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Research Paper

# Menu engineering re-engineered: Accounting for menu item substitutes in pricing and menu placement decisions

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ABSTRACT

Menu engineering is a popular technique deployed by restaurant operators to assess menu item popularity and profitability, and guide key decisions including menu item pricing, sell strategies, and menu design. While traditional menu engineering models have been criticized for their underlying assumption of menu item interdependency, there has been little focus in the literature on addressing this shortcoming. In this paper, we address one type of interdependency, menu item substitution. We propose a holistic 5-stage approach to menu item pricing and menu placement that leverages own- and cross-pricing elasticity data to account for within-category substitutes. We present a field experiment, using two years of data from 48 outlets within a U.S. steakhouse restaurant chain, to demonstrate how this approach can be applied in a restaurant setting. We also provide empirical support for the positive net revenue effects of menu item pricing, and menu placement, decisions that account for within-category substitutes.

## 1. Introduction

Menu engineering models use two data inputs - menu item popularity and contribution margin - to drive menu item pricing, resource allocation, and prioritization decisions. A fundamental assumption underlying these models is menu item independence, wherein decisions are focused at the individual menu item level, and do not explicitly consider interdependencies within or across menu categories (Cohen et al., 2007). Cohen et al. (2007) investigated one type of menu item interdependency, loss leader pricing wherein a menu item is priced at a less profitable price point than desired to stimulate sales of more profitable menu items. They found that this type of interdependency affects the way in which the performance of menu items is portrayed by traditional menu engineering models, and argued for the need for a more advanced menu product portfolio model that addresses menu item interdependence within the portfolio. In this study, we focus on another type of menu item interdependency - the presence of substitutes within a menu category - and extend the literature by advancing a framework that recognizes, and accounts for, within-category substitutes in menu item pricing. Furthermore, our framework explicitly considers the role of menu placement in supporting pricing decisions. Effective menu placement draws attention to highly profitable menu items, as opposed to their less profitable substitutes. Thus, our framework addresses within-category menu item placement to account for the substitution relationship between menu items such that the net revenue impact of related pricing decisions can be maximized.

Our proposed framework is comprised of five stages. In Stage 1, a traditional menu engineering matrix is developed to assess menu item performance. In Stage 2, an economics-based approach is applied to enhance the matrix with two additional layers of data that enable the identification of within-category substitutes: menu items' own- and cross-price elasticity estimates. In Stage 3 of the framework, own- and cross-price elasticity estimates are used to assess the net revenue impact of price changes, and make price adjustments. In Stage 4, the menu mix shift associated with menu placement changes over time is tracked to enable the classification of a menu's within-category positions on a scale from very sweet to very sour, the goal being to drive placement decisions that support the desired effects any price adjustments made in Stage 3. Finally, Stage 5 encompasses validation wherein the actual net revenue impact of both menu item pricing and placement decisions is quantified.

In this paper, we present a field experiment wherein we demonstrate the application of our proposed framework, and its associated financial benefits. Specifically, using two years of data for one product category - entrées - from 48 outlets within a U.S. steakhouse restaurant chain, we provide evidence that consideration of within-category substitutes can yield insights that drive a more nuanced, and arguably sophisticated, approach to menu item pricing, and menu placement,

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decisions than a traditional menu engineering model alone allows. Furthermore, we provide empirical support for the positive net revenue effects of menu item pricing, and menu placement, decisions that account for within-category substitutes. Restaurant outlets in this study experienced an average increase in annual net revenue of 1.8% ($28,800) following a 2% increase in average entrée price. Furthermore, an average incremental annual net revenue gain of 1.6% ($25,600) was achieved through menu placement changes that considered the substitute relationship between entrées.

In pursing this research, our goal is to contribute to the literature by addressing an important type of menu item interdependency, menu item substitution, specifically the impact of this type of interdependency on within-category menu pricing and menu placement. We also seek to provide practitioners with a structured framework within which they can evaluate the presence of within-category substitutes when making menu item pricing and placement decisions. As the empirical results of this study suggest, failure to take into account menu item substitutability may negate the expected net revenue benefits of increasing the price of a given menu item if that price increase shifts customer demand to less profitable menu items. Equally, failure to recognize the relationships between menu items can lead to sub-optimal menu layout decisions, and represent a significant lost revenue opportunity. For example, demand is unlikely to shift from a less profitable menu item to a more profitable substitute if the two items are not placed close to each other on a menu, and if the visibility of the latter is not augmented. A menu layout that does not facilitate consumers' choice behavior could also engender consumer frustration. Thus, from both a menu pricing, and a menu placement, perspective, it behooves practitioners to understand how they can leverage data on menu items' own-and cross-price elasticities to enhance their menu engineering efforts.

## 2. Literature review

### 2.1. Menu engineering

In the late 1980s, Kasavana and Smith (1990) leveraged the Boston Consulting Group's portfolio analysis model to develop the menu engineering matrix approach to menu analysis. Menu engineering, a modification of Miller's (1987) menu analysis model, requires that restaurants classify within-category menu items (e.g., appetizers, entrees and desserts) into four categories based on their popularity (menu mix share) and contribution margin (price minus food cost): Stars (above-average menu mix share and contribution margin), Plow Horses (above average in menu mix share and below average in contribution margin), Puzzles (below average in menu mix share and above average in contribution margin), and Dogs (below average in menu mix share and contribution margin). The classification of menu items into these four categories provides insights that management can leverage to drive menu item pricing, upselling, and elimination decisions, and inform related menu placement decisions (Kwong, 2005; Ozdemir, 2012).

Since its inception, a number of modifications to the menu engineering model, in addition to alternative approaches to menu analysis, have been introduced in the literature. Pavesic (1983) introduced a modified matrix model that uses food cost and weighted average contribution margin (included popularity and contribution margin) in a Cost/Margin model. Subsequently, a number of researchers attempted to go beyond contribution margin and address other costs, primarily labor cost, in menu analysis (e.g., Hayes and Huffman, 1985; Bayou and Bennett, 1992; LeBruto et al., 1995; Horton, 2001). Multidimensional menu mix models have also been developed to evaluate menu effectiveness. For example, a model developed by Cohen et al. (1998) uses food cost percentage, price, popularity, contribution margin, and total contribution margin to visually represent a menu item's profile. More recently, Taylor et al. (2009) proposed the application of data envelopment analysis to analyze menu item performance, while Yang and Chang (2011) introduced a binomial real option pricing model to guide menu portfolio planning. Finally, a number of researchers have incorporated activity-based costing data into traditional menu engineering methods to recognize overhead costs in cost calculations (e.g., Raab et al., 2010; Linassi et al., 2016).

Despite the introduction of these alternatives to the traditional menu engineering model, the traditional model remains a dominant tool for menu analysis in the field. This has been aided in large part by the incorporation of traditional menu engineering models into restaurant software solutions (e.g., Avero and Oracle). It is in the context of the popularity of traditional menu engineering model that we propose a framework for enhancing the traditional menu engineering matrix with own- and cross-price elasticity data to account for within-category substitutes in menu pricing and placement decisions.

### 2.2. Menu engineering based-decisions

Within the traditional menu engineering framework, it is generally prescribed that Stars are good candidates for a price increase, and should be placed in a highly visible position on the menu. Likewise Plow Horses, given their popularity, are good candidates for a price increase, which may move them into the Star category. With Puzzles, one option is to try to make these items more attractive (e.g., providing a description, and making the items more visible on the menu). Another is to reduce price, with the goal of driving sufficient volume to produce higher overall profits. While Dogs can be candidate for removal from a menu, another option is to deemphasize them by placing them in a less visible position on the menu, and not investing any resources to promote them.

Once a strategy has been developed for each menu item, management typically monitor the impact of any prices changes on demand, and further adjust prices if necessary (Kimes et al., 2012). Inherent in this approach to pricing is the notion of own-price elasticity of demand (Kelly et al., 1994). Own-price elasticity is a measure of how sensitive the quantity demanded of a given product is to a change in the product's own price. Thus, if, for example, demand for a given menu item decreases significantly following a price increase, suggesting elastic demand, management may decide to drop its price to its previous level for the next period. Conversely, if a price increase yields little change in demand for a given menu item, suggesting somewhat inelastic demand, management may decide to further increase its price.

While consideration of a menu item's own-price elasticity of demand can guide pricing decisions for that item, it does not reflect the potential knock-on effects of individual menu item price changes on the sales volume for other menu items, or net revenue goals for an entire product portfolio. Thus, failure to recognize interdependencies between menu items could result in suboptimal pricing decisions when considering the menu item portfolio as a whole.

### 2.3. Menu item interrelationships

Cohen et al. (2007) have identified four types of menu item interdependencies: (1) a complementary or substitution relationship between menu items; (2) price/quality benchmarking wherein the attractiveness of one menu item is assessed in comparison with alternatives; (3) loss leader pricing; and (4) production costs when the cost of producing a certain menu item is dependent on other menu items. Their examination of loss leader pricing pointed to the potential pitfalls of not considering the impact of interdependencies on performance of a product portfolio when making menu item pricing, resource allocation, and prioritization decisions. However, the literature is relatively silent on the potential role that other types of interdependencies may have on the efficacy of menu item-related decisions. Here, we focus on one such interdependency: the substitution relationship between menu items.

Two products are considered substitutes if both can satisfy the same need for the consumer (Henderson and Quandt, 1958). Typically, items within a product category constitute substitutes (Cohen et al., 2007). For example, an individual consumer will generally choose one dessert from the range of available desserts. Thus, increasing the price of a given item within a product category may shift demand to substitute items. While items across product categories may also represent substitutes (e.g., a consumer may choose to substitute an entrée with a selection of appetizers) (Mulhern and Leone, 1991), this research is concerned with within-category menu item substitution.

A number of approaches have been proposed in the literature to measure substitutability (Lattin and McAlister, 1985). Marketers have developed behavioral techniques to infer competitive interrelationships from consumer choice (e.g., Urban et al., 1984). Researchers have also leveraged online consumer-generated data to understand substitutability (McAuley et al., 2015). The measurement of substitutability has also been addressed in the field of economics with cross-price elasticity of demand probably the most well-known, and widely accepted measure of one brand's competitive impact on another (e.g., Wedel and Zhang, 2004; Duvvuri et al., 2007). Cross-price elasticity of demand measures the responsiveness in the quantity demanded of one product when a change in price takes place in another product, with a positive cross elasticity denoting two substitute products. Reibstein and Gatignon (1984), for example, found that a pricing strategy that considers cross-price elasticity leads to higher profits than a simpler model that only accounts for own-price elasticity.

The majority of studies that have measured substitutability have been conducted in a retail setting. In this study, we adopt an economics-based approach to empirically assess the substitutability of within-category menu items in a restaurant context.

### 2.4. Menu placement in support of pricing decisions

Menu item pricing decisions are rarely made in a vacuum. Rather, they are typically accompanied by consideration of menu placement in order to draw attention to highly profitable menu items that are targeted for promotion, and deemphasize less profitable substitutes. A price increase on a profitable menu item may fail to yield desired net revenue results if a lower contribution margin substitute is more visible on the menu. Thus, leveraging the true net revenue potential of any pricing decision requires a disciplined approach to menu placement that also takes into account the substitutability of within-category menu items.

The serial position effect, which describes how the position of an item in a sequence affects recall accuracy, has significant implications for menu placement. This effect comprises of two components - the primacy effect and the recency effect - which explain how items presented at the beginning, and end, of a sequence are recalled with greater accuracy than those in the middle (Dittmer and Griffin, 1994; Pavesic, 2011). The primacy effect describes the likelihood of remembering items that are first on a list because they are stored in long-term memory more easily than items further down the list (Glanzer, 1972). There is a relatively small amount of processing effort expended in rehearsing the first item on a list by itself, while proceeding items must be rehearsed with all the other preceding information, causing significant cognitive burden and affecting recall. The recency effect describes the likelihood of remembering items that are last on a list as they are still in working memory (i.e., the part of our short-term memory that processes conscious and immediate perceptual information) (Glanzer and Cunitz, 1966).

Drawing on the serial position effect, it is generally prescribed that the first few positions or spots within a vertically-arranged menu category on a menu are sweet spots, and, after that, it is the last item in the list that gets the most attention. However, the literature provides little evidence of the revenue impacts of menu placement tactics. For example, Kincaid and Corson (2003) manipulated menu item placement by switching the contents of two pages of a three-page menu, and found no significant differences in menu item sales before and after the placement switch, while Bowen and Morris (1995) found that increasing the visibility of a menu item did not result in proportionately greater sales of that item.

Here, we seek to extend this field of research in two ways. First, we propose that experimentation is key to gaining a more nuanced understanding of sweet and sour spots on a given menu. Some sweet (sour) spots are arguably sweeter (sourer) than others. Thus, experimentation in the form of menu placement changes over time, and the evaluation of resulting changes in menu mix, can enable the restaurant operator to better refine the classification of within-category sweet and sour spots. Second, we probe the net revenue effects of the proposed refinement to menu item classification, whilst also taking into account the substitution relationship between menu items.

## 3. A five stage menu re-engineering framework

Our proposed framework for recognizing, and accounting for within-category substitutes in menu item pricing and placement decisions is comprised of five stages (see Fig. 1).

### 3.1. Stage 1: develop a menu engineering matrix

Stage 1 encompasses a traditional menu engineering analysis whereby two metrics, popularity (menu mix percentage) and profitability (contribution margin), are used to categorize the menu items within a product category into four quadrants: Stars, Plough Horses, Puzzles, and Dogs.

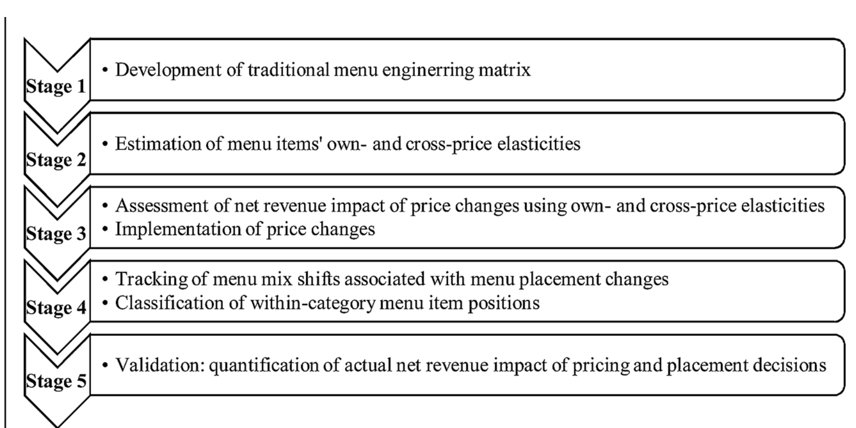



**Fig. 1.** Framework for accounting for within-category substitutes in menu pricing and placement decisions.

### 3.2. Stage 2: Estimate own-price and cross elasticities

In Stage 2, a linear demand model is used to derive estimates of menu items' own-price, and cross-price elasticities within a given product category. The linear model and its elasticities as represented as follows (Bolton, 1989):

$$\text{MenuMix}_{i,j,t} = \alpha + \beta_i \text{Price}_{i,j,t} + \sum_{k=1}^{n} \beta_k \text{Price}_{k,j,t} + \varepsilon_{t,i}$$

and

$$\eta_i = \beta_i \frac{Price_{i,j,t}{}^{*}}{MenuMix_{i,j,t}{}^{*}}$$

$$\eta_{ik} = \beta_k \frac{Price_{k,j,t}{}^{*}}{MenuMix_{i,j,t}{}^{*}}$$

where $MenuMix_{i,j,t}$ = percentage of sales generated by product $i$ within a given product category $j$ over time period $t$

$Price_{i,j,t}$ = average price of product $i$ within a given product category $j$ over time period $t$

$Price_{k,j,t}$ = average price of product $k$ within a given product category $j$ over time period $t$

$\eta_i$ = product $i$'s own price elasticity

$\eta_{ik}$ = cross-price elasticity for products $i$ and $k$

Our approach entails the classification of individual menu items as *Sensitive* or *Not Sensitive* based on their own-price elasticities. Menu items classified as *Sensitive* are those with a negative and statistically significant ($p < .05$) own-price coefficient. All other menu items are classified as *Not Sensitive* (i.e., demand for these items is relatively inelastic). So, let's say that a pork entrée has a statistically significant own-price elasticity coefficient of -0.35. This entrée would then be classified as *Sensitive*, with a 1% increase in its price estimated to yield a 0.35% decrease in demand for that entrée.

Substitutes for the *Sensitive* menu items are those items with cross-price elasticity coefficients that are positive and significantly different to zero ($p < .05$). Returning to the pork entrée example: assume that a chicken entrée is a substitute for the pork entrée with a statistically significant cross-price elasticity estimate of 0.32. This would mean that a 1% increase in the price of the pork entrée would drive an estimated 0.32% increase in demand for the chicken entrée.

Furthermore, we classify each *Sensitive* menu item as *Trading Up* or *Trading Down* based on the overall difference in marginal contribution yielded by that item and its substitutes when the price of the *Sensitive* item is increased. First, the marginal contribution for the *Sensitive* menu item is calculated as a function of its own-price elasticity estimate, menu mix share and item contribution. This is then compared to the marginal contribution from substitute items, calculated as a function of cross-price elasticity estimates, the menu mix share of substitute menu items, and their contribution. When the marginal contribution from the *Sensitive* menu item exceeds the marginal contribution from substitute menu items, the *Sensitive* item is classified as *Trading Down*. Conversely, a *Sensitive* item is classified as *Trading Up* when the marginal contribution from substitute menu items exceeds the marginal contribution from the *Sensitive* menu item.

Returning to the example of the *Sensitive* pork entrée: recall that its own-price elasticity estimate was $-0.35$, and assume that its current menu mix is 16%, and its dollar contribution $12.50. The marginal contribution associated with a 1% increase in the price of the pork entrée would then be $0.70 (i.e., $-0.35 \times 16\% \times \$12.50$). Further, recall that the chicken entrée is a substitute for the pork entrée with a cross-price elasticity estimate of 0.32. Assume that the chicken entrée holds a current menu mix of 20%, and a dollar contribution of $14.56. The marginal contribution associated with a change in demand for the chicken entrée with a 1% increase in the price of the pork entrée would be $0.93 (i.e., $0.32 \times 20\% \times \$14.56$). The net difference in marginal contribution of $-\$0.23$ (i.e., $0.70-$0.93) suggests that the *Sensitive* pork entrée is *Trading Up*. In other words, while an increase in the price of the pork entrée would negatively impact its demand, this loss would be offset by the gain from the additional demand for the chicken entrée (i.e., the overall effect of the trade is positive).

### 3.3. Stage 3: Estimate the net revenue impact of price changes and make price adjustments

The derivation of own- and cross-price elasticities, along with menu mix data, allows for the estimation of the overall net revenue impact of changing the price of *Sensitive* menu items. Returning to the *Sensitive* pork entrée and substitute chicken entrée example. Recall that the contribution on the pork entrée is $12.50, and let's assume that, with 16% of the menu mix, 200 pork entrées are sold. Also, recall that the contribution on the chicken entrée is $14.56, and assume that, with 20% of the menu mix, 250 chicken entrées are sold. Hence, at current prices and sales volume, the combined net revenue from these two entrées would be $6140 (Pork: 200 * $12.50 = $2,500; Chicken: 250 * $14.56 = $3,640). If the current selling price of the pork entrée was increased from $20 to $21, a 5% increase in price, its demand, based on the estimated own-price elasticity coefficient of 0.35, would drop by 1.75% (0.35 * 5%), reducing its contribution to the menu mix from 16% to 14.25%, and its net revenue contribution from $2,500 to $2,362.50. At the same time, based on the cross-elasticity coefficient of 0.32 for the chicken entrée, the estimated increase in demand for chicken would be 1.6%, bringing its share of the menu mix to 21.6%, and its net revenue contribution from $3640 to $3931.20. In sum, a $1 increase in the price of the pork entrée would yield a total revenue gain is $6293.70, an increase of $153.70 on the net revenue gain at current prices.

While a menu item's sensitivity, and trading relationships will enable the estimation of the revenue impact of a price change, additional qualitative metrics such as competitors' pricing, and the price gap between a given menu item and other items on the menu, should be taken into account when determining the actual magnitude of any price increase. For example, an operator may decide to increase the price of a Sensitive item in order to close the price gap between it, and a menu item that it trades up to, in order to encourage purchase of the more profitable item.

### 3.4. Stage 4: Estimate the menu mix shift associated with actual menu placement changes to determine the optimal placement of menu items

Once pricing decisions have been made with respect to Sensitive menu items, the next stage is to determine how to strategically feature those items, and their trades, on the menu. While the serial position effect dictates that the first and last positions on a menu are sweet spots, the goal in Stage 4 is to gain a more nuanced understanding of sweet and sour spots. To do so, a number of actual menu placement changes are made, and the resulting menu mix shifts are tracked. By tracking the menu mix shift for individual menu items following placement changes, both in terms of direction (i.e., increase or decrease) and magnitude, a more refined classification of sweet and sour spots can be generated to better guide placement decisions (e.g., Extra Sweet, Sweet, Sour, or Extra Sour).

### 3.5. Stage 5: process validation

The key to validating the efficacy of the proposed approach to menu item pricing and menu placement is to employ a methodology that will allow for the measurement of the impact of both pricing and menu placement decisions on performance. In order to do this, our approach entails implementing desired price changes across all subject restaurants. Restaurants are then randomly assigned to one of two conditions: Test and Control. In the Test condition, the menu placement decisions are implemented, while in the Control condition they are not. This approach enables the decision maker to parse out the net revenue effects of price changes (Control restaurants: net revenue pre-vs. post-price changes), and menu placement decisions (Net revenue: Test vs. Control restaurants).

## 4. Method

To test the proposed 5-stage approach to menu item pricing and placement, we used two years of data (June 2015 through May 2017) from a steakhouse restaurant chain with over 100 outlets across the United States. Because menu item prices and menu mix can vary across locations, we confined our analysis to 48 restaurants within the chain. These 48 restaurants share a similar profile in terms of the demographics of their customer base. Consequently, their menu items prices are the same, and the menu mix percentage held by menu items across the restaurants is largely consistent.

We focused on one product category in our analysis: entrées. The restaurant chain features seven menu items in this category. To protect the anonymity of the restaurant chain, we assigned each of the entrée items under investigation a generic name to reflect the nature of the offerings: NY Strip Steak, Surf n' Turf, Angus Beef Burger, 8oz Sirloin Steak, Lobster, Norwegian Salmon, and Soup & Salad. The most recent fifty-two weeks of data at the time of the study (i.e., June 2016 through May 2017) were used to calculate the menu mix percentage for each menu item. A full year of product mix is essential to capture each item's popularity, and remove any risk of seasonal adjustments. The restaurant chain updates menu item cost information on a monthly basis. Thus, to calculate a menu item's contribution margin, the most recently updated item cost at the time of the study was deducted from the selling price of that item at the time. The selling prices, category mix percentages, and contribution margins for all items at the time of the study are provided in Table 1.

To derive estimates of price sensitivities, we used 104 weeks of data (June 2015 through May 2017). A two-year period was used to ensure that there was at least one price change for all menu items included in the analysis. Daily data, extracted from the restaurants' point of sales system, were used in the analysis, resulting in 728 observations per restaurant (364 observations per restaurant per year, over 2 years of data). Outlier dates including major holidays, promotions such as limited-time offers, and other sales-impacting events (e.g., weather-related changes in demand) were removed from all analyses.

## 5. Data analysis

### 5.1. Stage 1: develop menu engineering matrix

The implementation of Stage 1 of the proposed approach to menu item pricing and placement yielded the menu engineering matrix provided in Fig. 2. The average contribution margin (Profitability) was $16.20 and the average mix (Popularity) was 14.28%. The NY Strip Steak and Surf n' Turf emerged as Stars, the Angus Beef Burger and Lobster entrées as Plow Horses, the 8oz Sirloin Steak and the Norwegian Salmon entrées as Puzzles, and the Soup & Salad entrée as a Dog.

**Table 1**
Menu item baseline performance data (May 2017: pre-price changes).

| Menu Item | Price | Quantity Sold | Category Mix | Contribution Margin |
|---|---|---|---|---|
| Lobster | $22.00 | 45,900 | 17% | $14.18 |
| Angus beef burger | $18.00 | 62,100 | 23% | $11.72 |
| NY strip steak | $25.00 | 40,500 | 15% | $16.69 |
| Surf n' turf | $28.00 | 56,700 | 21% | $18.77 |
| Soup & salad | $24.00 | 29,700 | 11% | $15.22 |
| 8 oz. sirloin steak | $26.00 | 21,600 | 8% | $17.31 |
| Norwegian salmon | $30.00 | 13,500 | 5% | $19.53 |

### 5.2. Stage 2: estimate own-price and cross-price elasticities

The results of the series of linear regressions employed to estimate the own-price, and cross-price elasticities for all menu items are presented in Table 2. With a negative and statistically significant ($p < .05$) own-price coefficient, the Lobster (−0.37), Surf n' Turf (−0.79), and Soup & Salad (−0.52) entrées were classified as *Sensitive* menu items. The own-price coefficients for all other entrée items were not significant ($p > .05$). Hence, they were classified as *Not Sensitive* entrée items (i.e., NY Strip Steak: +0.47; Angus Beef Burger: +0.02; 8oz Sirloin Steak: +0.19; and Norwegian Salmon: +0.04).

In terms of substitutes, three entrées emerged as substitutes for the Lobster entrée: 8oz Sirloin Steak, NY Strip Steak, and Surf n' Turf (Cross-price elasticities: 0.23, 0.12 and 0.10 respectively; $p < .05$). Substitute entrées for the Surf n' Turf entrée were the Lobster and Norwegian Salmon entrées (Cross-price elasticities: 0.43 and 0.12 respectively; $p < .05$). The Angus Beef Burger emerged as a substitute for the Soup & Salad entrée (Cross-price elasticity: 0.24; $p < .05$).

Next, the *Sensitive* entrée items were classified as *Trading Up* or *Trading Down*. The marginal contribution of the Lobster entrée was −$0.89 (−0.37 × 17% × $14.18) and the marginal contributions of its substitutes were as follows: 8oz Sirloin Steak: $0.32 (0.23*8%*$17.31); NY Strip Steak: $0.30 (0.12*15%*$16.69); and, Surf n' Turf: $0.39 (0.1*21%*$18.77). The sum of the marginal contribution from the three substitute entrées ($1.01) exceeded that of Lobster entrée (-$0.89), with a net contribution of $0.12. Thus, the Lobster was classified as *Trading Up*. The Surf n' Turf entrée was classified as *Trading Down*. Its marginal contribution was −$3.11(−0.79*21%*$18.77), with the marginal contribution of its substitutes, Lobster and Norwegian salmon, $1.04 (0.43*17%*$14.18) and $0.12 (0.12*5%*$19.53) respectively, yielding a net contribution of −$1.96. The Soup & Salad entrée was also classified as *Trading Down*, with a marginal contribution of −$0.87. The marginal contribution from its substitute, Angus Beef Burger was $0.65 (0.24*23%*$11.72), with a net marginal contribution of −$0.22. These trading relationships are summarized in Table 3, and are visually represented in Fig. 3.

### 5.3. Stage 3: estimate the net revenue impact of price changes and make price adjustments

Own-price and cross-price elasticity coefficients allow for the estimation of the net revenue impact of changes in the price of Sensitive menu items.

Focusing first on the Lobster entrée, the item's position within the traditional menu engineering matrix suggested that it was a candidate for a price increase. However, the Sensitivity rating for the Lobster entrée indicated that, while a price increase would enhance its contribution margin, it would also decrease its menu mix since the item was highly sensitive to price changes. At the same time, this entrée was estimated to trade up to three other entrée items: 8oz Sirloin Steak, NY Strip Steak, and Surf n' Turf. Thus, in order to assess the potential net revenue impact of a price change for the Lobster entrée, the effect of this change on the performance of these three substitute, trade up items had to be considered. Specifically, the data indicated that a 1% increase in the price of the Lobster entrée would result in a 0.37% decrease in demand for that entrée. Thus, if the price of the Lobster entrée was increased by $1 (i.e., a price increase of 4.5%), demand for the Lobster entrée would decrease by 1.68%, and shift demand to the three substitute entrée items: 8oz Sirloin Steak (1.05%), NY Strip Steak (0.55%), and Surf n' Turf (0.45%). Based on 52 weeks of product mix data, this would yield an estimated increase in annual net revenue of $114,805 (See Table 4).

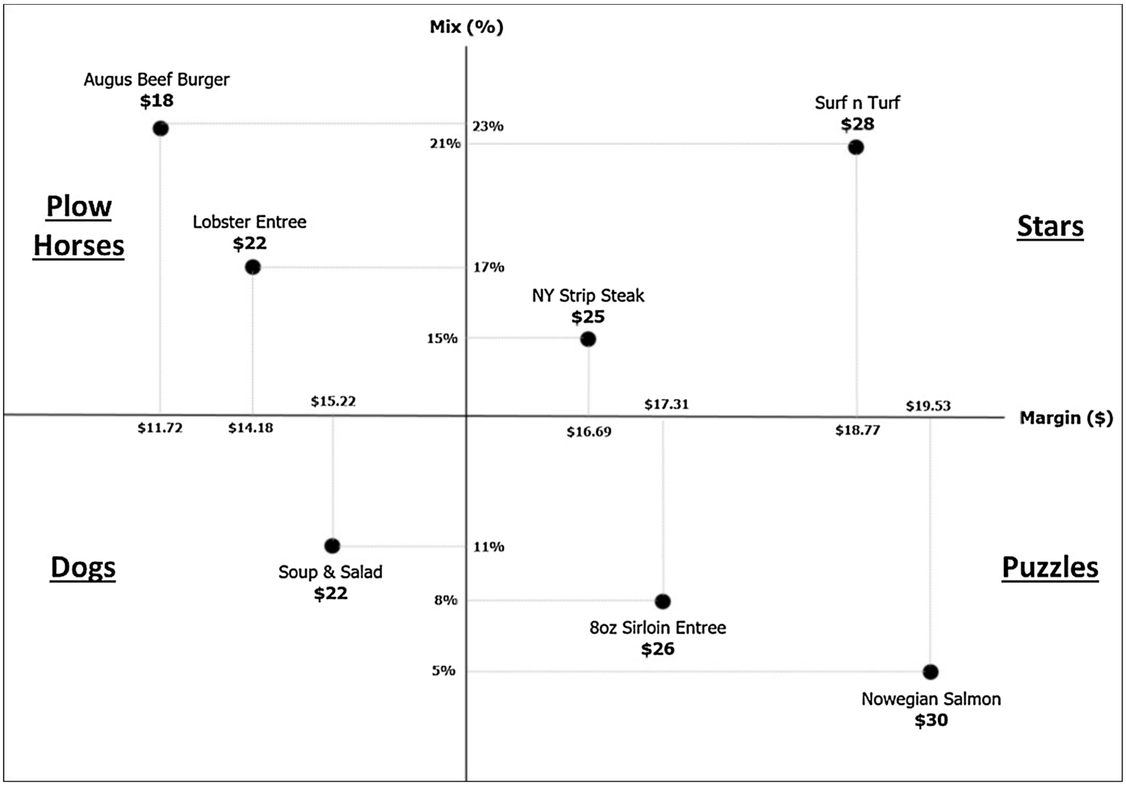



**Fig. 2.** Traditional menu engineering matrix.

**Table 2**
Own and cross price elasticities.

| Menu Item | Own Price elasticity | Cross Price Elasticity | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Lobster | Angus beef burger | NY strip steak | Surf n' turf | Soup & salad | 8 oz. sirloin steak | Norwegian salmon |
| Lobster | −0.37* | – | +0.04 | +0.12* | +0.10* | −0.12 | +0.23* | +0.00 |
| Angus beef burger | +0.02 | +0.01 | – | −0.03 | +0.02 | −0.04 | +0.05 | −0.03 |
| NY strip steak | +0.47 | −0.09 | −0.18 | – | −0.14 | −0.08 | −0.02 | +0.04 |
| Surf n' turf | −0.79* | +0.43* | +0.06 | +0.06 | – | +0.05 | +0.07 | +0.12* |
| Soup & salad | −0.52* | +0.06 | +0.24* | +0.07 | +0.04 | – | +0.06 | +0.05 |
| 8 oz. sirloin steak | +0.19 | −0.08 | +0.07 | −0.01 | +0.06 | +0.08 | – | +0.07 |
| Norwegian salmon | +0.04 | −0.06 | +0.01 | +0.01 | +0.04 | +0.02 | +0.02 | – |

* $p < .05$.

Ultimately, the decision was made to increase the price of the Lobster entrée by $2 yielding an estimated an increase in annual net revenue of $137,810 (see Table 4). This dollar amount reduced the price gap with the 8oz Sirloin Steak, a more profitable menu item than the Lobster, and its main trade. It was determined that price gap reduction could potentially accelerate the rate of trade between the two entrées, and generate even more revenue.

The position of the Surf n' Turf entrée within the menu engineering matrix would suggest that this popular and highly profitable entrée item be considered for a price increase. However, the Surf n' Turf's own-price elasticity, and significant cross-price elasticities with the Lobster and Norwegian Salmon entrées, suggested that an increase in price would result in loss of sales volume (based on own-price elasticity) and overall profitability (by virtue of cross-price elasticities). With a $1.00 increase in the Surf n' Turf selling price (i.e., 4%), the profit per Surf n' Turf entrée sold would increase but, due to the inter-dependencies with the Lobster and Norwegian Salmon entrées, the price increase would have a negative impact on the product category's net sales – a decrease of $12,510 (See Table 5). Thus, a decision was made to hold the current price of the Surf n' Turf.

The Soup & Salad entrée is located in the least desirable area of the menu engineering matrix (i.e., Dog). The prescription for this least

**Table 3**
Sensitive menu item trading relationships.

| Menu Item | Marginal contribution with 1% increase in *Sensitive* entrée price | | | | | | | Net | Trade |
|---|---|---|---|---|---|---|---|---|---|
| | Lobster | Angus beef burger | NY strip steak | Surf n' turf | Soup & salad | 8 oz. sirloin steak | Norwegian salmon | | |
| Lobster | −$0.89 | – | $0.30 | $0.39 | – | $0.32 | – | $0.12 | Up |
| Surf n' turf | $1.04 | – | – | −$3.11 | – | – | $0.12 | −$1.96 | Down |
| Soup & salad | – | $0.65 | – | – | −$0.87 | – | – | −$0.22 | Down |

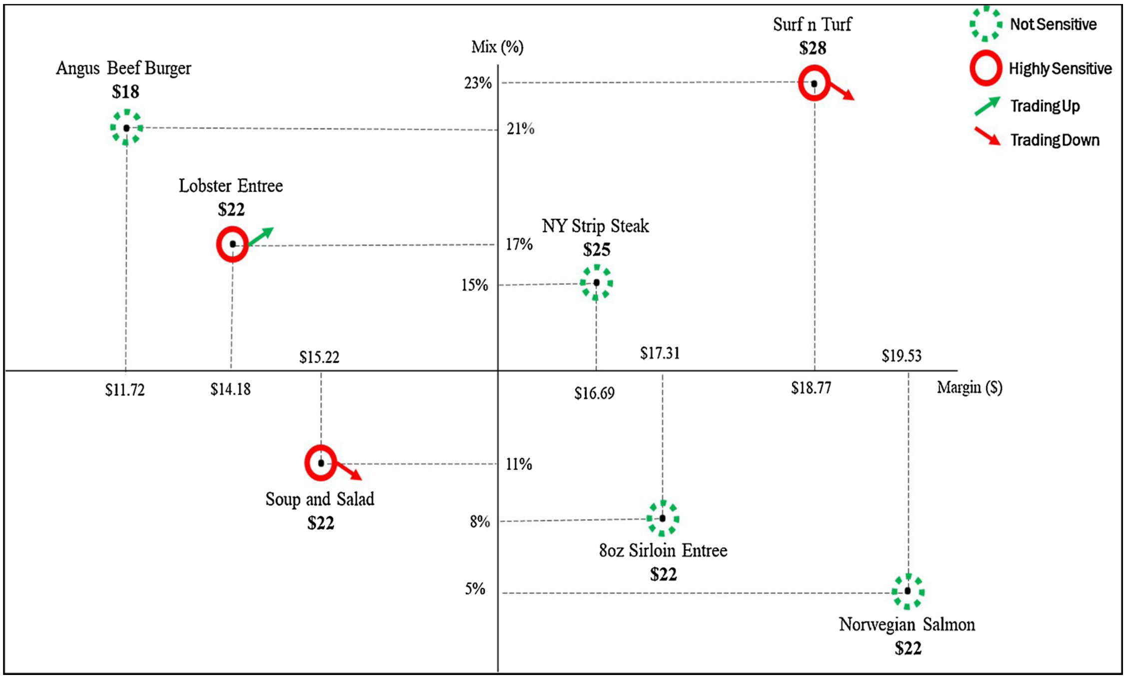



**Fig. 3.** Sensitivity ratings and trading relationships layered on top of the traditional menu engineering matrix.

popular, least profitable menu item would be to remove it from the menu or increase its price to better its profitability. This menu item is a staple for the *Lunchers* segment for the restaurant chain under examination in this study, thus removal from the menu was not an option. Leveraging own-price and cross-price elasticity data, the net sales impact of a price increase for the Soup & Salad entrée was estimated. Considering the Soup & Salad's own-price elasticity and significant cross-price elasticity with the Angus Beef Burger, a $1 increase in the price of the Soup & Salad would yield negative impact on the product category's net sales – a decrease of $24,909 (See Table 6). Thus, a decision was made to hold the current price of the Soup & Salad.

### *5.4. Stage 4: estimate the menu mix shift associated with actual menu placement changes to determine the optimal placement of menu items*

Once we had determined the selling price for menu items based on their sensitivity ratings and trading relationships, we focused on menu placement.

From June 2016 through November 2016, Menu A was used across all 48 restaurants in the study (See Appendix A: Menu A). The Angus Beef Burger was featured in a photograph at the top of the menu, was listed first on the menu, and held the greatest proportion of the menu mix (23%). The Norwegian Salmon and Lobster entrées held the second and third spots on the menu respectively, followed by the NY Strip Steak, Surf n' Turf, 8ox Sirloin Steak, and finally the Soup & Salad. For the second half of the year (November 2016 through May 2017), we implemented menu placement changes, replacing Menu A with Menu B across all 48 restaurants (See Appendix A: Menu B). We shifted the Lobster entrée to the first spot on the menu, and featured it in the photograph at the top of the menu. We shifted the Angus Beef Burger to the second to last spot on the menu, the 8oz Sirloin Steak to the second spot, and the Norwegian Salmon to the third spot.

The change in the menu mix held by individual menu items following the transition from Menu A to Menu B was calculated using 26 weeks of data (13 weeks pre- and post-transition). An analysis of the direction and magnitude of the menu mix shift associated with

**Table 4**
Net Revenue pre-and post-increases in Lobster entrée price.

| Time period | Menu Item | Price | Contribution Margin | Mix | Quantity | Net Revenue |
|---|---|---|---|---|---|---|
| **Pre-price change** | Lobster | $22.00 | $14.18 | 17% | 45,900 | $650,862 |
| | 8oz sirloin steak | $26.00 | $17.31 | 8% | 21,600 | $373,896 |
| | NY strip steak | $25.00 | $16.69 | 15% | 40,500 | $675,945 |
| | Surf n' Turf | $28.00 | $18.77 | 21% | 56,700 | $1,064,259 |
| | | | | | | **$2,764,962** |
| **Post-price change ($1 increase)** | Lobster | $23.00 | $16.18 | 15.32% | 41,359 | $669,190 |
| | 8oz sirloin steak | $26.00 | $17.31 | 9.05% | 24,423 | $422,757 |
| | NY strip steak | $25.00 | $16.69 | 15.55% | 41,973 | $700,525 |
| | Surf n' Turf | $28.00 | $18.77 | 21.45% | 57,927 | $1,087,295 |
| | | | | | | **$2,879,767** |
| | | | | | ***Difference*** | ***$114,805*** |
| **Post-price change ($2 increase)** | Lobster | $24.00 | $16.18 | 13.64% | 36,818 | $595,718 |
| | 8oz sirloin steak | $26.00 | $17.31 | 10.09% | 27,245 | $471,619 |
| | NY strip steak | $25.00 | $16.69 | 16.09% | 43,445 | $725,105 |
| | Surf n' Turf | $28.00 | $18.77 | 21.91% | 59,154 | $1,110,331 |
| | | | | | | **$2,902,772** |
| | | | | | ***Difference*** | ***$137,810*** |

**Table 5**
Net Revenue pre-and post-$1 increase in Surf n' Turf entrée price.

| Time period | Menu Item | Price | Contribution Margin | Mix | Quantity | Net Sales |
|---|---|---|---|---|---|---|
| **Pre-price change** | Surf n' Turf | $28.00 | $18.77 | 21% | 56,700 | $1,064,259 |
| | Lobster | $22.00 | $14.18 | 17% | 45,900 | $650,862 |
| | Norwegian salmon | $30.00 | $19.53 | 5% | 13,500 | $263,655 |
| | | | | | | **$1,978,776** |
| **Post-price change** | Surf n' Turf | $29.00 | $19.77 | 18.18% | 49,082 | $970,354 |
| | Lobster | $22.00 | $14.18 | 18.54% | 50,046 | $709,658 |
| | Norwegian salmon | $30.00 | $19.53 | 5.43% | 14,657 | $286,254 |
| | | | | | | **$1,966,266** |
| | | | | | ***Difference*** | ***-$12,510*** |

**Table 6**
Net Revenue pre-and post-$1 increase in Soup & Salad entrée price.

| Time period | Menu Item | Price | Contribution Margin | Mix | Quantity | Net Revenues |
|---|---|---|---|---|---|---|
| **Pre-price change** | Soup & salad | $22.00 | $15.22 | 11% | 29,700 | $452,034 |
| | Angus beef burger | $18.00 | $11.72 | 23% | 62,100 | $727,812 |
| | | | | | | **$1,179,846** |
| **Post-price change** | Soup & salad | $23.00 | $16.22 | 8.64% | 23,318 | $378,221 |
| | Angus beef burger | $18.00 | $11.72 | 24.55% | 66,273 | $776,716 |
| | | | | | | **$1,154,937** |
| | | | | | ***Difference*** | ***-$24,909*** |

changing menu item positions on the menu from a given position on Menu A to another position on Menu B (e.g., moving the Lobster from the third position on Menu A to the first position on Menu B) enabled us to classify the various menu positions as Extra Sour, Sour, Sweet, and Extra Sweet spots (see Appendix B). The top position on the menu was classified as an Extra Sweet spot since the estimated gain in menu mix with movement to this positon was greater than with movement to any other position on the menu. Moving a menu item from a Sweet spot to the Extra Sweet spot yielded an estimated 1.23% gain in terms of menu mix, while the menu mix gain associated with a movement from a Sour Spot, and an Extra Sour Spot, to an Extra Sweet spot was estimated at 2.81% and 3.57% respectively (i.e., these estimates represent the average gains in category mix achieved by virtue of shifting the location of menu items on Menu A to different locations on Menu B). The second, sixth and seventh positions on the menu were classified as Sweet spots. Moving a menu item to these positions was also estimated to yield a gain in terms of menu mix, but the magnitude of the increase was not as large as for the Extra Sweet Spot: a 1.58% gain in menu mix moving from a Sour Spot, and a 2.34% gain in mix moving from an Extra Sour Spot. The third and fifth positions on the menu were classified as Sour spots, with the fourth position on the menu classified as an Extra Sour spot. Movement from an Extra Sour to a Sour spot was estimated to yield a 0.76% increase in mix. See Table 7 for all estimates, positive and negative, associated with changing menu position depending on the position a menu item moved from, or to, on the menu. Drawing on this classification of positions within the menu, Menu C was developed (See Appendix A, Menu C).

To increase the positive trading behavior between the Lobster entrée and the 8oz Sirloin Steak, the main trade for the Lobster, and a more profitable menu item, the Lobster entrée's visibility was reduced. It was moved from the Extra Sweet spot on the menu (i.e., the first position) to a Sweet spot (i.e., the second position), while the 8oz Sirloin Steak's visibility was increased by placing it in the Extra Sweet spot, and featuring it in the photograph at the top of the menu. Because the Surf n' Turf traded down to the Lobster entrée, the goal was to ensure that the visibility of the more profitable Surf n' Turf was higher than that of the Lobster entrée. While both the second and sixth positions on the menu were determined to be sweet spots, the sixth spot was slightly more attractive in terms of its impact on purchase behavior, thus the Surf n' Turf was placed in the more visible sixth position. In a similar manner, the goal was to position the Angus Beef Burger such that any downward trading behavior from the Soup & Salad entrée to the Angus Beef Burger would be minimized. Hence, we moved the Angus Beef Burger from a Sweet spot on the menu (i.e., the sixth position) to a Sour spot (i.e., the fifth position). This move served to both reduce its visibility, and visually increase the physical distance between it and the Soup & Salad. Arguably, the trades between the two items could also be limited by increasing the Soup & Salad entrée visibility (e.g., by adding a call-out or picture, or by boxing the item name). However, this could potentially increase trade downs from other, more profitable items. Thus, the Soup & Salad entrée maintained its menu positioning, without any further highlighting. Listing a menu item separately, and/ or in a different listing style (e.g., italicized), as the Soup & Salad is on each of the menus in this study, can serve to highlight a menu item and increase its desirability. In this instance, however, the positioning of the Soup & Salad entrée relates specifically to its non-protein content. It is the only non-protein entrée on the restaurant chain's menu - likely explaining why it is not very popular even though it is in a Sweet spot - so management wanted to keep its listing separate, and of a different style, to all of the other menu items within the entrée category.

**Table 7**
Estimated mix shifts (+/-) from moving items from more desirable to less desirable spots (Note: estimates derived from moving menu item positions on Menu A to different positions on Menu B).

| | Extra Sweet | Sweet | Sour | Extra Sour |
|---|---|---|---|---|
| **Extra Sweet** | – | −1.23% | −2.81% | −3.57% |
| **Sweet** | +1.23% | – | −1.58% | −2.34% |
| **Sour** | +2.81% | +1.58% | – | −0.76% |
| **Extra Sour** | +3.57% | +2.34% | +0.76% | – |

### 5.5. Stage 5: validation

Validation of the menu item pricing and menu placement decisions made in relation to the entrée items for the 48 restaurants in this study comprised of a number of phases.

#### 5.5.1. Phase one

In June 2017, we implemented the $2 price increase for the Lobster entrée across all 48 restaurant in the study. Based on the previous 52 weeks of quantity sold data for, and menu mix held by, the Lobster entrée, this represented an overall increase of 2% in the average entrée price. We then selected 12 restaurants as Test restaurants, and implemented Menu C in those restaurants. The remainder of the restaurants were classified as Control restaurants, where no changes were made to the menu (i.e., Menu B remained in place, with the only changes being the increase in the Lobster Entree price). Note that all of the restaurants selected for inclusion in this study shared a similar profile in terms of the demographics of their customer base, menu prices and menu mix. Thus, the Test restaurants, located in key locations across the U.S., were determined to provide a good representation of the characteristics of the restaurants in the sample, while also meeting the restaurant chain's executive management requirement that the number of Test restaurants not exceed 15 in order to minimize any potential risks associated with implementing Menu C.

#### 5.5.2. Phase two

In Phase 2 of validation, we focused on the sales decomposition for the Control restaurants in order to examine the performance effects of the 2% increase in average entrée price. Table 8 indicates the percentage difference in key performance metrics for the Control restaurants pre- and post-price changes (13 weeks pre- versus post-price change). These restaurants experienced an average increase of 1.8% in net sales revenue ($463,896 for the 13 weeks pre-menu change vs. $472,246 for the 13 weeks post-menu change). Given an average unit volume (AUV) of $1.6 m per year for the 48 restaurants in this study, this represented an average incremental yearly net sales revenue gain of $28,800 per Control restaurant. This revenue lift was primarily a function of an increase in average check (1.7%), with little change in traffic (i.e., customer volume), menu mix, or units per transaction (UPT): 0.1%, −0.1% and −.02% respectively.

#### 5.5.3. Phase three

In this phase of validation, we examined the performance effects of the menu placement changes associated with Menu C by comparing key performance metrics across the Test and Control restaurants (13 weeks pre-versus post-price and menu placement changes). As indicated in Table 8, the implementation of Menu C, in addition to the price change at the Test restaurants resulted in an average increase in net sales revenue of 3.4%. This represents an incremental gain of 1.6% over the pre- versus post-price change increase in net sales revenue of 1.8% for the Control restaurants. With an AUV of $1.6 m, this 1.6% represents an average incremental net sales revenue gain of $25,600 per restaurant per year over and above the average net sales revenue increase achieved via the price increase alone for the Control restaurants. Further, this incremental net sales revenue gain was a function of an increase in average check of 1.3% over the control restaurants (Test restaurants: 3% vs. Control restaurants: 1.7%), with minimal impact on traffic of 0.3% (Test restaurants: 0.4% vs. Control restaurants: 0.1%). As evidenced by the incremental menu mix shift of 0.8% (Test restaurants: 0.7% vs. Control restaurants: −0.1%), the increase in average check was largely a function of a shift in customer demand towards more profitable entrée items. Additionally, the UPTs increased slightly (0.5%) over those in the Control restaurants (Test restaurants: 0.3% vs. Control restaurants: −0.2%).

#### 5.5.4. Phase four

In the final phase of validation, we examined year-over-year (YOY) changes in key performance metrics. When evaluating the performance effects of any price or menu placement changes, seasonality effects need to be taken into account. How much of a change in net sales revenue, traffic, and average check is due to normal business seasonality, and how much can be attributed to price and menu placement changes? Thus, in order to remove any potential seasonality impact on traffic, we also examined YOY (2017 vs. 2016) percentage changes in topline performance metrics for the Control and Test restaurants. Fig. 4 visually illustrates this analysis using data for the Test restaurants. Weeks 1–13 represent the 13 weeks pre-price and menu placement changes, and weeks 14–26 represent the 13 weeks post-price and menu placement changes. The YOY percentage change for each of the top-line performance metrics (i.e., sales, traffic, and average check) was calculated on a weekly basis. As indicated on the right-hand side of Fig. 4 i.e., weeks 14 through 26), all performance metrics for the Test restaurants improved in 2017, post the price and menu placement changes, versus the same period in 2016.

The overall results of the YOY analysis are summarized in Table 9. First, for the Test restaurants, the price increase and menu placement changes yielded a net gain in sales revenue of 1.5% YOY (i.e., 2017 post- versus pre-price and menu placement changes increase in net sales revenue of 3.4% vs. 2016 post- versus pre-increase of 1.9%), driven by a 1.3% increase YOY in average check, and little change in customer volume YOY (0.2%). For the Control restaurants, the price increase yielded a net gain in sales revenue of 0.4% YOY (i.e., 2017 post- versus pre-price change increase in net sales revenue of 1.8% vs. 2016 post- versus pre-increase of 1.4%). This increase in net sales revenue was driven by a 0.4% increase YOY in average check, and no change in customer volume YOY (0%).

In sum, taking seasonality effects into account, the general pattern in pre- vs. post-performance metrics reported in Sections 5.5.2 and 5.5.3 for 2017 held YOY, with the YOY results underscoring the incremental net sales impact of menu placement, over and above price changes alone.

## 6. Discussion

Menu engineering constitutes a popular approach to assessing menu item performance, and is used by restaurant operators to support menu item prioritization, pricing, and resource allocation decisions. While a number of researchers have proposed modified menu engineering models that go beyond menu item popularity and profitability to incorporate other factors such as labor cost and time (e.g., Horton, 2001, Taylor et al., 2009), the traditional menu engineering matrix remains a dominant tool for menu analysis in the field. A criticism of the traditional menu engineering model is that it does not consider the potential for interdependence among menu items (Cohen et al., 2007). In their research, Cohen et al. (2007) addressed one type of menu item interdependency, loss leader pricing. In this study, our focus was on another type of interdependency, substitutes within a given menu category, and we explored the potential impact of such interdependency on menu item pricing and placement decisions.

This research contributes to the literature in several ways. First, to our knowledge, it is the first study to apply an economics-based approach to assessing product substitutes in a within-category, restaurant

**Table 8**
Change in performance metrics pre- versus post-price and menu placement changes.

| | Price | Net Sales Revenue | Traffic | Average Check | Mix Shift | Units per transaction |
|---|---|---|---|---|---|---|
| Control Restaurants | +2.0% | +1.8% | +0.1% | +1.7% | −0.1% | −0.2% |
| Test Restaurants | +2.0% | +3.4% | +0.4% | +3.0% | +0.7% | +0.3% |
| *Difference* | *0%* | 1.6% | 0.3% | 1.3% | 0.8% | 0.5% |

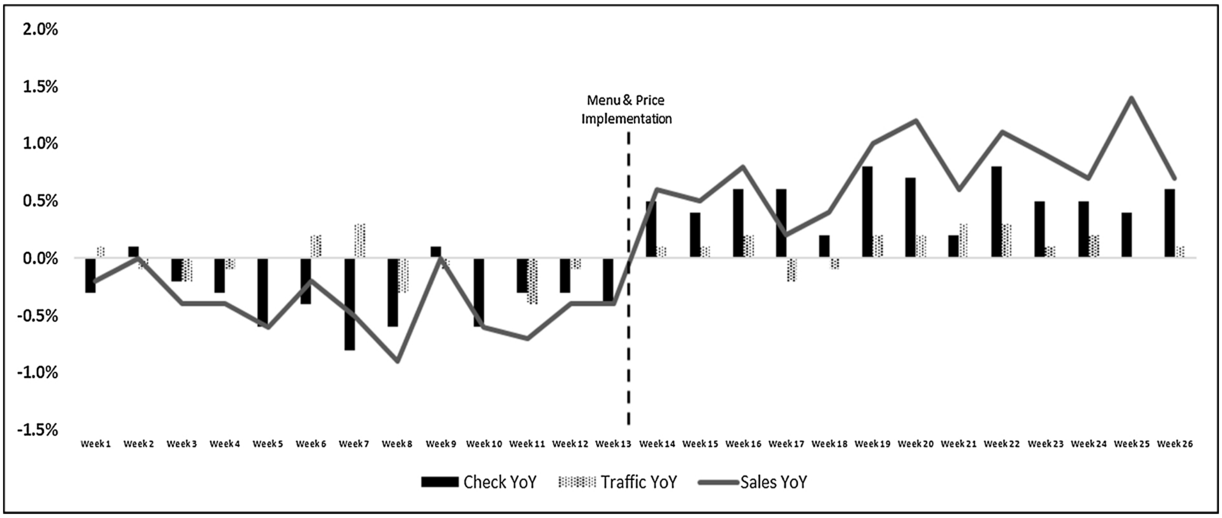



**Fig. 4.** YOY % change (2017 vs. 2016) in topline performance metrics for Test restaurants (13 weeks pre- versus 13 weeks post-price and menu placement changes).

**Table 9**
YOY % change (2017 vs. 2016) in topline performance metrics for Test and Control restaurants.

| | Price | Net Sales Revenue | Traffic | Average Check |
|---|---|---|---|---|
| Control Restaurants | +2.0% | +0.4% | +0.0% | +0.4% |
| Test Restaurants | +2.0% | +1.5% | +0.2% | +1.3% |
| *Difference* | *0%* | 1.1% | 0.2% | 0.9% |

menu context. Prior work in the domain of substitutes has primarily been conducted in a retail setting, with a number of approaches proposed to measure substitutability including behavioral techniques (e.g., Urban et al., 1984) and the use of online consumer-generated data (e.g., McAuley et al., 2015). Here, we leveraged an economics-based approach to demonstrate that the demand for menu items within a given menu category can be relatively elastic, or inelastic, and advance the classification of menu items as *Sensitive* or *Not Sensitive* based on their own-price elasticities. Leveraging estimates of menu items' cross-price elasticities, we further proposed the classification of *Sensitive* menu items as *Trading Up* or *Trading Down*, and we demonstrated how to estimate the net revenue impact of changes to *Sensitive* menu item prices as a function of their trading relationships.

Second, using data from 48 outlets within a U.S. steakhouse restaurant chain, we extended the work of Cohen et al. (2007) in the domain of menu item interdependency by demonstrating that an understanding of *Sensitive* menu items' own-price elasticities, and their trading relationships may yield decisions that are not always in line with what the traditional menu engineering matrix prescribes. For example, in our study, the position of the Surf n' Turf entrée within the menu engineering matrix would suggest that it was a good candidate for a price increase. However, because this was a *Sensitive* menu item, and was *Trading Down*, our results indicated that a price increase for the Surf n' Turf entrée would have had a negative impact on the entrée category's net revenue. Equally, the prescription for Dogs from a traditional menu engineering perspective would be to eliminate them from the menu, or increase price to boost profitability. However, based on consideration of its own price-elasticity and trading relationship, the decision in relation to the Soup & Salad entrée - a Dog within the traditional menu engineering matrix - was to hold its price. Even where the findings of our analysis were in step with prescribed menu engineering strategies (i.e., increasing the price of the Lobster entrée), consideration of the trading relationships of the Lobster entrée with its three substitutes provided insights into the true net revenue impact of a price change for the Lobster entrée on the performance of the entire entrée category, and guided menu placement decisions for the Lobster entrée, and its substitutes.

Third, while best practice, based largely on the serial effect (Pavesic, 2011), dictates that menu items targeted for promotion should be placed in a sweet spot at either the start or the end of a menu, we propose that an experimentation approach to menu placement, wherein menu mix changes are monitored post-menu placement changes, can yield a more refined understanding of a menu's sweet and sour spots. Furthermore, prior research has examined various aspects of menu placement on sales performance (e.g., Bowen and Morris, 1995; Kincaid and Corson, 2003). However, it provides little insight into the revenue effects of within-category menu placement decisions. This study extends the literature on menu placement by providing empirical support for a positive effect of within-category menu placement on net revenue performance. Specifically, we demonstrated, using control and test restaurant groups that the *right* menu placement decisions can yield net revenue increases over and above those yielded by price increases.

This research has a number of implications for restaurant operators. First, this research suggests that operators need to consider the potential net revenue impact of within-category menu item substitutes when making menu pricing decisions. Failure to consider the cross-price elasticity of menu items may distort the net revenue projections associated with price increases, and lead to suboptimal pricing decisions. Large national, and multi-national, restaurant chains may likely have an in-house analytics team that has the expertise required to perform the relatively complex calculation of own- and cross-price elasticities. However, how should smaller chains, or the independent restaurant owner, proceed if in-house analytical expertise is lacking? One option would be to engage the services of a hospitality consulting company that specializes in this type of work. In this instance, the operator should work with the consultants to determine an expected return on investment prior to embarking on the project. Another option would be to invest in professional development whereby one or several employees from the restaurant company would take a continuing education short-course to gain the requisite skills needed implement the framework that we propose. These employees could then champion the methodology internally, and potentially train other team members to implement the framework. A third option would be to take a more experimental approach to gaining insights into product sensitivities and trading relationships. Specifically, rather than engaging in the calculation of own- and cross-price elasticities, management could use proxy data for Sensitivities and Trading Relationships. For instance, management could implement a menu item price increase, and get at that item's sensitivity by looking at its loss/gain in mix following the price increase. Trading relationships could then be extracted by examining the shifts in demand across menu items post the price increase. The notion of approaching menu engineering in this manner, whereby menu item sensitivities and trading relationships are held explicitly in mind, is arguably a great step ahead for many restaurant owners. However, this experimental approach engenders some risk. By its very nature, it entails the implementation of price changes in the absence of the statistical evidence of potential outcomes that our proposed methodology provides.

Second, when making within-category menu placement decisions to support the promotion of highly profitable, high volume menu items, restaurant operators should move beyond prescribed industry best practice. Rather than apply broad stroke rules to determine menu placement, our findings suggest that operators should experiment with menu placement changes, and track resulting changes in menu mix, to fine tune their understanding of their specific menu's best and worst within-category positions.

The 5-stage approach to menu pricing, and related menu placement decisions that we advance in this paper provides restaurant operators a structure within which to begin to move beyond traditional menu engineering to drive more data-rich menu-related decisions.

## 7. Limitations and directions for future research

There are a number of limitations to this study. First, our research comprised of a field experiment, which enabled us to fully implement our proposed 5-stage approach to menu pricing and placement decisions, and quantify the actual performance effects of those decisions. However, a criticism of field experiments is that the experimenter cannot control variables to the extent that they can be controlled in a laboratory setting. That said, to minimize the potential impact of extraneous variables on the performance metrics of interest in this study, we focused on restaurant outlets within one restaurant chain. This approach allowed for consistency in terms of operating procedures across the restaurant outlets in the study, thereby minimizing the potential effects that differences in operating procedures across outlets might have on performance metrics. The restaurant outlets that we selected were also consistent in terms of demographic profiles, menu item prices, and menu mix.

The use of a field experiment did not permit a comparison of the net revenue effects of our proposed approach to menu item pricing and placement, and those yielded by the traditional menu engineering approach, nor was it intended to. Rather, the goal was to illustrate how consideration of within-category substitutes can lead to decisions that do not always fit with those prescribed by the traditional menu engineering model, and to empirically investigate the positive net revenue effects of such decisions. Future research in a laboratory setting could be conducted to probe the differential net revenue effects of the two approaches, without risk to a restaurant's actual net revenue performance.

Second, the focus of our work was within-category menu item substitutes. Future research should address the effects of cross-category complements and substitutes on menu pricing and placement decisions. For example, might price increases within one menu category drive the sales volume of complementary and substitute items in other menu categories, and if so, what does that mean for pricing and placement decisions? On a related note, in this study, we tracked and reported UPT for entrées as UPT constitutes a key element of a sales decomposition. However, since our focus was within-category menu pricing and placement, we tracked and reported UPT for entrées only. Further research is warranted to evaluate UPT for all menu categories in the context of a broader menu-wide complement/substitute study.

Finally, menu placement constitutes only one element of restaurant menu design. A number of other aspects of menu design have received attention in the literature, from text descriptors, font, and photographs, to price positioning and presentation (e.g., Lockyer, 2006; Yang et al., 2009; Yang, 2012). While this research included the use of a photograph at the top of a menu list, to the extent that it was an integral part of the menu at the restaurant chain under investigation, future research should explicitly consider how photography, and other elements of menu design can be manipulated, in addition to menu placement, to exploit the trading relationships between within-category menu items.

## Appendix A. Entrée menus

**Menu A**

**June 2016 – November 2016**

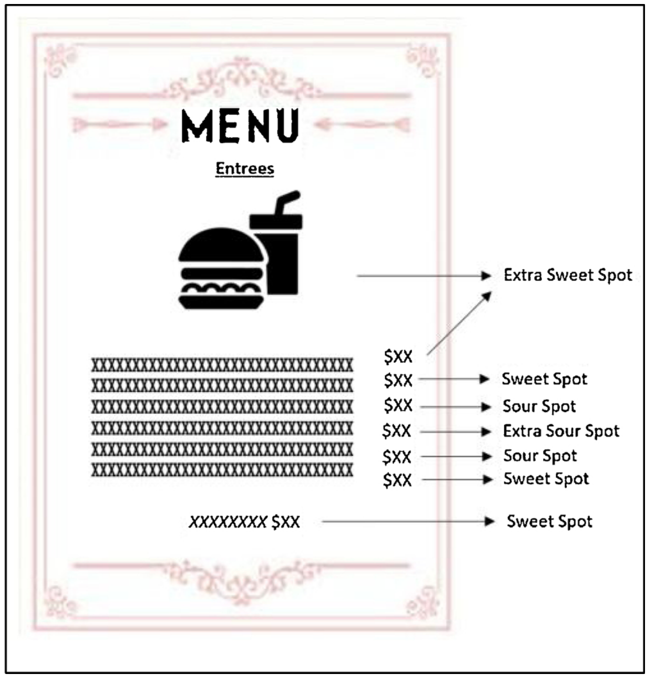

**Menu B**

**December 2016 – May 2017**


**Menu C**

**May 2017 onwards**

## Appendix B. Extra sweet to extra sour spots on menu

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