

The background of the cover features a large, faint watermark of the Cornell University seal. The seal is circular and contains the text "CORNELL UNIVERSITY" at the top and "FOUNDED A.D. 1865" at the bottom. In the center of the seal is a shield with a book and a lamp, and a smaller shield above it with a cross and a book.

**An Independent Economic Evaluation of
the Impacts of the
Paper and Packaging Board Advertising
Campaign: 2015-2018**

By Harry Kaiser, PhD

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Introduction and Background

The U.S. paper and packaging industry is a major sector of the U.S. economy generating sales of \$126 billion per year, offering over 369,000 jobs and creating over 5,000 products from recovered paper. The industry accounts for 2.7 percent of the U.S. manufacturing GDP in 2016.

In November 2013, a majority of the industry voting supported the creation of a checkoff program to help stem the decline in paper consumption and help grow demand for packaging. On January 22, 2014, USDA established the Paper and Paper-Based Packaging Promotion, Research and Information Order for the purpose of maintaining and expanding markets for paper and paper-based packaging.

On July 8, 2015 the Paper & Packaging – How Life Unfolds® consumer campaign launched representing a unified effort by the paper and packaging industry to increase awareness of the benefits of paper and packaging resulting in increased consumer appreciation and ultimately preference and consumption. To promote the use of paper and paper-based packaging, the campaign highlights the personally relevant benefits and values these products bring to our daily lives – demonstrating how paper and packaging enhance business and personal productivity, better learning, creativity, packaging innovation and product safety.

More than 40 U.S. manufacturers and importers of paper and paper-based packaging collectively fund the program which covers bond paper, printing and writing paper, kraft paper, paperboard and containerboard. The participating companies contribute a mandatory assessment of 35 cents per short ton. Domestic manufacturers and importers of less than 100,000 short tons of paper and paper-based packaging per year are exempt from paying assessments. Between 2015 and 2018, the average budget for P+PB has been \$26.5 million per year.

Under the most recent enacted Farm Bill, all federally authorized checkoff programs are required to have an independent economic evaluation of its overall effectiveness conducted at least once every five years. With almost \$1 billion spent on checkoff programs each year by U.S. farms and firms, the government wants stakeholders to have independent information on the effectiveness of these programs.

Objective

The primary purpose of this study is to provide an independent economic evaluation of the effectiveness and impacts of the P+PB campaign over the past four years, 2015-2018. Specifically, this study has two general objectives:

1. To measure whether the P+PB campaign increased or prevented the decline of consumption of paper and paper-based packaging products compared to what would have occurred in the absence of the campaign.
2. To measure the benefits of the P+PB campaign in terms of incremental profitability for the entire industry and compare these benefits with the cost of the checkoff to compute a rate of return on investment of this campaign to its stakeholders.

In order to meet these objectives, the analysis needed to address two important questions regarding the P+PB campaign:

1. What is the responsiveness of paper and paper-based packaging products demand to P+PB advertising?
2. What is the overall rate of return on investment (ROI) of the P+PB campaign to the stakeholders of the checkoff program?

In this study, the impacts of all factors affecting domestic paper and paper-based packaging products demand (“demand drivers”) for which data are available are measured statistically. In this way, we can net out the impacts of other demand drivers (e.g., white collar employment) besides P+PB marketing activities affecting paper and paper-based packaging product demand over time. In addition, the gross profitability of the incremental sales generated by P+PB activities is estimated. These benefits to firms in the paper and paper-based packaging industry are compared with the costs associated with P+PB. Based on the estimated impacts from the demand models, an ROI is derived for the P+PB campaign.

This independent evaluation is carried out by Dr. Harry M. Kaiser, the Gellert Family Professor of Applied Economics and Management at Cornell University. Dr. Kaiser is a national and internationally renowned expert in the economics of generic advertising and promotion programs. Dr. Kaiser has written 135 refereed journal articles, five books, 17 book chapters, over 150 research bulletins, and received \$8 million in research grants in the area of agricultural marketing with an emphasis on promotion programs.

Data Limitations

This analysis is based on secondary government data, private research and P+PB. The accuracy of the results depends primarily on the quality of this secondary data, the bulk of which mainly measure demand and demand drivers for paper and paper-based packaging products. While these data are judged to be the best available for this economic evaluation, there are three potential limitations or concerns regarding the data used in this project.

The first is the number of observations in the study. Since quarterly data are judged to have too much seasonal noise to control for in the analysis, annual data for the period 1995-2018 are used instead. This results in a total of 24 observations for the statistical analysis. Ideally, one would want more than 30 observations for the regression models. To deal with this, the number of demand drivers (explanatory variables) in each of the five demand models is restricted.

Second, and related, while 24 observations are not a lot from a statistical regression model viewpoint, 24 years is a long period of time, and structural change most likely occurred in the paper and packaging industry since 1995. To control for this, the demand models have included measures that may capture some of this change over time.

The third is the lack of data about the marketing efforts of the largest e-retailers, Amazon and Walmart. However, the explanatory variables in the containerboard demand model explained over 90% of the variation in containerboard sales. Thus, the model is still very accurate even without a measure of important e-retailers' marketing.

Methodology

This study quantifies the relationship between the marketing campaign of P+PB and the domestic demand for paper and paper-based packaging products. The econometric approach quantifies economic relationships using economic theory and statistical procedures with data. It enables one to simultaneously account for the impact of a variety of factors affecting demand and supply for a commodity. By casting the economic evaluation in this type of framework, one can filter out the effect of other factors and, hence, quantify directly the net impact of the P+PB campaign on paper and paper-based packaging products.

This report analyzes the impacts of the P+PB campaign on both individual paper and paper-based packaging grades and on all grades combined. Specifically, there are five grades examined in this report: containerboard, paperboard, kraft paper, bond paper, and other printing and writing paper. Each of these grades has experienced very different patterns of consumption in the past 25 years. Each is described individually below:

- **Containerboard:** This grade includes linerboard and corrugating medium used in corrugated boxes and corrugated displays.
- **Paperboard:** This grade includes folding boxes, beverage cartons, paper cups and plates, set-up boxes, paperboard tubes, cans and drums.
- **Kraft:** This grade is composed of the following products: grocery bags and sacks, shipping sacks, wrapping paper and other kraft paper products.
- **Bond paper:** This grade is used to produce office cut size paper (8 1/2 x 11).
- **Printing and writing paper:** This grade includes multiple products, such as: magazine paper, envelopes, directories, books, brochures, catalogs and newspaper inserts.

These models are used to test whether the P+PB campaign has a statistically significant impact on paper and paper-based packaging product demand. In order to isolate the effect of P+PB campaign on demand, many different demand drivers were initially included in the model. The final model includes only those drivers that are statistically significant.¹

Table 1 in the Appendix lists all the demand drivers initially tried in each of the five grade demand models. The five grades are all measured in 1,000 metric tons, and the data source for tons produced is secured through American Forest and Paper Association (AF&PA). Of these potential demand drivers, the final selected demand models include the following demand drivers:

Containerboard

Regarding the demand drivers in the containerboard demand model, the nondurable plus durable goods production index is considered an important demand driver because an increase in production of these goods increases the demand for containerboard. Specifically, based on the recommendation of Stan Lancey, Senior Economist, AF&PA, an index with a weight of 70% nondurable (consumer, non-energy, non-durable goods production) and 30% durable goods production is used. Another important demand driver for containerboard is e-commerce, which is measured in the demand model as e-commerce sales as a percentage of total retail sales. The growth of e-commerce in recent years has certainly had a positive impact on containerboard demand. Relatedly, Gross Domestic Product (GDP) is an important demand driver for containerboard since increases in GDP increase the demand for containerboard. Basis weight for containerboard is included because demand is measured in short tons, and the basis weight for containerboard has been decreasing over time. Finally, expenditures on the P+PB campaign are included in the model to test whether they have a positive and statistically significant impact on containerboard demand.

| Containerboard Demand Drivers | |
|--|----------------------------------|
| 70% Nondurable Goods Production Index & 30% Durable Goods Production Index | Federal Reserve Board |
| E-commerce as a % of Retail Sales | U.S. Census Bureau |
| GDP (inflation adjusted) | U.S. Bureau of Economic Analysis |
| Basis Weight | Fibre Box Association |
| Expenditures on P+PB campaign | P+PB |

Paperboard

For the paperboard demand model, an important demand driver is nondurable goods production. As production of nondurables increases, the demand for paperboard increases. Likewise, the state of the economy, measured here by GDP, should have a positive impact on

¹ In some cases, two or more statistically significant demand drivers are highly correlated with each other, which causes a statistical problem (called “multicollinearity”) when both (or all) variables are included in the model. In cases where two or more variables are highly correlated, only one of these variables is included in the model. In such cases, the variable that is the most significant by itself is kept in the model, while the other(s) are omitted.

paperboard demand and is therefore included as a demand driver. A simple linear trend variable is included to capture the aggregate impact of any omitted variables impacting paperboard demand. Expenditures on the P+PB campaign are included in the model to test whether they have a positive and statistically significant impact on paperboard demand.

| Paperboard Demand Drivers | |
|---|----------------------------------|
| Nondurable Goods Production Index | Federal Reserve Board |
| GDP (inflation adjusted) | U.S. Bureau of Economic Analysis |
| Trend (to capture impact of demand drivers not included in the model) | |
| Expenditures on P+PB campaign | P+PB |

Kraft

Kraft paper demand is impacted by food sales, particularly at grocery stores, since paper grocery bags are one of the main products of kraft paper. Accordingly, food and beverage sales expenditures are included as a demand driver in the kraft demand model. Relatedly, the ratio of away-from-home food consumption expenditures to food consumed at home expenditures is included since eating away from home decreases the number of paper grocery bags used, which should have a negative impact on kraft paper. Like the other grade demand models, GDP is included since it should positively impact kraft paper demand. A simple trend variable is included to capture the aggregate impact of any omitted variables impacting kraft paper demand. Finally, the P+PB campaign expenditures are included to examine whether they positively impact kraft paper demand.

| Kraft Demand Drivers | |
|---|----------------------------------|
| U.S. Retail Food & Beverages Sales | U.S. Census Bureau |
| Ratio At-home Food Sales/Away-from-home Food Sales | U.S. Census Bureau |
| GDP (inflation adjusted) | U.S. Bureau of Economic Analysis |
| Trend (to capture impact of demand drivers not included in the model) | |
| Expenditures on P+PB campaign | P+PB |

Bond Paper

Bond paper is positively impacted by employment in white collar professions. The greater the number of people working in white collar professions, the greater the demand for bond paper. Relatedly, the state of the economy, measured here by GDP, should have a positive impact on bond paper demand and is therefore included as a demand driver. Another important demand driver is the increasing trend of people using their digital devices such as mobile phones, tablets and computers. This demand driver is measured by the number of minutes each day people spend viewing their cell phones, which is expected to adversely impact bond paper demand since these devices are substitutes to bond paper. The price of bond paper (measured as the producer price index for stationery products) is included as a potential demand driver for bond paper. A simple linear trend variable is included to capture the aggregate impact of any omitted variables impacting bond paper demand. Finally, the P+PB campaign expenditures are

included to examine whether they positively impact bond paper demand.

| Bond Paper Demand Drivers | |
|---|----------------------------------|
| White Collar Employment (expanded definition w/ education & health) | Bureau of Labor Statistics |
| GDP (inflation adjusted) | U.S. Bureau of Economic Analysis |
| Mobile Phone Screen Time (nonvoice) | eMarketer |
| Producer Price Index (stationary) | Bureau of Labor Statistics |
| Trend (to capture impact of demand drivers not included in the model) | |
| Expenditures on P+PB campaign | P+PB |

Printing and Writing Paper

The same demand drivers for bond paper affect the printing and writing paper demand model except for the price for stationery products. In addition, consumption in the previous year is included in the printing and writing paper demand model since consumption in the previous year is highly correlated with consumption in the current year. Last, the P+PB campaign expenditures are included to examine whether they positively impact printing and writing demand.

| Printing and Writing Paper Demand Drivers | |
|---|----------------------------------|
| White Collar Employment (expanded definition w/ education & health) | Bureau of Labor Statistics |
| GDP (inflation adjusted) | U.S. Bureau of Economic Analysis |
| Mobile Phone Screen Time (nonvoice) | eMarketer |
| Trend (to capture impact of demand drivers not included in the model) | |
| Printing & Writing Paper Apparent Consumption in Previous Year | AF&PA |
| Expenditures on P+PB campaign | P+PB |

To compare the relative importance of each demand driver on paper and paper-based packaging product demand, the results from the econometric model are converted into “elasticities.” An elasticity measures the percentage change in demand given a 1% change in a specific demand driver, holding all other factors constant. For example, the computed elasticity of containerboard demand with respect to GDP measures the percentage change in demand given a 1% change in GDP, holding constant all other demand drivers. Since elasticities are calculated for each demand factor in each model, one can compare them to determine which factors have the largest impact on demand.

The econometric results are then used to simulate the impacts of the P+PB campaign on demand for alternative funding scenarios. Specifically, demand for each of the five paper grades is simulated over time under two scenarios: (1) “with the P+PB campaign” baseline scenario, where all demand drivers, including P+PB marketing expenditures are set at their historical levels for the most recent four-year period, 2015-2018 and (2) “without P+PB campaign” counterfactual scenario, which is identical to the first scenario except that P+PB marketing expenditures are set to zero for 2015-2018. A comparison of simulated paper and

paper-based packaging product demand between the two scenarios provides a measure of the impact of the P+PB campaign on demand.

Once the econometric demand models for the five paper grades is estimated, the P+PB advertising elasticity of demand is used to simulate the two scenarios defined above: (1) with P+PB campaign and (2) without P+PB campaign. The following steps are used to generate a net rate of return on investment (ROI) for the P+PB campaign.

First, consumption is simulated for each of the five grades for the two scenarios. Incremental tonnage for each grade is simulated by subtracting consumption in the “without P+PB campaign” scenario from tonnage for the “with P+PB campaign” scenario. A more detailed explanation of this is provided in the Appendix of this report.

Second, using data on the discounted price and delivery costs for each paper grade, from a highly respected price reporting and market analysis provider for the forest products sector, to get the average gross profitability per ton, the incremental tonnage due to the P+PB campaign is multiplied by gross profitability for each grade to incremental gross profitability due to the campaign. An ROI can then be calculated as:

$$\text{Net ROI} = \frac{\{[(\text{Price} - \text{Discount}) - \text{Delivery Costs}] \times \text{Incremental Sales Volume}\} - \text{Cost of P+PB}}{\text{Cost of P+PB}}$$

The ROI is calculated based on the summation of the incremental gross profits and P+PB costs over the four-year period, 2015-2018, and for the five paper grades. The RISI data are based on national averages for each grade.

Results

The econometric models are estimated using annual data from 1995 through 2018. Two functional forms are estimated, linear and double logarithmic, and the form that has the best statistical fit in terms of adjusted R² and statistical significance of the demand drivers is chosen as the final model. The linear functional form is chosen for all models except for kraft paper, which is specified in double logarithmic form. The full set of statistical regression results are shown in the Appendix of the report. Table 2 in the Appendix reports the elasticities for all demand drivers for each of the five grades. The elasticities in this table are based on average values for the most recent four-year time period, 2015-2018.

The accuracy of all five models in predicting actual consumption is quite good. Figures 1 through 5 plot the actual vs. predicted annual consumption for each grade for an in-sample simulation, 1995-2018. The mean absolute percentage errors for the models are very good: 0.94% for containerboard, 0.86% for paperboard, 4.35% for kraft paper, 2.76% for bond paper, and 2.05% for printing and writing paper. Hence, the models are judged to be sound for the simulations to be conducted.

Containerboard

In terms of demand drivers for containerboard, the results indicate that GDP is

extremely important. For every 1% increase in real, inflation adjusted GDP, consumption of containerboard increases by 3.458%, holding all other demand drivers constant. Clearly, containerboard consumption is substantially tied to the health of the economy. All the other demand drivers, while less impactful, also have a statistically significant impact on containerboard consumption. A 1% increase in basis weight is found to increase containerboard consumption 0.513%, holding other demand drivers constant. A 1% increase in e-commerce sales as a percent of total retail sales, holding all other demand drivers constant, increases containerboard consumption by 0.088%. Most important to this analysis is the P+PB campaign elasticity. Holding all other demand drivers constant, a 1% increase in P+PB campaign expenditures increases containerboard consumption by 0.026%. To test the robustness of the estimated P+PB campaign elasticity impacts for consistency with *OMB Circular A-94*, a 90% confidence interval is computed for the elasticity. This interval can be interpreted as the range of possible values where one can be confident that the true population advertising elasticity could be expected to fall 90% of the time. The 90% confidence interval (lower bound, upper bound) for the P+PB elasticity is (0.013, 0.039). Since the lower bound of this confidence interval is still positive, this provides statistical confidence at the 90% significance level that the true population advertising elasticity is 0.013 or higher.

Paperboard

Like containerboard, GDP is the most important demand driver for paperboard consumption. Specifically, the results indicate that a 1% increase in real, inflation adjusted GDP increases paperboard consumption by 2.958%, holding all other demand drivers constant. The other demand drivers are also statistically significant factors affecting paperboard demand. A 1% increase in nondurable goods production is found to increase paperboard consumption by 0.298%, holding all other demand drivers constant. The net combined impact of all other demand drivers not included in the model, as reflected by the trend term, indicates a negative effect of these factors on paperboard consumption overtime. The average annual decline each year in paperboard consumption due to these factors not included in the model, holding other demand drivers constant, has been 0.39% per year since 2015. The P+PB campaign has had a significant impact on paperboard consumption. Specifically, holding all other demand drivers constant, a 1% increase in P+PB marketing expenditures increases paperboard consumption by 0.021%. The 90% confidence interval for the P+PB campaign elasticity is (0.003, 0.039).

Kraft

Kraft paper consumption is highly impacted by food and beverage sales. The results indicate that a 1% increase in real, inflation adjusted food and beverages sales increase kraft paper consumption by 4.422%, holding all other demand drivers constant. Kraft paper consumption is negatively impacted by away from home food sales. Specifically, a 1% increase in the ratio of food away to food at home sales decreases kraft paper consumption by 1.903%, holding constant other demand drivers. Real, inflation adjusted, GDP positively impacts kraft paper consumption. A 1% increase in real GDP, holding constant other demand drivers, increases kraft paper consumption by 0.402%. The net combined impact of all other demand drivers not included in the model, as reflected by the trend term, indicates a negative effect of these factors on kraft paper consumption overtime. The average annual decline each year in

kraft paper consumption due to these factors not included in the model, holding other demand drivers constant, has been 0.333% per year since 2015. The P+PB campaign has had a significant impact on kraft paper consumption. Holding all other demand drivers constant, a 1% increase in P+PB marketing expenditures increases kraft paper consumption by 0.012%. The 90% confidence interval for the P+PB campaign elasticity is (0.004, 0.02).

Bond Paper

White collar employment is a major demand driver for bond paper. The model suggests that a 1% increase in white collar employment increases bond paper consumption by 3.128%, holding all other demand drivers constant. The price of stationery has a negative correlation with bond paper consumption reflecting the law of demand in economics. Specifically, holding all other demand drivers constant, a 1% increase in the real, inflation adjusted Producer Price Index for stationery products decreased bond paper consumption by 0.736%. Mobile phone devices have been a major negative demand driver for bond paper. A 1% increase in screen time (non-voice) decreases bond paper consumption by 0.377%, holding other demand drivers constant. GDP has a huge positive impact; a 1% increase in real, inflation adjusted, GDP increase bond paper consumption by 3.625%, holding all other demand drivers constant. The net combined impact of all other demand drivers not included in the model, as reflected by the trend term, indicates a huge negative effect of these factors on bond paper consumption overtime. The average annual decline each year in bond paper consumption due to these factors not included in the model, holding other demand drivers constant, has been 4.178% per year since 2015. Unlike all other four paper grades, the P+PB campaign has not had a measurable impact on bond paper consumption, which has displayed large annual decreases in consumption since 2004. However, since bond paper consumption in the past year had its lowest decrease since 2013, perhaps the impact of the P+PB campaign is taking longer on bond paper consumption than the other four grades.

Printing and Writing Paper

GDP is a significant demand driver for printing and writing paper. A 1% increase in GDP increases printing and writing paper consumption by 5.343%, holding other demand drivers constant. White collar employment is also an important demand driver for this category of paper. A 1% increase in white collar employment increase printing and writing paper consumption by 0.763%, holding other demand drivers constant. Another important demand driver is printing and writing paper consumption in the previous year, which is included since consumption in the previous year is highly correlated with consumption in the current year. Specifically, a 1% increase in consumption in the previous year's increases current year consumption by 0.657%, holding all other factors constant. Mobile phone devices have been a major negative demand driver for printing and writing paper. A 1% in screen time (non-voice) decreases the printing and writing paper consumption by 0.351%, holding other demand drivers constant. The net combined impact of all other demand drivers not included in the model, as reflected by the trend term, indicates a huge negative effect of these factors on the printing and writing paper consumption overtime. The average annual decline each year in printing and writing paper consumption due to these factors not included in the model, holding other demand drivers constant, has been 6.550% per year since 2015. The P+PB campaign has had a

significant impact on printing and writing paper consumption. Specifically, holding all other demand drivers constant, a 1% increase in P+PB marketing expenditures increases other printing and writing paper consumption by 0.046. The 90% confidence interval for the P+PB campaign elasticity is (0, 0.092).

These results clearly show that the P+PB campaign has had a positive and statistically significant impact on the demand for four of the five paper grades with bond paper being the exception. To simulate the counterfactual without the P+PB campaign scenario, actual consumption for each grade is multiplied by the factor: $(1 - \text{P+PB advertising elasticity})$. This product provides the measurement for the counterfactual without the P+PB campaign scenario. Figures 6 through 9 display annual consumption from 2015 through 2018 for the two scenarios.

The P+PB campaign had its largest, absolute impact on containerboard consumption (Figure 6). The average annual incremental sales volume of containerboard generated by the P+PB campaign from 2015-2018 is 851,000 tons or 3.406 million tons for the four years. This represents an average percentage increase of 2.6%. Put differently, had there not been a P+PB campaign over this period, containerboard consumption would have been 2.6% lower than it actually was.

Regarding paperboard, the average annual incremental sales volume due to the P+PB campaign is 194,000 tons or 774,000 tons for the four years. This represents an average percentage increase of 2.1%. In other words, had there not been a P+PB campaign over this period, paperboard consumption would have been 2.1% lower than it actually was.

The P+PB campaign generated incremental sales of 17,000 tons per year, or 67,000 tons over the four-year period for kraft paper. This represents an average percentage increase of 1.2%. Again, this means that without the P+PB campaign, kraft paper consumption would have been 1.2% lower.

While bond paper consumption is not impacted by the P+PB campaign, printing and writing paper is impacted. The average annual incremental sales volume due to the P+PB campaign is 641,000 tons or 2.563 million tons for the four years. This represents an average percentage increase of 4.6%. Had there not been a P+PB campaign, printing and writing paper consumption would have been 4.6% less than it was.

The total impact of the P+PB campaign on paper and packaged good sales is 1.7 million tons per year, which represents an 2.8% increase in consumption. To test the robustness of these impacts for consistency with *OMB Circular A-94*, a 90% confidence interval is computed for these simulation results. The 90% confidence interval (lower bound, upper bound) for this impact is (1.9%, 3.7%). Since the lower bound of this confidence interval is still positive, this provides statistical confidence at the 90% significance level that the true population advertising impact is 1.7% or higher.

Using procedures discussed above, a net ROI is computed for the entire P+PB campaign across the five grades and for the four-year period, 2015-2018. Over the past four years, the industry spent a total of \$105.2 million on the P+PB campaign. The campaign returned a total

of \$1.41 billion over this period. Therefore, the net ROI is 12.41:1. That is, every dollar invested in the P+PB campaign returned \$12.41 in net profits to the industry. A 90% confidence interval for this ROI is (3.06, 21.76). This provides statistical confidence at the 90% significance level that the true population ROI is 3.06 or higher.

Conclusions

The primary goal of this study was to conduct an independent economic evaluation of the effectiveness and impacts of the P+PB campaign over the past four years, 2015-2018. Accordingly, the two specific objectives were to: (1) measure whether the P+PB campaign increased consumption of paper products and paper-based packaging products compared to what would have occurred in the absence of the campaign, and (2) measure the benefits of the P+PB campaign in terms of incremental profitability for the entire industry and compare these benefits with the cost of the checkoff to compute a rate of return on investment of this campaign to its stakeholders.

To address these two goals, two important questions were addressed regarding the P+PB campaign:

1. What is the responsiveness of paper and paper packaging products demand to P+PB advertising?
2. What is the overall rate of return on investment (ROI) of the P+PB campaign to the stakeholders of the checkoff program?

To answer these questions, the relationship between the P+PB campaign and the domestic demand for paper and paper-based packaging products was quantified using econometric techniques. The econometric approach quantifies economic relationships using economic theory and statistical procedures with data. It enables one to simultaneously account for the impact of a variety of factors affecting demand and supply for a commodity. By casting the economic evaluation in this type of framework, the effects of other factors can be filtered out, and, hence, the net impact of the P+PB campaign on paper and paper-based packaging products could be quantified. In addition, the gross profitability of the incremental sales generated by P+PB activities was estimated. These benefits to firms in the paper and paper-based packaging industry were compared with the costs associated with the P+PB campaign. Based on the estimated impacts from the demand models, an ROI was derived for the P+PB campaign.

The primary findings of this study were:

- ✓ The P+PB campaign had a positive and statistically significant impact on consumption of four of the five paper grades with the exception of bond paper.
- ✓ Overall, the P+PB campaign increased or protected the consumption of four of the five paper grades by 1.7 million tons per year compared to what it would have been in the absence of the program. In other words, had there not been a P+PB campaign, consumption would have been 2.8% lower than it actually was for

2015-2018.

- ✓ Over the past four years, the industry spent a total of \$105.2 million on the P+PB campaign. The campaign returned a total of \$1.41 billion over this period.
- ✓ Therefore, the net ROI is 12.41:1. That is, every dollar invested in the P+PB campaign returned \$12.41 in net profit to the industry.
- ✓ A 90% confidence interval for this ROI is (3.06, 21.76). This provides statistical confidence at the 90% significance level that the true population ROI is 3.06 or higher.

Appendix

The technical details and full set of results for the econometric model are discussed in this appendix. The econometric model consists of five separately estimated demand equations for the five paper grades. Each model is estimated with annual time series data for the period 1995 through 2018. Two functional forms are estimated, linear and double logarithmic, and the form that has the best statistical fit in terms of adjusted R^2 and statistical significance of the demand drivers is chosen as the final model. The linear functional form is chosen for all models except for kraft paper, which is specified in double logarithmic form. All monetary variables are deflated by the Consumer Price Index for all items to remove the effects of inflation over time. Campaign expenditures by P+PB are also included for the current year as well as the previous year to capture possible carry-over effects of the campaign. Only the statistically significant P+PB variables are included in the final models.

Continue to the following pages for a full analysis of each grade.

Containerboard

The following are the regression results for the containerboard demand model. All demand drivers included in the final model, presented below, are statistically significant at the 5% level or better. To correct for serial correlation, an auto-regressive (AR1) error process is appended to the error term. All have the signs that are expected. Since this is a linear model², the elasticities are equal to the estimated coefficient times the demand driver divided by containerboard demand. The computed elasticities in Table 2 of the text are based on average values from 2015-2018. The goodness of fit of the model is excellent as depicted by a high R² and adjusted R². Note that P+PB campaign expenditures, lagged one year, are included in this model rather than current expenditures, indicating the campaign has a one-year lagged effect on containerboard consumption.

| Dependent Variable: CONTAINERBOARD CONSUMPTION | | | | |
|--|-------------|-----------------------|-------------|----------|
| Method: Least Squares | | | | |
| Sample (adjusted): 1997 2018 | | | | |
| Included observations: 22 after adjustments | | | | |
| Convergence achieved after 7 iterations | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| .7*NONDURINDEX+.3*DURIND | | | | |
| EX | 108.7005 | 14.01650 | 7.755180 | 0.0000 |
| ECOMMERCE PERCENT | 31458.21 | 2501.461 | 12.57593 | 0.0000 |
| Δ (GDPREAL) | 2.913967 | 0.310515 | 9.384314 | 0.0000 |
| BASIS WEIGHT | 129.6691 | 11.08007 | 11.70291 | 0.0000 |
| P+PB(-1)/CPIALL(-1) | 0.007893 | 0.002243 | 3.519010 | 0.0028 |
| AR(1) | -0.508632 | 0.218078 | -2.332337 | 0.0331 |
| R-squared | 0.940094 | Mean dependent var | | 31673.04 |
| Adjusted R-squared | 0.921374 | S.D. dependent var | | 1337.578 |
| S.E. of regression | 375.0617 | Akaike info criterion | | 14.91906 |
| Sum squared resid | 2250740. | Schwarz criterion | | 15.21662 |
| Log likelihood | -158.1096 | Hannan-Quinn criter. | | 14.98915 |
| Durbin-Watson stat | 2.233758 | | | |
| Inverted AR Roots | -0.51 | | | |

² In this model, as well as containerboard, bond paper, and printing and writing paper, instead of measuring real GDP in level terms, this variable is differenced. This variable is differenced because doing so yielded more statistically significant results, and the expected positive sign.

Paperboard

The regression results for the paperboard model are displayed below. All demand drivers included in the final model are statistically significant at the 5% level or better. Again, since this is a linear model, the elasticities are equal to the estimated coefficient times the demand driver divided by paperboard demand. The computed elasticities in Table 2 of the text are based on average values from 2015-2018. Similar to the containerboard model, the goodness of fit of the model is excellent as depicted by a high R^2 and adjusted R^2 . Also, P+PB campaign expenditures, lagged one year, are included in this model rather than current expenditures, indicating the campaign has a one-year lagged effect on paperboard consumption.

| Dependent Variable: PAPERBOARD CONSUMPTION | | | | |
|---|-------------|-----------------------|-------------|----------|
| Method: Least Squares | | | | |
| Sample (adjusted): 1996 2018 | | | | |
| Included observations: 23 after adjustments | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| CONSTANT | 7014.329 | 688.4244 | 10.18896 | 0.0000 |
| NONDURINDEX | 28.20954 | 6.151154 | 4.586056 | 0.0002 |
| $\Delta(\text{GDPREAL})$ | 0.705758 | 0.128967 | 5.472395 | 0.0000 |
| TREND | -38.97034 | 5.666951 | -6.876773 | 0.0000 |
| P+PB(-1)/CPIALL(-1) | 0.001792 | 0.000885 | 2.026303 | 0.0578 |
| R-squared | 0.922758 | Mean dependent var | | 9736.963 |
| Adjusted R-squared | 0.905593 | S.D. dependent var | | 409.1226 |
| S.E. of regression | 125.7059 | Akaike info criterion | | 12.69543 |
| Sum squared resid | 284435.5 | Schwarz criterion | | 12.94227 |
| Log likelihood | -140.9974 | Hannan-Quinn criter. | | 12.75751 |
| F-statistic | 53.75837 | Durbin-Watson stat | | 1.344078 |
| Prob(F-statistic) | 0.000000 | | | |

Kraft

Unlike the other four models, the logarithmic functional form is used for kraft paper. All the demand drivers in the model, except for GDP and TREND, are statistically significant at the 10% level or better. TREND is marginally statistically significant. The goodness of fit of the model is excellent as depicted by a high R^2 and adjusted R^2 . Current year P+PB marketing expenditures rather than one-year lag are included in this model indicating the campaign has an instantaneous effect on kraft paper consumption.

| Dependent Variable: LOG(KRAFT PAPER CONSUMPTION) | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: Least Squares | | | | |
| Sample: 1995 2018 | | | | |
| Included observations: 24 | | | | |
| White heteroskedasticity-consistent standard errors & covariance | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| CONSTANT | -23.94507 | 8.853147 | -2.704696 | 0.0145 |
| LOG(FOOD/BEV SALES) | 4.422225 | 1.151749 | 3.839574 | 0.0012 |
| LOG(AFH/AH) | -1.903132 | 0.904616 | -2.103802 | 0.0497 |
| LOG(GDPREAL) | 0.401763 | 0.615368 | 0.652883 | 0.5221 |
| LOG(P+PB/CPIALL) | 0.012285 | 0.004640 | 2.647281 | 0.0164 |
| TREND | -0.014785 | 0.011484 | -1.287447 | 0.2142 |
| R-squared | 0.921491 | Mean dependent var | | 7.233534 |
| Adjusted R-squared | 0.899683 | S.D. dependent var | | 0.199688 |
| S.E. of regression | 0.063247 | Akaike info criterion | | -2.471224 |
| Sum squared resid | 0.072003 | Schwarz criterion | | -2.176710 |
| Log likelihood | 35.65469 | Hannan-Quinn criter. | | -2.393089 |
| F-statistic | 42.25454 | Durbin-Watson stat | | 2.280010 |
| Prob(F-statistic) | 0.000000 | Wald F-statistic | | 89.59415 |
| Prob(Wald F-statistic) | 0.000000 | | | |

Bond Paper

All demand drivers in the bond paper demand equation, displayed below, are statistically significant, except for the P+PB campaign. The goodness of fit of the model is excellent as depicted by a high R^2 and adjusted R^2 . Neither the current year P+PB campaign expenditures nor its one-year lag are included in this model indicating the campaign has an instantaneous effect on bond paper consumption, and hence are omitted from the model.

| Dependent Variable: BOND PAPER CONSUMPTION | | | | |
|--|-------------|-----------------------|-------------|----------|
| Method: Least Squares | | | | |
| Sample (adjusted): 1996 2018 | | | | |
| Included observations: 23 after adjustments | | | | |
| White heteroskedasticity-consistent standard errors & covariance | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| WCOLLARNEW | 0.214721 | 0.015054 | 14.26309 | 0.0000 |
| Δ(GDPREAL | 0.337687 | 0.185836 | 1.817122 | 0.0859 |
| TREND | -152.0710 | 21.28378 | -7.144922 | 0.0000 |
| PPISTAT/CPIALL | -4307.634 | 793.8918 | -5.425971 | 0.0000 |
| SCREENTIME | -7.840859 | 1.216093 | -6.447582 | 0.0000 |
| R-squared | 0.957770 | Mean dependent var | | 4721.043 |
| Adjusted R-squared | 0.948386 | S.D. dependent var | | 750.5168 |
| S.E. of regression | 170.5083 | Akaike info criterion | | 13.30511 |
| Sum squared resid | 523315.5 | Schwarz criterion | | 13.55195 |
| Log likelihood | -148.0087 | Hannan-Quinn criter. | | 13.36719 |
| Durbin-Watson stat | 1.176545 | | | |

Printing and Writing Paper

The regression results for the printing and writing paper model are displayed below. All demand drivers, except the P+PB campaign, included in the final model are statistically significant at the 5% level or better. The P+PB campaign is statistically significant at better than the 10% level based on a one-tailed t-test. Similar to the other models, the goodness of fit of the model is excellent as depicted by a high R^2 and adjusted R^2 .

| Dependent Variable: OTHER WRITING PAPER | | | | |
|---|-------------|-----------------------|-------------|--------|
| Method: Least Squares | | | | |
| Sample (adjusted): 1996 2018 | | | | |
| Included observations: 23 after adjustments | | | | |
| HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 3.0000) | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| WHITE COLLAR | 0.210451 | 0.102799 | 2.047202 | 0.0564 |
| SCREENTIME | -25.21439 | 10.98281 | -2.295804 | 0.0347 |
| $\Delta(\text{GDPREAL})$ | 5.342611 | 0.410938 | 13.00102 | 0.0000 |
| TREND | -162.5814 | 76.51205 | -2.124913 | 0.0486 |
| P+PB(-1)/CPIALL(-1) | 0.005920 | 0.003922 | 1.509488 | 0.1495 |
| OWP(-1) | 0.625775 | 0.148059 | 4.226522 | 0.0006 |
| R-squared | 0.981531 | Mean dependent var | 21421.62 | |
| Adjusted R-squared | 0.976099 | S.D. dependent var | 4974.045 | |
| S.E. of regression | 768.9913 | Akaike info criterion | 16.34749 | |
| Sum squared resid | 10052911 | Schwarz criterion | 16.64371 | |
| Log likelihood | -181.9962 | Hannan-Quinn criter. | 16.42199 | |
| Durbin-Watson stat | 1.997437 | | | |

Table 1. List of variables initially tried in each of the five paper grade demand models.

| Demand Drivers Tested Econometric Model | | | |
|--|----------------------|----------------------------------|----------------------|
| Grade | Data Series Dates | Sources | Included in Model |
| Containerboard | | | |
| 70% Nondurable Goods Production Index & 30% Durable Goods Production Index | 1994 | Federal Reserve Board | Yes |
| E-commerce as a % of Retail Sales | 1999 | U.S. Census Bureau | Yes |
| GDP (inflation adjusted) | 1994 | U.S. Bureau of Economic Analysis | Yes |
| Basis Weight | 1990 | Fibre Box Association | Yes |
| Containerboard Apparent Consumption | 1995 | AF&PA | Yes |
| Consumer Price Index for all items | 1994 | Bureau of Labor Statistics | No |
| Producer Price Index for Containerboard | 1994 | Bureau of Labor Statistics | No |
| Imported and Exported Foods | | | No |
| Durables Minus Automobile Sales | | | No |
| Large E-retailer's Marketing Expenditures | | | No |
| Paperboard | | | |
| Nondurable Goods Production Index | 1994 | Federal Reserve Board | Yes |
| GDP (inflation adjusted) | 1994 | U.S. Bureau of Economic Analysis | Yes |
| Trend (to capture impact of demand drivers not included in the model) | | | Yes |
| Paperboard Apparent Consumption | 1995 | AF&PA | Yes |
| Consumer Price Index for all items | 1994 | Bureau of Labor Statistics | No |
| Producer Price Index for Paperboard | 1994 | Bureau of Labor Statistics | No |
| Producer Price Index for Plastic | 2003 | Bureau of Labor Statistics | No |
| Kraft | | | |
| U.S. Retail Food & Beverages Sales | 1994 | U.S. Census Bureau | Yes |
| Ratio At-home Food Sales/Away-from-home Food Sales | 1994 | U.S. Census Bureau | Yes |
| GDP (inflation adjusted) | 1994 | U.S. Bureau of Economic Analysis | Yes |
| Trend (to capture impact of demand drivers not included in the model) | | | Yes |
| Kraft Apparent Consumption | 1995 | AF&PA | Yes |
| Consumer Price Index for all items | 1994 | Bureau of Labor Statistics | No |
| Consumer Price Index, Food & Beverage | 1994 | Bureau of Labor Statistics | No |
| Bag Bans | | | No |
| Bond Paper | | | |
| White Collar Employment (expanded definition w/ education & health) | 1995 | Bureau of Labor Statistics | Yes |

| | | | |
|---|--------|----------------------------------|-----|
| GDP (inflation adjusted) | 1994 | U.S. Bureau of Economic Analysis | Yes |
| Mobile Phone Screen Time (nonvoice) | 2008 | eMarketer | Yes |
| Producer Price Index (stationary) | 1994 | Bureau of Labor Statistics | Yes |
| Trend (to capture impact of demand drivers not included in the model) | | | Yes |
| Bond Paper Apparent Consumption | 1995 | AF&PA | Yes |
| Consumer Price Index for all items | 1994 | Bureau of Labor Statistics | No |
| Internet | 2000 | Pew Research Center | No |
| Office Space | 1984 | CoStar Group | No |
| Digital Electronics Indices (tablets, smart phones, e-readers) | Varies | Pew Research Center | No |
| Presidential Elections | | | No |
| Printing & Writing Paper | | | |
| White Collar Employment (expanded definition w/ education & health) | 1995 | Bureau of Labor Statistics | Yes |
| GDP (inflation adjusted) | 1994 | U.S. Bureau of Economic Analysis | Yes |
| Mobile Phone Screen Time (nonvoice) | 2008 | eMarketer | Yes |
| Trend (to capture impact of demand drivers not included in the model) | | | Yes |
| Printing & Writing Paper Apparent Consumption in Previous Year | | AF&PA | Yes |
| Printing & Writing Paper Apparent Consumption | 1995 | AF&PA | Yes |
| Consumer Price Index for all items | 1994 | Bureau of Labor Statistics | No |
| Internet | 2000 | Pew Research Center | No |
| Office Space | 1984 | CoStar Group | No |
| Digital Electronics Indices (tablets, smart phones, e-readers) | Varies | Pew Research Center | No |
| Producer Price Index (paper manufacturing) | 1994 | Bureau of Labor Statistics | No |
| Other | | | |
| Annual Audited Ad Program Expenditures | 2015 | P+PB | Yes |
| Category Advertising Spending | | | No |

Table 2. Estimated elasticities for five paper grade demand models.

| Grade/Demand Driver | Average Elasticity |
|---|---------------------------|
| Containerboard | |
| Nondurable goods-durable goods production index | 0.343 |
| E-commerce as percent of total retail sales | 0.088 |
| Basis weight | 0.513 |
| Gross Domestic Product | 3.458 |
| Paper and Packaging Board marketing campaign | 0.026 |
| Paperboard | |
| Nondurable goods production index | 0.298 |
| Gross Domestic Product | 2.958 |
| Trend term | -0.390 |
| Paper and Packaging Board marketing campaign | 0.021 |
| Kraft paper | |
| Food and beverage sales expenditures | 4.422 |
| Ratio of away from home to at home food expenditures | -1.903 |
| Gross Domestic Product | 0.402 |
| Trend term | -0.333 |
| Paper and Packaging Board marketing campaign | 0.012 |
| Bond paper | |
| White collar employment | 3.128 |
| Producer Price Index for stationery | -0.736 |
| Mobile phone (non-voice) screen time | -0.377 |
| Gross Domestic Product | 3.625 |
| Trend term | -4.178 |
| Paper and Packaging Board marketing campaign | 0.000 |
| Printing and writing paper | |
| White collar employment | 0.763 |
| Mobile phone (non-voice) screen time | -0.351 |
| Gross Domestic Product | 5.343 |
| Trend term | -6.550 |
| Printing and writing paper consumption in previous year | 0.657 |
| Paper and Packaging Board marketing campaign | 0.046 |

Figure 1. Predicted vs. Actual Containerboard Demand

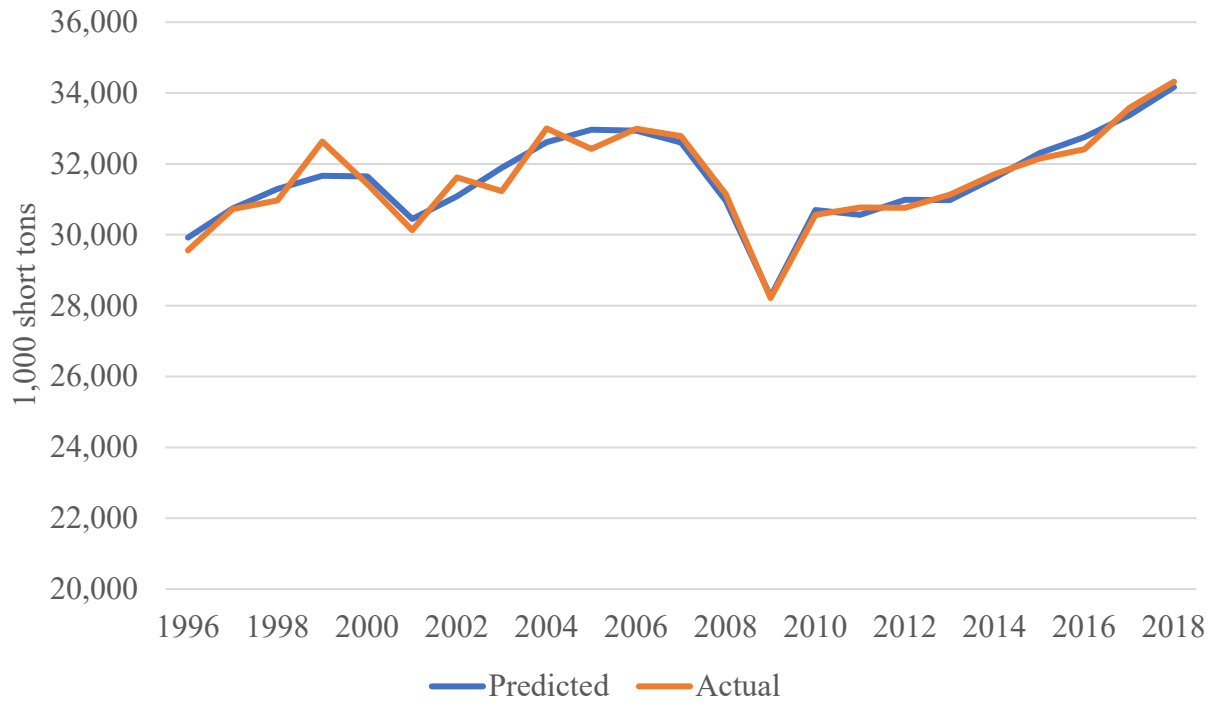
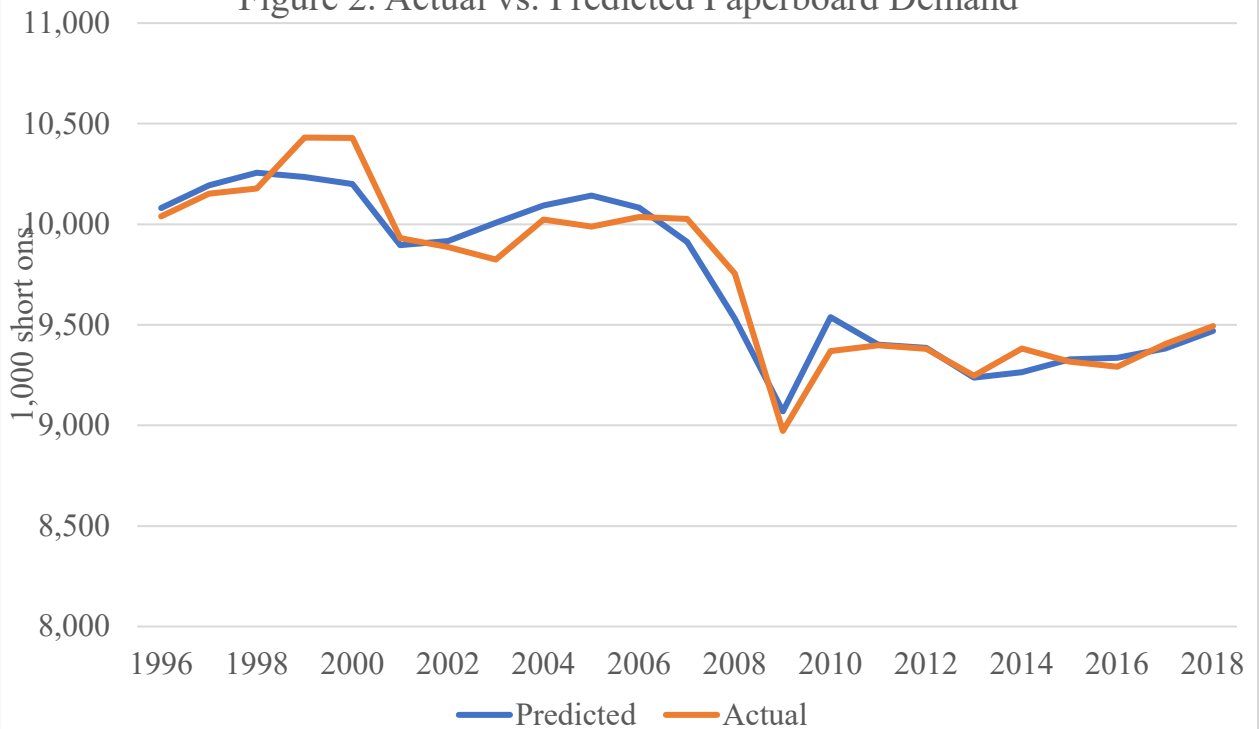


Figure 2. Actual vs. Predicted Paperboard Demand



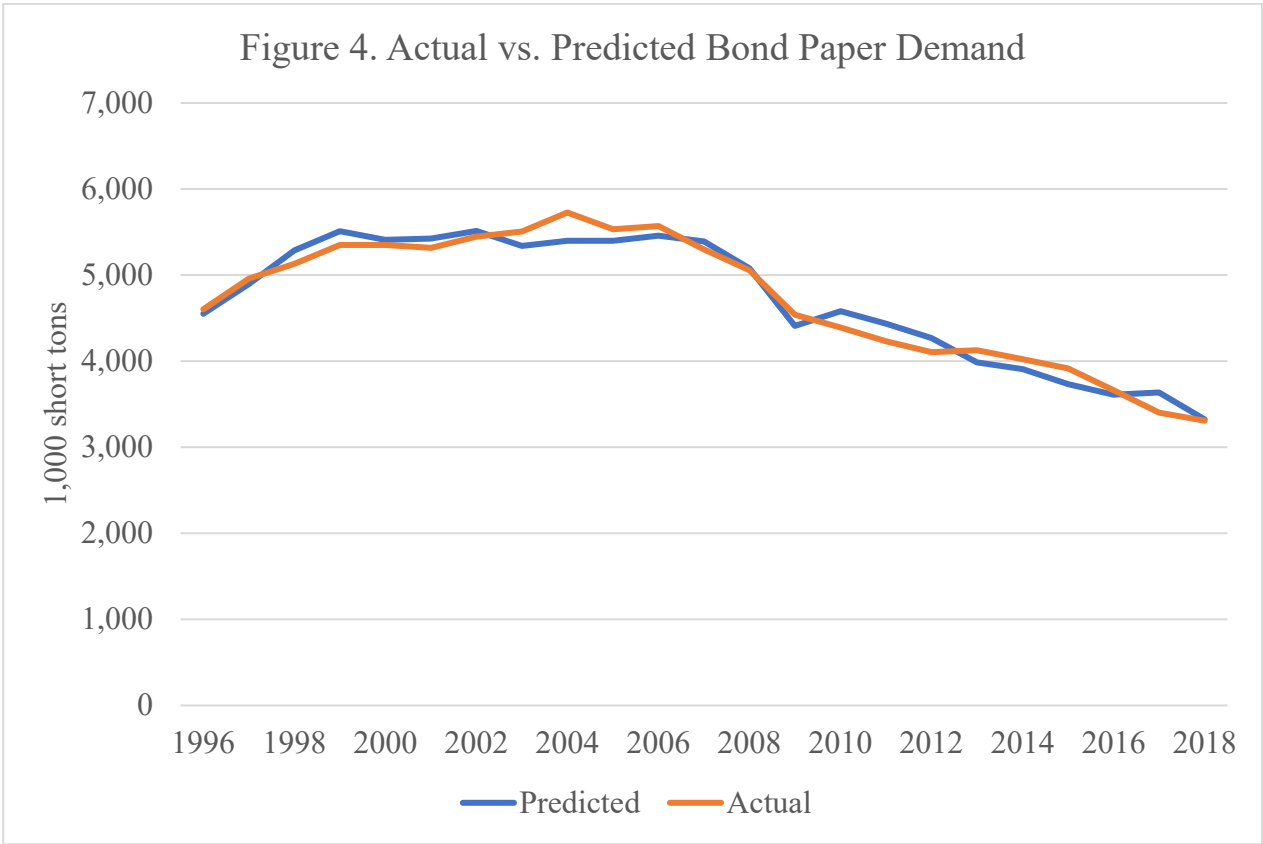
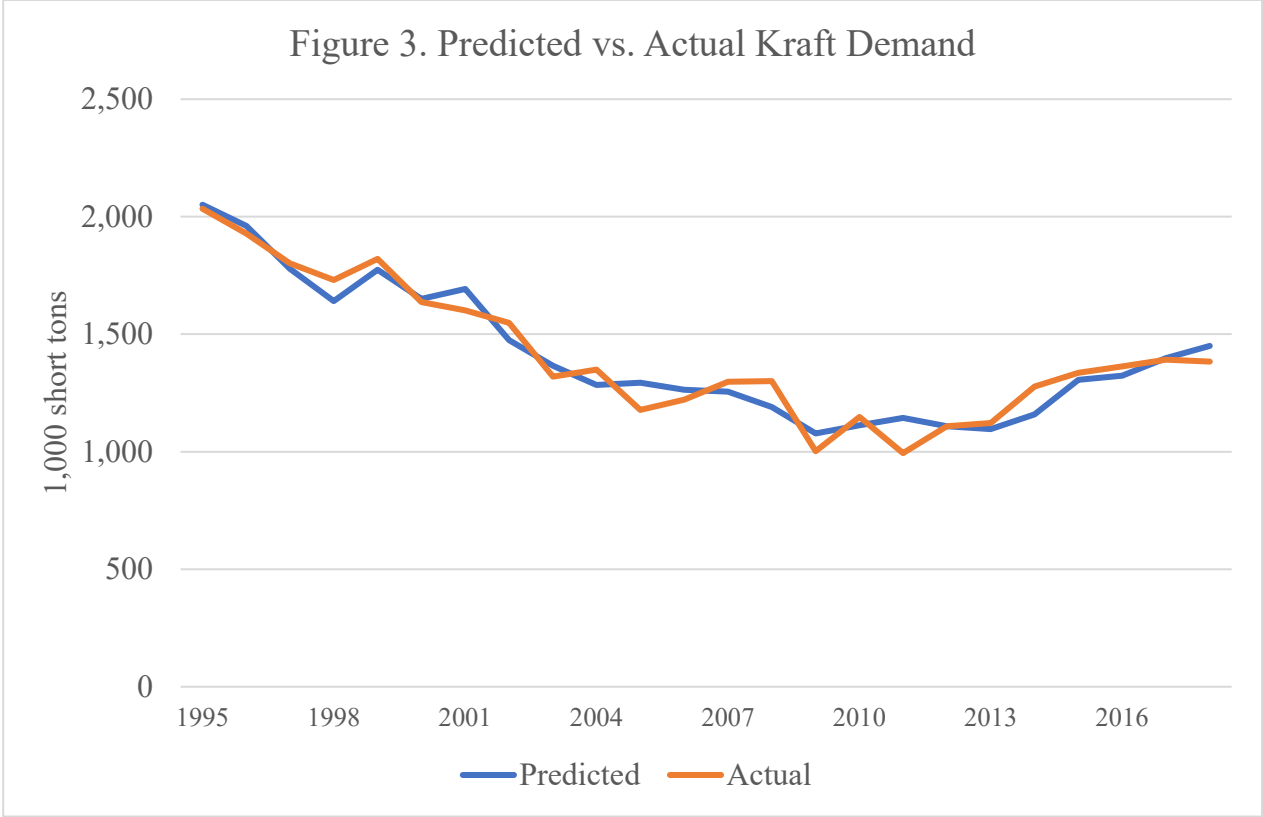


Figure 5. Predicted vs. Actual Printing and Writing Paper Demand

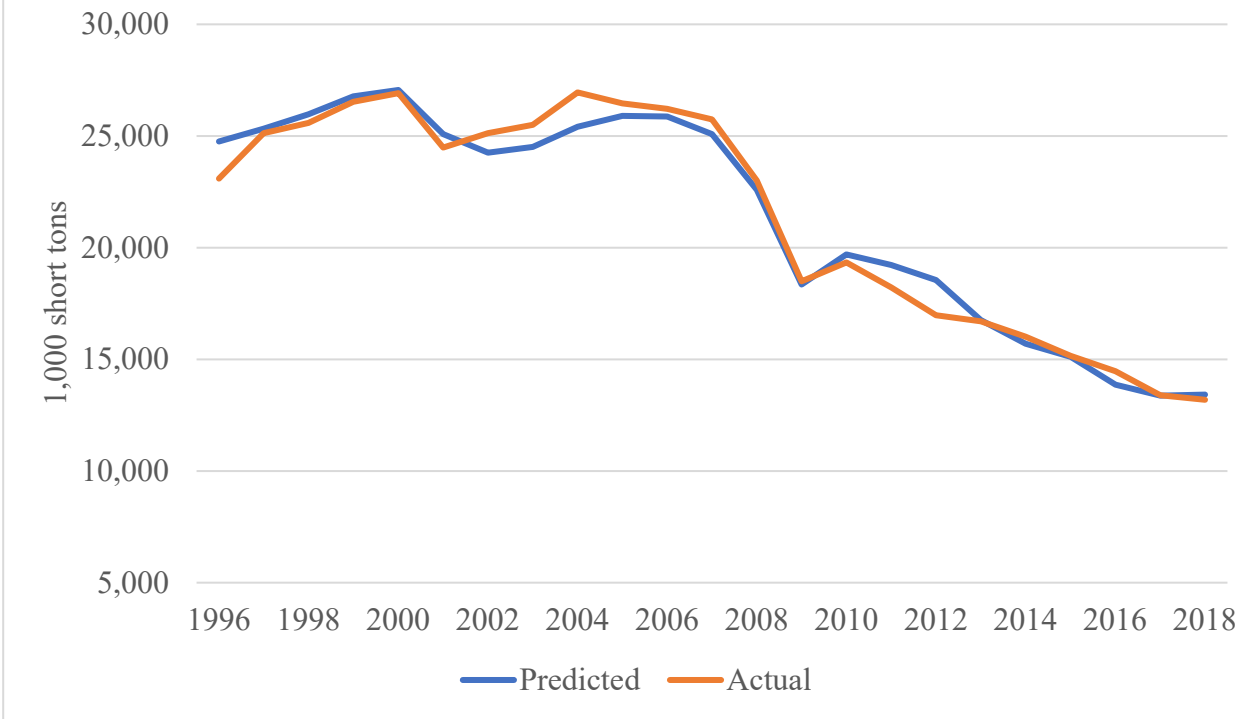


Figure 6. Containerboard consumption with and without P+PB campaign

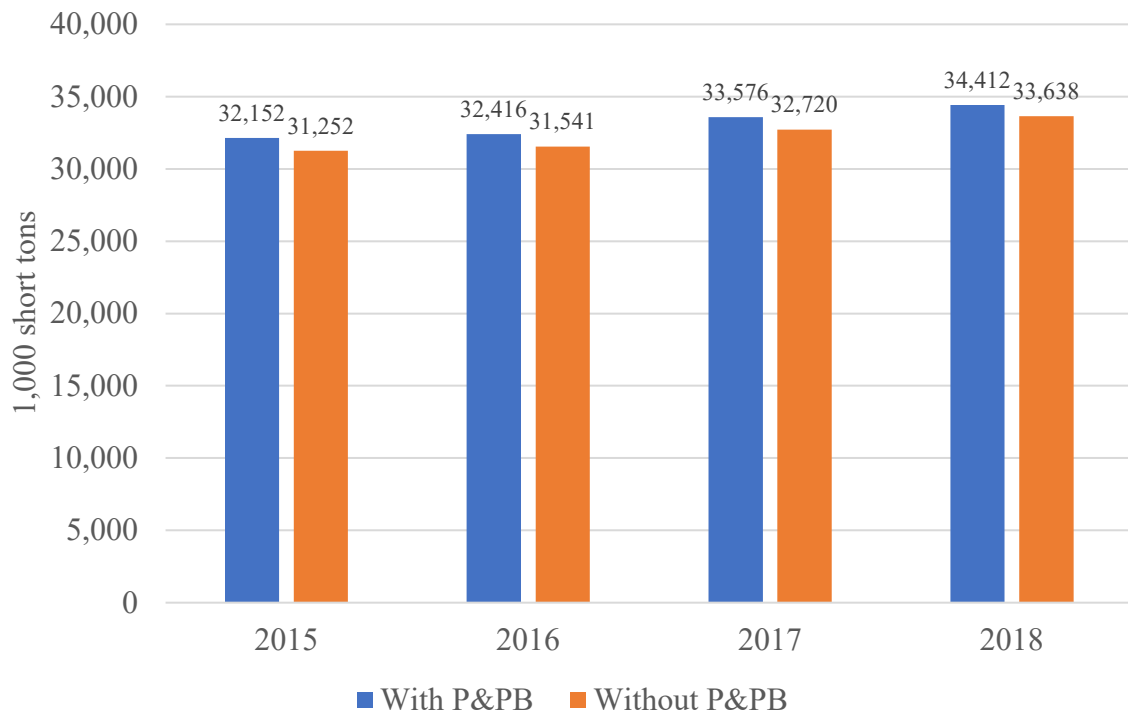
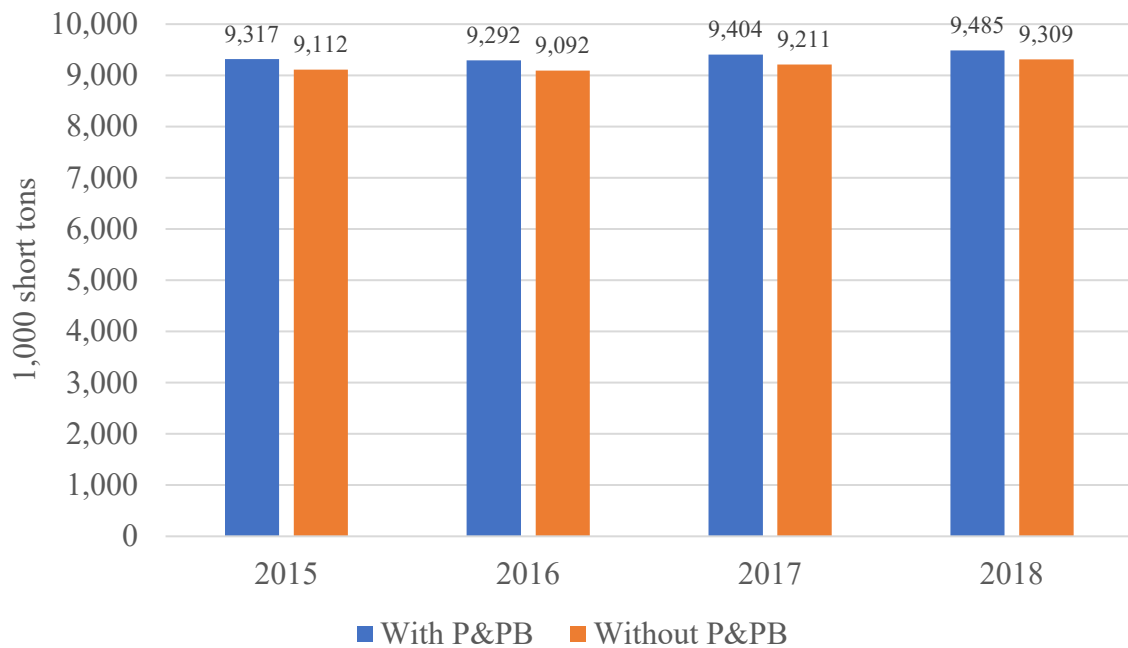
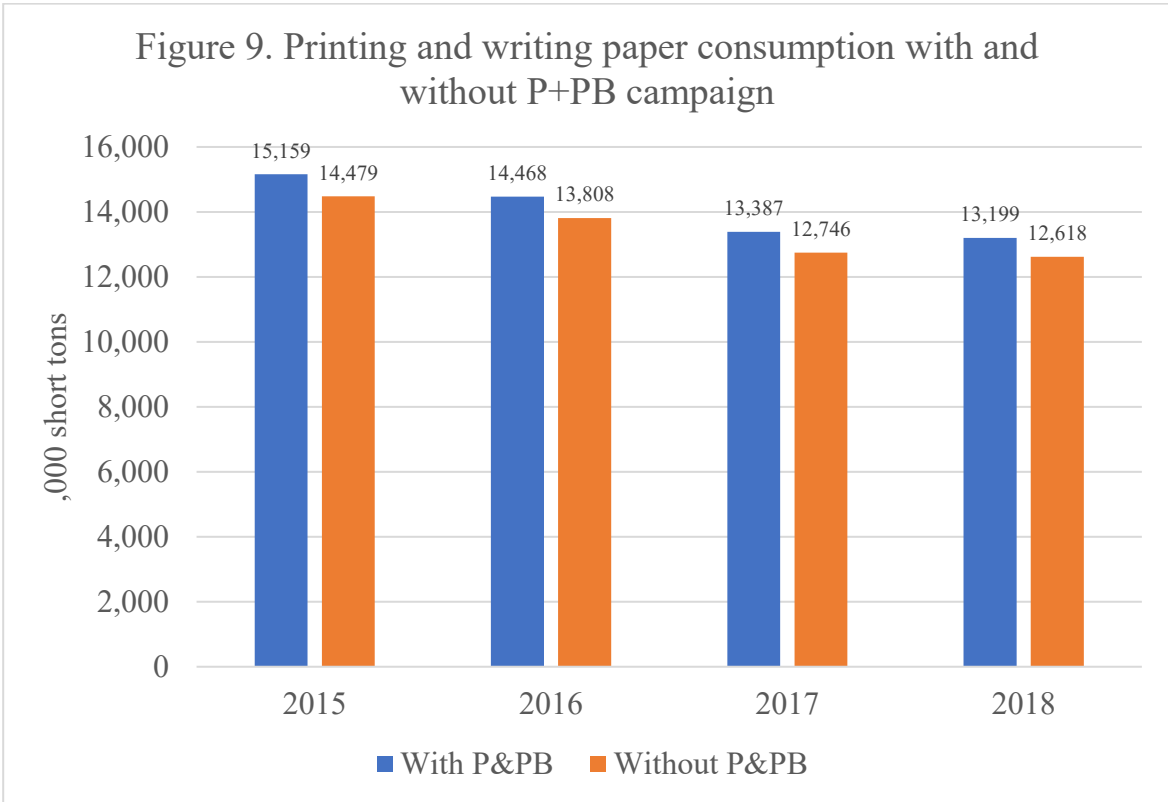
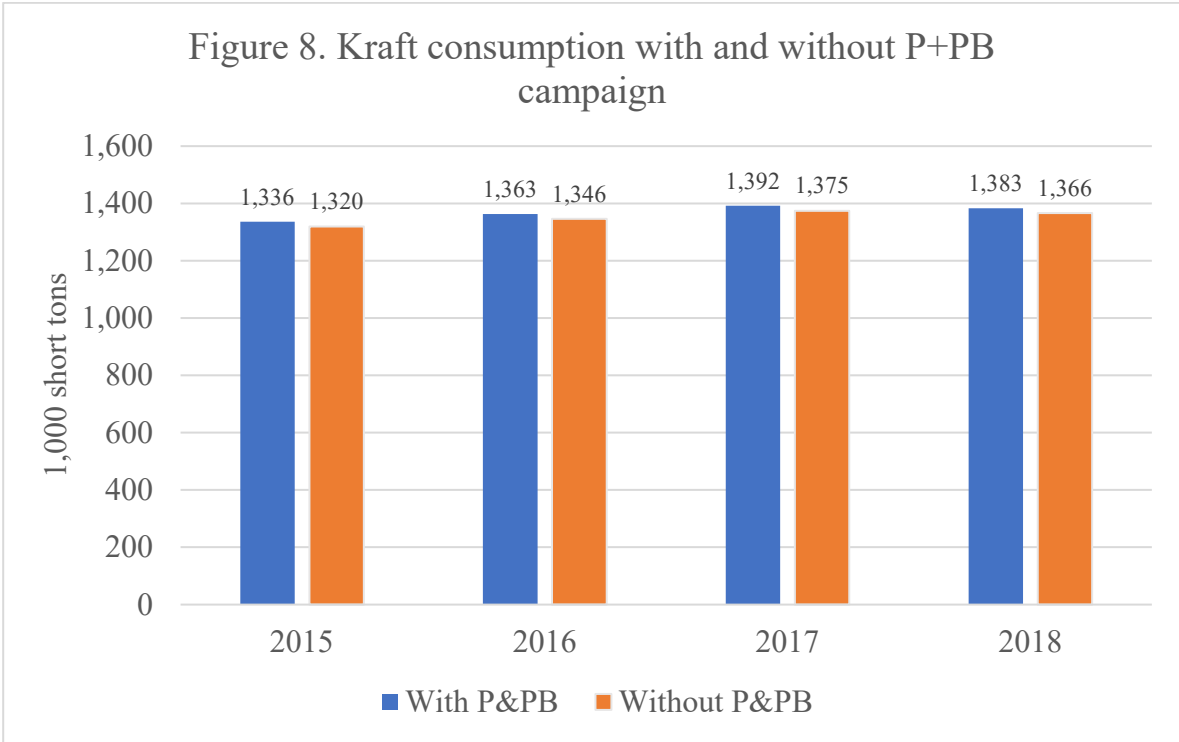


Figure 7. Paperboard consumption with and without P+PB campaign





*No Bond Paper chart because there is no change reported.