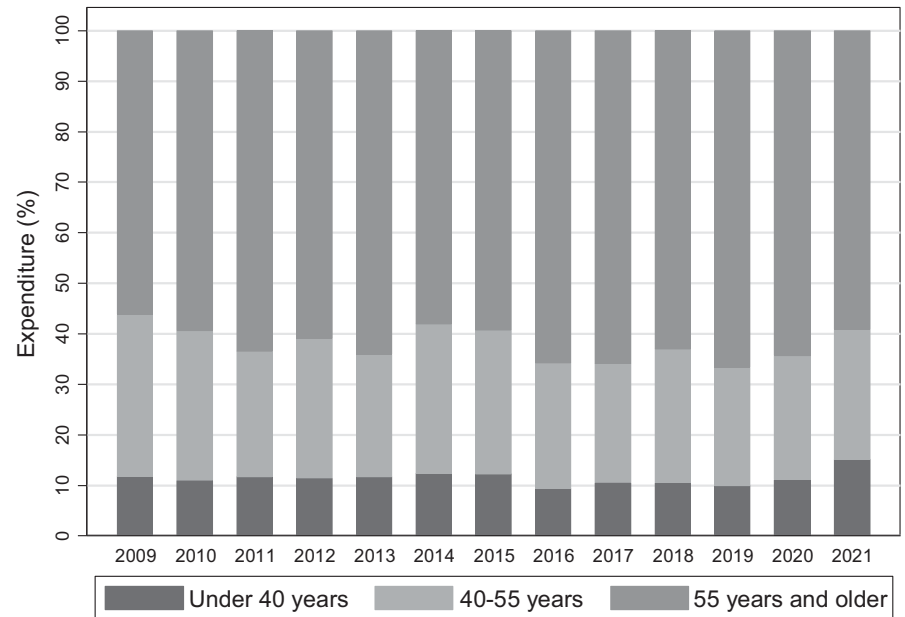

Fig. 2. Percentage of expenditures on landscaping services by age cohort using the consumer expenditure survey collected by the US Bureau of Labor Statistics during 2009–21. Because the latest consumer expenditure data captured expenditures only through the second quarter of 2021, we calculated projected percentages of purchasers for the third and fourth quarters of 2021 using the average four-quarter purchasing percentage ratios from prior years.

purchase landscape services than other participants. Those factors had no significant effect on SFD participant expenditures. For townhouse participants, ownership was associated with decreased expenditures and presence of a porch had no effect. Larger homes, signified by having a greater number of rooms, were associated with an increased likelihood of SFD participants being purchasers, a decreased likelihood of townhouse participants being
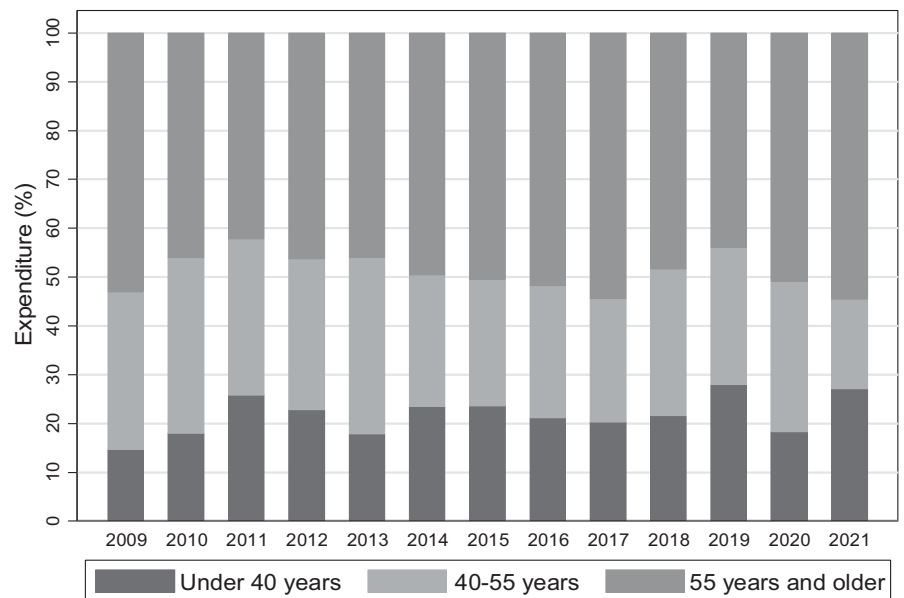

Fig. 3. Percentage of expenditures on do-it-yourself equipment by age cohort using the consumer expenditure survey collected by the US Bureau of Labor Statistics during 2009–21. Because the latest consumer expenditure data captured expenditures only through the second quarter of 2021, we calculated projected percentages of purchasers for the third and fourth quarters of 2021 using the average four-quarter purchasing percentage ratios from prior years.
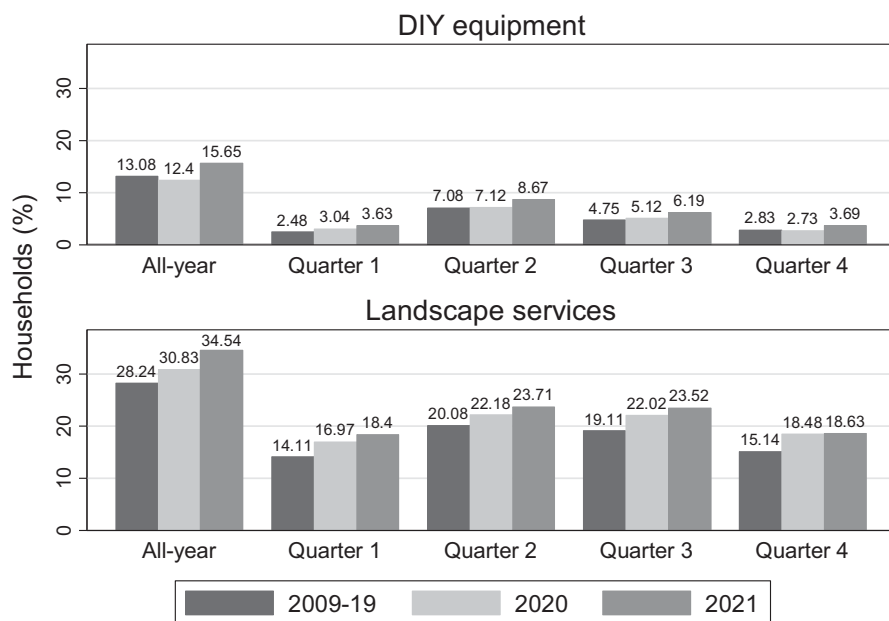
Fig. 4. Percentage of households that made purchases of landscape services and do-it-yourself (DIY) equipment before and after onset of the COVID-19 pandemic by quarter using the consumer expenditure survey collected by the US Bureau of Labor Statistics during 2009–21. Because the latest consumer expenditure data captured expenditures only through the second quarter of 2021, we calculated projected percentages of purchasers for the third and fourth quarters of 2021 using the average four-quarter purchasing percentage ratios from prior years.

purchasers, and greater expenditures by SFD and townhouse purchasers.

Our analysis of annual trends revealed significant negative coefficients for SFD participants with both likelihood of purchasing services and purchaser expenditures decreasing during the study period. There was no such change for townhouse participants. In terms of age cohorts, we observed positive trends for SFD participants who were younger than 55 years. Relative to the oldest age cohort (55 years and older), the likelihood of purchases by younger participants increased over time, as did those purchasers' expenditures. These results were consistent with the initial estimates shown in Fig. 2. In contrast, the proportion of townhouse participants who were purchasers of landscape services remained steady. Their expenditures generally declined over time with the exception of the youngest cohort (younger than 40 years), whose expenditures increased. Moreover, we found that the likelihood of hiring landscape services increased after onset of the COVID-19 pandemic and that the average expenditures by purchasers decreased. These results were in line with our initial estimates (see Table 3 and Fig. 4). In addition, the estimates by quarter showed that the peak purchasing season for landscape services by townhome participants was Q2 and Q3.

DIY EQUIPMENT EXPENDITURES. Table 5 reports the results of the double-hurdle model for DIY equipment purchases and expenditures for Q1 2009 through Q2 2021. It also provides a comparison of purchases and expenditures by SFD and townhouse participants.

Generally, the effects of the sociodemographic characteristics for DIY equipment were different from the effects on landscape services. Household income was an exception: it was associated with a greater probability of making purchases and greater expenditures by SFD and townhouse DIY equipment purchasers.

For SFD households, the oldest age cohort of respondents (55 years and older, which was the base group) was significantly more likely to purchase DIY equipment than the younger cohorts. And among SFD purchasers of DIY equipment, the oldest age cohort spent more than the youngest cohort (younger than 40 years) and approximately the same amount as the middle-aged cohort (40–54 years). Greater education level increased the

Table 3. Purchasers' average expenditures on landscape services and do-it-yourself (DIY) equipment by quarter before and after onset of the COVID-19 pandemic using the consumer expenditure survey data collected by the US Bureau of Labor Statistics during 2009–21.

	Avg expenditure ($)			Column 4 P value difference (column 1 − column 2)	Column 5 P value difference (column 1 − column 3)
	Column 1 2009–19	Column 2 2020	Column 3 2021		
Landscape services					
Quarter 1	67.76	64.73	77.10	0.43	0.01
Quarter 2	117.65	112.94	135.64	0.34	0.00
Quarter 3	111.41	109.42	127.64[i]	0.67	–
Quarter 4	75.12	73.07	85.10[i]	0.60	–
DIY equipment					
Quarter 1	40.86	48.17	72.51	0.40	0.00
Quarter 2	140.31	146.67	228.37	0.70	0.00
Quarter 3	78.07	110.69	130.38[i]	0.01	–
Quarter 4	41.99	50.75	70.21[i]	0.26	–

[i] Because the latest consumer survey data captured expenditures only through the second quarter of 2021, we calculated projected expenditures on landscape services and DIY equipment for the third and fourth quarters of 2021 using the average four-quarter expenditure ratios from prior years.

Table 4. Estimates from of the double-hurdle model for landscape service purchases and expenditures using the consumer expenditure survey data collected by the US Bureau of Labor Statistics during the first quarter of 2009 to the second quarter of 2021.

	Single-family detached		Townhouse	
	Column 1 **Participation**	**Column 2** **Expenditure**	**Column 3** **Participation**	**Column 4** **Expenditure**
	Coefficient (robust *SE*)			
Sociodemographic characteristics				
Age1 (younger than 40 years)	−0.385***[i]	−0.335***	−0.187***	−0.517***
	(0.019)	(0.038)	(0.058)	(0.075)
Age2 (40–54 years)	−0.204***	−0.097***	−0.100*	−0.285***
	(0.016)	(0.029)	(0.057)	(0.073)
Gender	−0.153***	−0.102***	−0.053**	−0.005
	(0.006)	(0.012)	(0.024)	(0.030)
Caucasian	−0.031***	0.131***	0.131***	−0.053
	(0.009)	(0.016)	(0.028)	(0.037)
Married	−0.058***	−0.037**	0.043	−0.004
	(0.008)	(0.015)	(0.029)	(0.039)
Household size	−0.038***	−0.019***	−0.044***	0.013
	(0.004)	(0.007)	(0.016)	(0.021)
Earners	−0.074***	−0.037***	0.001	−0.027
	(0.005)	(0.008)	(0.019)	(0.025)
Person64[ii]	0.094***	0.066***	0.087***	0.009
	(0.006)	(0.010)	(0.024)	(0.030)
Child age	−0.011***	−0.010***	−0.004	−0.020**
	(0.002)	(0.003)	(0.007)	(0.009)
Education	0.317***	0.173***	0.183***	0.110***
	(0.006)	(0.011)	(0.020)	(0.026)
Income	0.050***	0.040***	0.055***	0.025***
	(0.002)	(0.003)	(0.007)	(0.008)
Geographic factors				
Urban	0.096***	−0.179***	0.207	−0.933***
	(0.016)	(0.034)	(0.172)	(0.235)
Northeast	−0.321***	0.152***	−0.301***	0.138***
	(0.010)	(0.019)	(0.033)	(0.042)
Midwest	−0.330***	−0.148***	0.073**	−0.042
	(0.009)	(0.018)	(0.036)	(0.043)
South	−0.100***	0.042***	−0.117***	−0.089**
	(0.008)	(0.014)	(0.031)	(0.038)
Population	−0.119***	−0.084***	−0.019*	−0.031**
	(0.003)	(0.005)	(0.011)	(0.015)
Housing status				
House owned	0.406***	−0.039	1.632***	−0.777***
	(0.012)	(0.027)	(0.039)	(0.084)
Porch	0.165***	0.011	0.318***	0.048
	(0.009)	(0.017)	(0.029)	(0.042)
Rooms	0.129***	0.136***	−0.102***	0.115***
	(0.004)	(0.007)	(0.017)	(0.022)
Year and seasonal trends				
Year trend (YT)	−0.005***	−0.008***	0.000	−0.021***
	(0.001)	(0.002)	(0.005)	(0.006)
YT × Age1	0.012***	0.010**	0.009	0.017*
	(0.002)	(0.005)	(0.007)	(0.009)
YT × Age2	0.011***	0.009**	0.009	0.013
	(0.002)	(0.004)	(0.008)	(0.010)
COVID	0.039***	−0.206***	0.165***	−0.261***
	(0.013)	(0.023)	(0.048)	(0.058)
Quarter 1	−0.041***	−0.074***	0.011	0.055
	(0.009)	(0.018)	(0.032)	(0.042)

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Table 4. (*Continued*)

	Single-family detached		Townhouse	
	Column 1 Participation	Column 2 Expenditure	Column 3 Participation	Column 4 Expenditure
	Coefficient (robust *SE*)			
Quarter 2	0.230***	0.268***	0.111***	0.223***
	(0.009)	(0.016)	(0.032)	(0.041)
Quarter 3	0.178***	0.267***	0.177***	0.166***
	(0.009)	(0.017)	(0.033)	(0.041)
Constant	−2.084***	4.124***	−2.793***	4.480***
	(0.030)	(0.060)	(0.195)	(0.278)
Observations (no.)[ii]	247,428	42,644[iii]	22,767	4,469

[i] *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

[ii] Number of household members older than 64 years.

[iii] Only passed the first hurdle (being potential purchasers) were included in the expenditure-stage estimations.

likelihood of purchasing but decreased expenditures. Participants who were male, Caucasian, married, and had relatively small household size were more likely to be purchasers, whereas participants who were male, married, and had relatively young children spent more.

For townhouse participants, most factors were not significant. Participants who were male and had a relatively large household size were more likely to purchase DIY equipment than participants who were female and had a relatively small household size. Caucasian purchasers spent more than purchasers of other races.

Our geographic analysis indicated that urban SFD participants were no more likely than rural SFD participants to make purchases but spent less on DIY equipment than their rural counterparts. Furthermore, SFD participants from relatively small cities were more likely than those from larger cities to purchase DIY equipment and spent more, the opposite of the results for landscape services.

In terms of regional differences for SFD participants, midwestern US participants were mostly likely to make equipment purchases, followed by participants in the northwestern, southern, and western US states. And among purchasers, SFD participants in the northeastern US states spent the most, followed by participants in the southern, midwestern, and western US states. In contrast, townhouse participants in the southern US states were most likely to be purchasers, followed by participants in the northeastern US states. We found no geographic differences in purchase and expenditure patterns for townhouse participants.

In terms of housing ownership and conditions for SFD participants, owning the house and having a relatively large house (more rooms) increased the likelihood of purchasing and spending on DIY equipment. Having a porch (suggesting the presence of a yard) was positively associated with the likelihood of making purchases. For townhouse participants, ownership and the presence of porches increased the likelihood of purchasing. Relatively large townhouses (more rooms) spent more on DIY equipment than smaller townhouses.

Unlike the results of the double-hurdle model for landscape services, in which the likelihood of purchasing increased over time, the results for DIY equipment reveal generally stable percentages of purchasers during the study period. A greater likelihood of purchases was evident only for SFD participants who were younger than 55 years, results consistent with the initial estimates presented in Fig. 3. Average expenditures by the younger age cohorts did not change over time. For townhouse participants, spending by participants who were 40 to 54 years old decreased significantly over time. We also found that, unlike expenditures of landscape services, after the onset of the COVID-19 pandemic, the likelihood of purchasing DIY equipment decreased for SFD participants, and expenditures for DIY equipment increased for both SFD and townhouse participants. Furthermore, the results of our analysis of expenditures by quarter indicated that the peak DIY equipment purchasing season for SFD and townhouse participants was the second quarter and that SFD participants' expenditures remained high in Q3.

Discussion and conclusions

Using a large representative sample of US consumers from the US Bureau of Labor Statistics' quarterly CE surveys, we identified patterns in decisions to purchase and expenditures made on landscaping services and DIY landscaping equipment for 2009 through 2021. This period allowed us to compare long-term consumption patterns and potential changes in consumption related to the economic downturns of 2007–09 and onset of the COVID-19 pandemic in 2020. We also examined how socio-demographics, geographic factors, and housing conditions influenced landscape service and DIY equipment purchasing likelihood and expenditures separately. Our detailed results had important implications for the landscaping industry going forward, particularly in terms of targeting marketing campaigns to increase demand by various consumer segments.

Overall, we found, on average, that 28% of the sample purchased landscape services and 13% bought DIY equipment, results that were consistent with data from the 2020 National Gardening Survey (National Gardening Association 2020) and the National Association of Landscape Professionals (2017). The average annual expenditures for landscape services and DIY equipment were ~$371 and $329, respectively. However, most household expenditures were more modest and the averages were driven up by a small proportion of households that made significantly larger purchases.

Over the study period, overall demand for landscape services declined both in the percentage of households

Table 5. Estimates from the double-hurdle model for do-it-yourself equipment expenditures using the consumer expenditure survey data collected by the US Bureau of Labor Statistics during the first quarter of 2009 to the second quarter of 2021.

	Single-family detached		Townhouse	
	Column 1 Participation	Column 2 Expenditure	Column 3 Participation	Column 4 Expenditure
	Coefficients (robust *SE*)			
Sociodemographic characteristics				
Age1 (younger than 40 years)	−0.101***[i]	−0.136**	0.006	0.108
	(0.026)	(0.068)	(0.128)	(0.340)
Age2 (40–54 years)	−0.069***	−0.022	−0.182	0.581
	(0.023)	(0.059)	(0.141)	(0.381)
Gender	0.035***	0.050**	0.134***	0.175
	(0.009)	(0.023)	(0.051)	(0.141)
Caucasian	0.105***	−0.012	0.091	0.496***
	(0.014)	(0.037)	(0.060)	(0.166)
Married	0.048***	0.114***	−0.004	−0.007
	(0.011)	(0.029)	(0.060)	(0.166)
Household size	−0.011**	−0.001	0.050*	−0.030
	(0.005)	(0.012)	(0.027)	(0.078)
Earners	0.001	0.008	0.046	0.030
	(0.006)	(0.016)	(0.037)	(0.107)
Person64[ii]	0.002	0.026	0.013	−0.037
	(0.008)	(0.021)	(0.053)	(0.136)
Child age	−0.001	−0.013**	0.006	−0.007
	(0.002)	(0.006)	(0.013)	(0.038)
Education	0.046***	−0.166***	−0.014	−0.031
	(0.008)	(0.020)	(0.043)	(0.132)
Income	0.057***	0.024***	0.030**	0.136***
	(0.003)	(0.007)	(0.015)	(0.040)
Geographic factors				
Urban	−0.001	−0.236***	0.065	−1.096
	(0.019)	(0.048)	(0.299)	(0.777)
Northeast	0.100***	0.425***	0.175**	0.155
	(0.015)	(0.039)	(0.074)	(0.211)
Midwest	0.158***	0.280***	0.051	0.061
	(0.013)	(0.034)	(0.089)	(0.261)
South	0.093***	0.314***	0.240***	0.165
	(0.012)	(0.032)	(0.070)	(0.198)
Population size	0.030***	0.019*	0.038*	−0.060
	(0.004)	(0.010)	(0.022)	(0.061)
Housing status				
House owned	0.097***	0.296***	0.239***	−0.203
	(0.016)	(0.045)	(0.069)	(0.214)
Porch	0.100***	−0.005	0.108*	0.100
	(0.013)	(0.034)	(0.064)	(0.191)
Rooms	0.040***	0.074***	0.021	0.255***
	(0.005)	(0.014)	(0.025)	(0.097)
Year and seasonal trends				
Year trend (YT)	0.010***	−0.002	0.014	−0.012
	(0.002)	(0.005)	(0.012)	(0.033)
YT × Age1	0.014***	0.012	0.001	−0.049
	(0.003)	(0.008)	(0.016)	(0.043)
YT × Age2	0.005*	0.008	0.013	−0.088*
	(0.003)	(0.007)	(0.018)	(0.048)
COVID	−0.055***	0.096**	−0.030	0.609**
	(0.018)	(0.044)	(0.102)	(0.272)
Quarter 1	−0.042***	−0.052	−0.111	0.139

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Table 5. (*Continued*)

	Single-family detached		Townhouse	
	Column 1 Participation	Column 2 Expenditure	Column 3 Participation	Column 4 Expenditure
	Coefficients (robust *SE*)			
	(0.015)	(0.041)	(0.081)	(0.242)
Quarter 2	0.455***	0.167***	0.328***	0.125
	(0.013)	(0.034)	(0.068)	(0.190)
Quarter 3	0.252***	0.033	0.072	−0.231
	(0.014)	(0.037)	(0.076)	(0.213)
Constant	−2.836***	4.298***	−3.420***	3.848***
	(0.042)	(0.111)	(0.355)	(0.954)
Observations (no.) [iii]	247,428	11,555[iii]	22,767	255

[i] *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

[ii] Number of household members older than 64 years.

[iii] Only passed the first hurdle (being potential purchasers) were included in the expenditure-stage estimations.

that purchased landscaping services and in purchasers' average expenditures, although we found demand for DIY equipment over the same period remained relatively unchanged. The patterns of landscape services and equipment consumption shifted in response to the pandemic. Specifically, in 2020 and 2021, the percentage of consumers who purchased landscape services increased, as did the percentage of consumers who made at least two purchases of services in 1 year. The trends of landscape service expenditures, on the other hand, first decreased in 2020 and then began to rebound in 2021 but not enough to reverse the overall downward trend. In contrast, purchases of DIY equipment were relatively stable. Although the percentage of households making DIY purchases increased following onset of the pandemic, the percentage of repeat purchasers also increased, leading to a small net decrease in the proportion of purchaser households. Expenditures on DIY equipment increased in response to the COVID-19 pandemic, particularly in the third quarter of 2020.

These findings regarding the effect of the pandemic were in line with findings of the 2021 National Gardening Survey, in which 42% of participants reported greater participation in gardening after onset of the pandemic, mostly among consumers who were already avid gardeners (National Gardening Association 2021). Although the number of consumers reached a record high during the pandemic, these results indicated that the increase in the expenditure arose mostly from existing consumers rather than from new consumers. New consumers' spending only made up a small percentage of the increased expenditure. However, existing literature suggested that post-pandemic trends may differ from pre-pandemic or pandemic trends (Campbell et al. 2021; San Fratello et al. 2022).

The analysis revealed regional differences in demand by US consumers for landscape services and equipment and in expenditures on those commodities. Overall, households in the western US states were most likely to purchase landscape services and spent more on services than households in the other regions. Midwestern US households were least likely to purchase landscape services and spent less on services than households in the other regions. Therefore, it was not surprising to find that midwestern US households were most likely to purchase DIY landscape equipment and spent more on the equipment than households in other regions. Likewise, households in the West were least likely to purchase DIY equipment and spent less on the equipment than households in the other regions.

The results for the age cohorts had important implications for the landscaping industry. We found that consumers in the oldest cohort (55 years or older) were consistently most likely to purchase services and DIY equipment despite declining in number in the population during the period and spent more than the youngest cohorts (younger than 40 years). They also shifted their purchases from services to equipment in response to the pandemic. Note, however, that the youngest consumers also represented an important market. They accounted
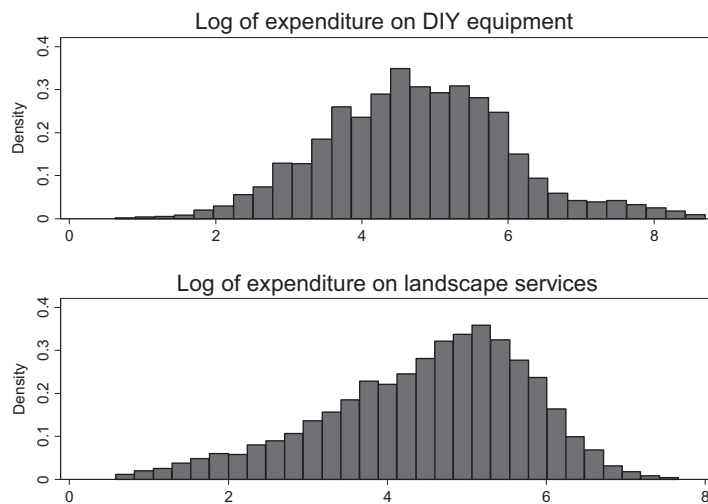

Fig. 5. Distribution of quarterly expenditures on landscape services and do-it-yourself (DIY) equipment in natural logarithm scale using the consumer expenditure survey collected by the US Bureau of Labor Statistics during 2009–21.

for a relatively large proportion of purchasers of DIY equipment. Furthermore, their purchases and expenditures for landscape services remained stable during the period with no significant drops in response to economic events, and their purchases of DIY equipment increased moderately. The youngest consumers' likelihood of purchasing services was always lower than their likelihood of purchasing equipment, further indicating their growing interest in DIY activities. Thus, younger consumers could have greater demand for DIY equipment than older consumers in subsequent years but likely would not have greater demand for landscape services.

These findings regarding age were in line with findings of the 2019 National Gardening Survey, which showed that millennials were responsible for a quarter of all money spent on gardening in 2018, despite having less wealth than older generations (National Gardening Association 2019). The 2021 National Gardening Survey examined how the COVID-19 pandemic affected gardening and found that 16 million US consumers took up gardening during COVID-19, many of whom were younger than 35 years (National Gardening Association 2021). However, as workers returned to their workplaces, their relative demand for services and equipment could shift again. According to San Fratello et al. (2022), young consumers were more likely to have started gardening in 2020 than older consumers, and many of the younger consumers indicated that they would not continue to garden as life returned to normal in 2021.

The results of the double-hurdle model provided guidance in terms of influential sociodemographic characteristics and geographic and housing factors that had different impacts on the purchase behavior of landscape services and DIY equipment. Given the different nature of landscaping services and DIY equipment purchases, the impacts of sociodemographics on the purchase of these two products would be different. For example, married consumers are more likely to buy DIY equipment rather than use landscape services. They might consider DIY gardening as a leisure activity and an experience the family can enjoy together.

To attract prospective consumers, suppliers should tailor their marketing strategies to meet the specific needs of these various types of consumers. For example, to develop the market for landscape services, suppliers should focus on consumers who are 55 years and older, who may be less able and/or inclined to do their own landscaping, and on consumers younger than 40 years who were less likely to have time for DIY landscaping. Furthermore, income has undoubtedly been one of the most influential factors in many purchasing behaviors, such as purchasing fresh flowers and potted plants (Zhao et al. 2016) and willingness to pay for lawn greenness (Zhou et al. 2009). Among all of the factors examined in the model, consumers' income level had positive and significant impacts on the decision to purchase and the amount to spend on landscape services for both SFD and townhouse residents. Thus, targeting consumers with higher incomes would be an effective way to attract new consumers and encourage more spending. The industry should emphasize the divergent motives these age cohorts had for hiring landscaping services, and market services to consumers who had relatively high incomes and more education.

Our study made several key contributions to the literature on consumer purchase decisions and expenditures over time. This was the first study to examine patterns of expenditures on landscape services and DIY equipment after the economic 2007–09 downturns and onset of the COVID-19 pandemic. Recent CE data provided us with the opportunity to analyze current spending and provide guidance for the landscaping industry. Second, we investigated a comprehensive set of sociodemographic factors that potentially influenced consumer decisions about landscaping purchases and how much purchasers were likely to spend. Last, the results provided valuable information to the industry regarding trends in purchases and expenditures by various segments of consumers over the past 13 years, information that had not been readily available in the past, and explored the influence of residing in SFD houses vs. townhouses, which likely present different landscaping needs.

Two limitations associated with our study can be addressed in future work. First, the CE dataset provided limited details about the products purchased and their prices so we cannot evaluate consumer preference for various types of landscape services and equipment and cannot examine price elasticities. Second, although the COVID-19 pandemic had a positive effect on purchases of landscape services and DIY equipment, the durability of those effects cannot yet be determined. Future studies should use the most recent available data to further explore how these consumption and expenditure patterns would potentially change as people started to return to workplaces.

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