

# Structural Breaks and Future Growth of the Green Industry<sup>1</sup>

Maria Perez<sup>2</sup>, Marco Palma<sup>2</sup>, Bridget Behe<sup>3</sup>, and Charles Hall<sup>4</sup>

## Abstract

Every industry undergoes changes, but structural changes can abruptly and radically alter business for many firms in that industry. Identifying the substantial shifts in the green industry with regard to consumer spending can help the industry better understand its history. Using an econometric model of that same consumer spending data to look forward to the future can show firms what might lie ahead. We analyzed the personal consumption expenditures for two items measured by the U.S. Bureau of Economic Analysis to identify structural breaks in the green industry. We then conducted an econometric forecast using that same data to predict future consumer spending projections to the year 2020. To accomplish this, we analyzed household expenditures for *Tools* (including gardening tools and equipment) and *Plants* (including seeds, flowers, and plants) from 1959 to 2014. We identified one industry structural break using the Schwarz criteria for *Tools* in 2006 and another one for *Plants* in 2007 and (separately) identified four breaks using Bayesian Information criteria: one break for *Tools* in 2006 and three breaks in *Plants* in 1986, 2003, and 2008. The potential causes of these breaks are discussed (e.g. housing bubble, financial market stress). Lastly, we employed an econometric model to forecast spending and show that it will grow from \$65.15 and \$86.52 in 2015 to \$71.17 and \$96.97, for *Tools* and *Plants* respectively, in 2020.

**Index words:** consumer, green industry, greenhouse production, nursery production.

## Significance to the Horticulture Industry

Firms that understand their industry's history and examine the timing and possible stimuli for significant events that change consumer spending can be better prepared for future events. This study investigated major potential changes in the green industry by analyzing household consumer spending on two items: horticultural *Tools* (including equipment) and *Plants* (including flowers, seeds, and plants). This investigation sought to identify the timing of industry-changing events, called economic structural break points. Since 1959, one econometric analysis showed that one structural break point for *Tools* occurred in 2006 and one for *Plants* in 2007. A separate analysis showed the same break point for *Tools* in 2006 and three breaks for *Plants* with the first one occurring in 1986, then 2003, and again in 2008. Our econometric model forecasts growth in consumer spending on *Tools* and *Plants* over the next five years. While it is difficult to pinpoint the exact causes of structural break points, most often they result from an economic crisis. Events like credit issues or having too many firms that are highly leveraged can be an indication of impending structural breaks. Structural breaks occurring around recessionary periods normally cause lawn and gardening sales to fall since industry products tend to be discretionary goods by consumers (Hall, 2010). Structural changes around the most recent deep recession in 2008, showed that consumers reacted by cutting back lawn and garden-related expenditures significantly. However, econometric models using that same data forecast with good reliability that household expenditures on *Tools* and *Plants* should both increase over the next five years. This optimistic news should help provide confidence to firms considering reasonable expansion in the coming five years.

## Introduction

The green industry is comprised of wholesale nursery and greenhouse growers, landscape service providers (e.g. architects, design/build firms, contractors, and maintenance firms), retail garden centers, home centers, and mass merchandisers with lawn and garden departments, and marketing intermediaries such as brokers and horticultural distribution centers (re-wholesalers). This outlook paper will continue to use the term 'green industry' but most of the comments herein refer specifically to nursery and greenhouse growers.

For the green industry, the years leading up to the Great Recession of 2008 were good ones. The green industry showed signs of strength and stability, much of it fueled by a booming housing market (Hall 2010). Overall economic contributions in 2007 were estimated to be \$175.26 billion (Hodges et al. 2015).

The green industry has been through some significant changes in consumer spending over the recent two decades. Those significant changes or structural breaks can be identified through analyses of household spending on green industry products. Structural breaks, a phrase from econometrics, denotes the moment in time-series data when trends and the patterns of associations among variables change. A better understanding of when and why such abrupt shifts occurred gives firms a better perspective regarding if or when those shifts may recur. Additionally, future predictions of household spending based on econometric models may help the industry better prepare for likely events to come.

A structural break is an economic concept that refers to a fundamental change in the 'structure' of a sector of the economy (Bair and Perron, 2003). It appears when there is an unexpected shift in a macroeconomic time series of data. The 'break' is reflective of substantial changes in economic conditions that occur when an industry or market fundamentally or dramatically shifts or changes how it functions or operates. Breaks are indications of major changes and identifying those breaks can help the industry better understand historical events. Understanding why the break occurred can also help firms understand and even anticipate, to some extent, the conditions that might occur again to cause such a major shift.

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<sup>2</sup>Department of Agricultural Economics, Texas A&M University.

<sup>3</sup>Department of Horticulture, Michigan State University.

<sup>4</sup>Department of Horticultural Sciences, Texas A&M University. Corresponding author email: c-hall@tamu.edu.

Economists identify structural break points by using a Bai and Perron (2003) test. This test does not require any information about the timing or underlying causes of the possible breaks or the number of breaks that may occur during the time period. The test looks for dramatic breaks based only on the data, and allows for correlation and heteroscedasticity. The test is considered endogenous since there is no prior knowledge of any possible structural break, policy or other factors that could have happened over the specified period. By estimating the break points in time, economists are able to consider whether there was any important event that caused, or did not cause, that structural change.

## Materials and Methods

*Assessing for structural breaks.* To identify structural breaks in the green industry, we selected data from the U.S. Bureau of Economic Analysis (2016) for personal consumption expenditures (PCEs) from 1959 through 2014. PCEs are the primary measures of consumer spending on goods and services in the U.S. economy and they account for approximately two-thirds of domestic gross domestic product. Thus, they comprise the primary engine that drives domestic economic growth. PCEs show how much of household income is being spent on current consumption as opposed to how much is being saved for future consumption.

PCEs also provide comprehensive measures of the types of goods and services that are purchased by households. For example, PCEs shows the portion of spending that is accounted for by items including lawn and garden products. They also show how consumers adjust their spending in response to changes in prices, such as reduced driving and lower gasoline purchases, when there is a sharp increase in prices.

The PCE estimates are available monthly, so they provide an early indication of the course of economic activity in the current quarter. For example, the PCE estimates for January are released at the end of February, and the estimates for February are released at the end of March; the advance GDP estimates for the first quarter are released at the end of April. We used two variables in the PCE data that captured lawn and garden expenditures: (1) *Tools* which included tools and equipment for house and garden, and (2) *Plants* which included flowers, seeds, and potted plants.

We identified potential structural breaks by using the Schwarz loss criterion to estimate the test and use the correct number of lags for the variables (Schwarz 1978). According to this criterion, one data series is treated as a function of previous values of itself and the other data series for only one lag and are estimated by ordinary least squares. The test for structural breaks considers the sum of squared residuals for zero breaks and for one break. For each data series, we considered all possible partitions in the data set. Whenever we observed a break, the sums of squares for each period, before and after the break, were calculated and combined. That result represents the sum of squares for one break. The sum of squares for zero breaks is taken from the whole period of observations.

To decide whether we should evaluate for a break or none of them, we selected the minimum number of Bayesian Information Criterion (BIC) and Schwarz criteria (LWZ) between the sum of squares residuals for one break and the one for zero breaks (Palma et al. 2010). This test could be performed for multiple breaks in a similar fashion. The existence of a break spurs us to identify any specific policy

or economic intervention in the industry that could have caused a structural change. Also, we would like to know if any important event, such as a policy or trade agreement, did not cause a structural break.

*Econometric analysis.* Future personal consumption expenditures are forecasted for the two variables *Plants* and *Tools* using the Theil procedure in RATS software (RATS 2016, Estima. Evanston, IL). This procedure computes forecasts for future periods; in this case, extending to 5 years. From the data, forecast mean errors, mean absolute errors, root mean squared errors and root mean squared errors of a naïve (flat line forecast) are calculated. Theil's U statistic is the ratio of the RMS error of the data to the RMS of the naïve forecast. Whenever Theil U statistic is less than one, we can be confident that the forecasted values are accurate.

## Results and Discussion

The two variables in the PCE data that captured lawn and garden expenditures were (1) *Tools* which included tools and equipment for house and garden, and (2) *Plants* which included flowers, seeds, and potted plants (Fig. 1). In 1960, household expenditures were less than \$4 each for *Tools* and *Plants* and have grown to \$64 and \$84, respectively, in 2014. Table 1 shows the descriptive statistics for the PCE data.

In the analysis, when we decided whether we should evaluate for one or no breaks, we selected either the minimum number of BIC and LWZ criteria between the sum of squares residuals for one break and the one for zero breaks (Palma et al. 2010). Given the number of observations in this data set, it was more reliable to use LWZ criteria. Using the LWZ criteria, we identified one break for *Tools* in 2006 and another one for *Plants* in 2007. The results using the BIC criteria showed one break for *Tools* in 2006 and three breaks in *Plants* in 1986, 2003, and 2008 (Table 2).

It is difficult to know the exact causes of structural breaks, but most often they result from an economic crisis. Historically, land bubbles, credit issues, and high leverage often make a dangerous mixture of economic conditions and lead to structural breaks (Bai and Perron 2003). The way the dynamics of structural breaks play out is well known. U.S. household debt started rising in the early 1980s, and its growth accelerated in 2001 (FRBNY 2016).

Leverage among Wall Street's five largest broker-dealers (Goldman Sachs, Merrill Lynch, Lehman Brothers, Bear Stearns, and Morgan Stanley) rose dramatically after 2004, when the U.S. Securities and Exchange Commission exempted these firms from the long-standing 12:1 leverage ratio limit and let them regulate themselves. From 1990 to 2007, the whole financial-services sector expanded 2.5 times faster than overall GDP, and its profits rose from their 1947–96 average of 0.75 percent of GDP to 2.5 percent in 2007 (BEA, 2016). Then falling home prices led to an unanticipated rise in foreclosure rates and a drop in the value of certain mortgage-backed securities. That decline quickly undid highly leveraged financial firms, whose failure spread loss and uncertainty throughout the system. U.S. consumer spending continued at a high level through the first half of 2008 but by the third quarter had dropped at a 3.1 percent annualized rate (BEA 2016).

A potentially deep recession had arrived in 2008 and the lawn and garden industry found itself in an unusual situation in that sales during the previous recession (2001) had actually

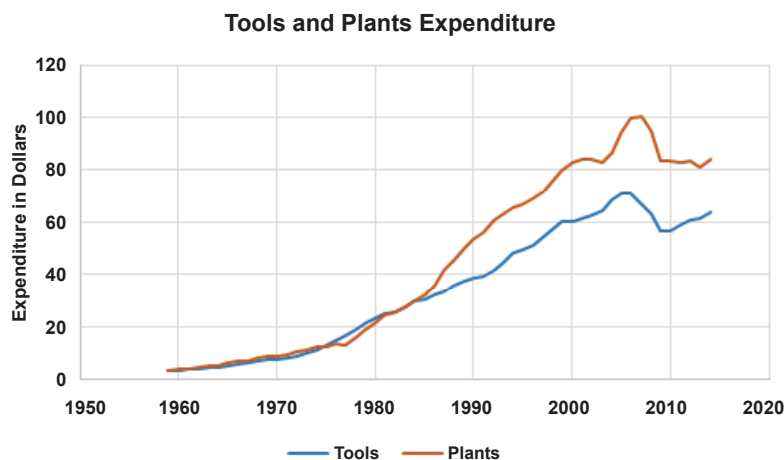


Fig. 1. Nominal data for personal consumption expenditures of *Tools* (including gardening tools and equipment) and *Plants* (including seeds, flowers, and plants) from 1959 to 2014 (Source: U.S. Bureau of Economic Analysis).

risen (people stayed at home more and participated in gardening and landscaping more). But this time, the economic impacts were so deep that consumers reacted by cutting back lawn and garden-related expenditures significantly. Thus the break points we identified for both *Tools* and *Plants* were in the period right before the Great Recession in 2008.

The *Plant* series also had a break in 2003 using the BIC criterion. This break may also be associated with the previous recession when was this one linked to the collapse of the dot-coms. It is important to note that not all structural changes are negative. The 1986 structural break in *Plants* is in fact an increase in expenditures. During the mid-1980s the U.S. experienced the second longest sustained economic expansion in history. Economic growth is accompanied by higher consumer expenditures and green industry products are not an exception.

In order to develop a forecast for the variables of interest (lawn and gardening sales), we used the Theil procedure in RATS software (RATS 2016). Whenever the Theil U statistic is less than one, we can be confident that the forecasted values are accurate. Our forecast statistics for *Tools* produced a mean error of 0.953659, mean absolute error of 1.06766805, RMS error of 1.379557356, and Theil U statistic of 0.8381367. Our forecast statistics for *Plants* produced a mean error of 0.531094487, mean absolute error of 1.068799642, RMS error of 1.782514942, and Theil U statistic of 0.9656215. Since both Theil U statistics met the criterion of  $< 1.0$ , we are confident of the forecasted values for both *Tools* and *Plants*. Using this method, we project future consumption of *Tools* and *Plants* to grow from \$65.15 and \$86.52 in 2015 to \$71.17 and \$96.97, respectively, in 2020 (Fig. 2).

Discerning the significance of these events is harder than recounting them. We interpret these results to reflect that the industry has experienced at least one structural break in

the past, a phrase from econometrics, where it denotes the moment in time-series data when trends and the patterns of associations among variables change. Such a break often means hard times. Adjustment is neither easy nor fast. Difficult and volatile conditions wipe out some firms, yet other firms prosper because they understand how to exploit the fact that old patterns vanish and new ones emerge. Structural breaks render obsolete many existing patterns of behavior, yet they point the way forward for some companies and at times even for whole economies. The wrong way forward in a structural break during hard times is to try more of the same. The break and the hard times are almost definitive indications that an old pattern has already been pushed to its limits and no longer is generating value. Others may call this a paradigm shift, where the old solutions no longer work and new and different paradigms emerge to solve the new problems.

Consider an analogy. When oil was cheap and plentiful, the U.S. created a vast infrastructure that worked well but only under circumstances that oil remained cheap and plentiful. When gasoline became expensive, many wished the country had a different infrastructure. Similarly, when economic opportunities abound, people invest in management infrastructure that harvests those opportunities very well. When the field of opportunities becomes less verdant, people must change their infrastructure. That's where the green industry finds itself today, yet poised to capture the opportunities in an expanding market that we project at least until 2020.

In ordinary hard times, management often reacts with some more traditional moves, which include reducing fixed costs, changing scope, and altering variety. But in hard times accompanied by structural breaks, management must rethink the way the business operates. Companies that survive structural shifts and go on to prosper often look beyond the tradi-

Table 1. Descriptive statistics of the series expressed in expenditure per capita for *Tools* (including gardening tools and equipment) and *Plants* (including seeds, flowers, and plants) for 1959 to 2014 in the U.S. green industry.

Variable	Years	Mean	Standard deviation	Min	Max
<i>Tools</i>	1959–2014	34.38	23.28	3.68	100.44
<i>Plants</i>	1959–2014	44.63	33.58	3.57	100.44

Table 2. Structural break points using two methods of analysis for *Tools* (including gardening tools and equipment) and *Plants* (including seeds, flowers, and plants) for 1959 to 2014 in the U.S. green industry.

	LWZ method	BIC method
<i>Tools</i>	1 break in 2006	1 break 2006
<i>Plants</i>	1 break in 2007	3 breaks in 1986, 2003, 2008

## Tools and Plants Expenditure

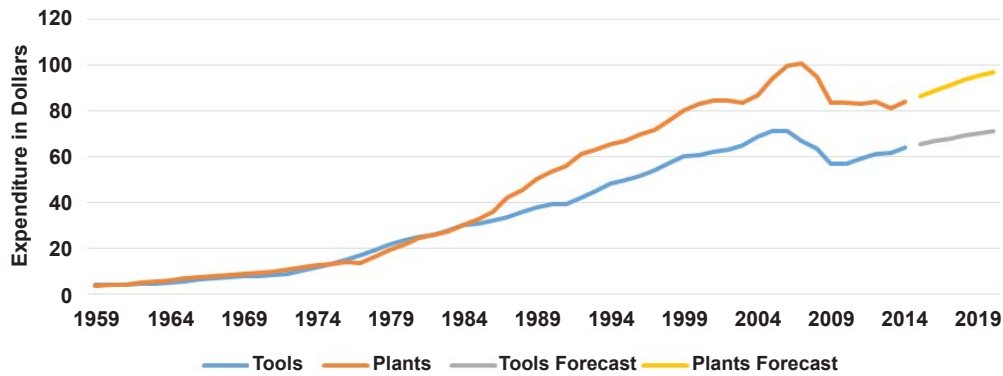


Fig. 2. Past expenditures and an econometric projection of the future growth in expenditures for *Tools* (including gardening tools and equipment) and *Plants* (including seeds, flowers, and plants) based on historic personal consumption expenditure data from 1959 through 20120 (Source: U.S. Bureau of Economic Analysis).

tional moves to the detailed structure of managerial work. In this case, several new issues come to the forefront:

- How does the business create value and is this still valuable (are as many people willing to pay as much) in the market?
- Which information flows can be omitted? Information that doesn't inform value-creating decisions is of no value and becomes a wasteful distraction.
- Which decisions and judgments can be standardized as standard operating procedures? These can save valuable time spent in costly meetings and needless communications.
- How can the company work with customers and suppliers to simplify their processes so that the company can simplify theirs?

Our analysis provides a look both forward and backward in personal consumption expenditures for the green industry. The response from industry participants prior to structural breaks is of critical importance, particularly in managing their working capital. Many green industry firms who exited the industry during structural break points did so not because they did not grow or sell quality plants, they did so because of a lack of working capital (Hall 2010).

In other words, in periods of economic expansion, managers often focus so intently on revenue and earnings growth that they ignore other, less obvious methods of value creation, such as working-capital management — the process of optimizing net current assets relative to business volume. Companies that manage their working capital prior to structural breaks occurring find that they can effectively generate cash, streamline their operations, and often improve their cost position. When the economy is expanding (a positive break point), the impact of reduced working capital can be the critical difference between funding a strategic project with cash on hand and funding it through a debt offering.

The payoff for effective working-capital management can be even greater during an economic contraction, when reduced access to external funding and sharp decreases in sales can greatly limit available cash. Although companies with liquidity issues face particular challenges in a downturn, all businesses can benefit from a renewed focus on working capital. Those with short-term liquidity problems can reduce inventories and optimize receivables and payables to free

up cash quickly; businesses with strong balance sheets but decreasing demand for their products can reduce inventories to offset falling sales so that working-capital ratios don't worsen; and companies whose performance remains strong can use working-capital strategies to solidify their financial position.

The green industry is among the most capital-intensive and dynamic sectors of agriculture. Each year, industry firms face important decisions on whether to use cash reserves or borrow funds to purchase items such as land, machinery, buildings, or equipment. These decisions commit large sums of money and affect the business over a number of years. Faced with limited sources of capital, management should carefully decide whether a particular project is economically acceptable, or which of several possible projects will contribute most to the value of the firm. The results from the structural break point analysis described herein should give managers added confidence in making strategically-important investments over the next few years.

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