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Evaluation of the Arkansas Double Up Food Bucks Program

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Abstract

Fruit and vegetable consumption is particularly low in Arkansas with only a small percentage of residents meeting daily recommendations. Arkansas also has one of the highest percentages of food insecurity and obesity in the United States. Low-income households, such as Supplemental Nutrition Assistance Program (SNAP) recipients, are at a higher risk of these issues. Financial assistance programs have been implemented to help in aiding these problems. The Double Up Food Bucks program (DUFB) is one of these programs. DUFB provides matching financial vouchers for SNAP benefits recipients spend on fresh local produce at participating grocery stores and farmers' markets. The goal of this program is to help SNAP recipients increase fruit and vegetable consumption. Previous studies have examined DUFB and similar programs; however, few have studied how these programs affect the participating locations. One objective of this study is to analyze the effect DUFB has on produce sales at grocery stores. Objective two is to conduct a simulation of the overall revenue produced by DUFB at farmers' markets. Store-level sales data was collected at three comparable sized stores with one serving as the treated and the others as controls in February 2016 and 2017. A difference-in-difference (DID) model was utilized to evaluate the effect of DUFB on sales after treatment for selected produce. For objective two, a demand shock caused by DUFB was simulated on various supply systems. DUFB was found to increases sales and quantity at the treated store as well as generate positive revenue in each system. DUFB increased sales for almost each tested produce. DUFB generated on average about $1.66 in revenue for each dollar of funding. Our evaluation indicates that DUFB was successful and can continue to be successful. Additional funding could see increased revenue for participating locations. Policy

decisions related to DUFB can be informed with these results. These results may also aid in decisions like DUFB.

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Introduction

American dietary guidelines recommend that citizens should consume about two cups of fruits and vegetables (F&V) daily (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). Despite this, only a small percentage of adults follow the recommendations. In 2015, only 12.2% of adults met fruit recommendations (Lee-Kwan, 2017). This percentage was smaller for vegetables with only 9.3% of American adults meeting the guidelines (Lee-Kwan, 2017). Increasing F&Vs intake can help reduce the risk of chronic diseases such as obesity (He et al., 2004; Institute of Medicine, 2011) and cardiovascular diseases (Hung et al., 2004; Institute of Medicine, 2011). Studies have also reported an inverse relationship between F&V consumption and depression with an increase reducing prevalence of depression symptoms (Gangwisch et al., 2015; Mihrshahi et al., 2015; Sánchez-Villegas et al., 2009). To address this issue, governmental nutritional assistance programs have been implemented.

The Supplemental Nutrition Assistance Program (SNAP) is the largest nutritional assistance program in the US. SNAP aims to reduce hunger for recipients by providing them benefits to expand their purchasing power (U.S. Department of Agriculture or USDA, 2012). SNAP participation has been shown to have positive benefts. These benefits include an increase in consumption of whole fruit (Gregory et al., 2013) and reduced food insecurity and insufficiency (Ratcliffe et al., 2011). However, the findings on weight status are inconclusive. Some find SNAP to be linked to a lower BMI, and a decrease in the risk of obesity (Almada and Tchernis, 2018; Nguyen et al., 2015). Others, however, show that SNAP recipients have a higher risk of obesity compared to eligble non-participants (Cole et al., 2008: Leung et al., 2013; Shenkin & Jacobson, 2010). SNAP recipients are allowed to purchase unhealthy items such as candy and sugar-sweetened beverages (USDA, 2013). Therefore, they have been shown to consume more unhealthy items and less F&V then their non-participating counterparts (Garasky et al., 2016; Leung et al., 2012; Shenkin & Jacobson, 2010).

Price is a main reason for low purchase of F&V among SNAP paricipants and other low-income individuals (Mushi-Brunt et al., 2007; Drewnowski, 2010). It is possible that SNAP recipients choose to purchase low-cost, energy-dense food with their benefits. Grains and sugars have been found to be less expensive per calorie compared to F&V (Drewnowski, 2010). Diets high in F&V consumption are shown to have higher costs (Rehm et al., 2011). This may be an indication that lowering price on F&Vs may lead to an uptick in purchases. Dong and Lin (2009) confirmed this by showing a 10% decrease in price would increase fruit purchases by 5.2% and the purchase of vegetables by 6.9%. A review by Andreyeva et al., (2010) reported fruit and vegetable purchases would rise 7% and 6%, respectively, if their prices shrunk by 10%. To combat this issue of high price, programs have been created to give financial incentives to purchase F&V. These programs have been shown to be succesful (Andreyeva & Luedicke, 2015; Bowling et al., 2016; Phipps et al., 2013; Olsho et al., 2016). Among which is the Double Up Food Bucks.

Double Up Food Bucks (DUFB) is an incentive program that aims to increase F&V consumption by matching the amount of SNAP benefits spent on fresh, local produce (Fair Food Network). SNAP participants receive a voucher with the matching amount to purchase more fresh produce to maximum of $ 20 per day. The program first started back in 2009 in Detroit farmers' markets (FMs) (Fair Food Network). Since then, it has continued to grow. (Fair Food Network). The Arkansas DUFB started in 2016. It was implemented in 19 FMs and four grocery stores across the state (Arkansas Coalition for Obesity Prevention). As of 2019, 31 locations participate in the program-23 FMs and 8 grocery stores- most located in the central and northwest areas of the state (Arkansas Coalition for Obesity Prevention).

Arkansas F&V consumption is lower compared to the national average. Only 9.5% and 7.8% of Arkansas adults meet daily F&V recommendations, respectively (Center for Disease Control or CDC, 2018). Furthermore, Arkansas has a high rate of food insecurity (Feeding America, 2019) and obesity (Arkansas Coalition for Obesity Prevention). Few studies have investigated the program impact of DUFB in Michigan and Utah (Cohen et al., 2017; Cohen et al., 2018; Durward et al., 2018; Savoie-Roskos et al., 2016; Steele-Adjognon and Weatherspoon, 2017). They have shown program success. Between 2012 and 2013, 11,983 Detroit citizens particiapted the program at FMs with a total of $318,222 of DUFB funded (Cohen et al., 2018). DUFB has been shown to increase daily F&V consumption (Cohen et al., 2018) and related monthly spending (Steele-Adjognon and Weatherspoon, 2017). Particpants have reported increased food securirty with the program (Durward et al., 2018; Savkoie-Roskos et al., 2016). However, these studies do not test how DUFB affects sales at participating locations. Therefore, it is important to know the impact on local participating stores and farmers' markets.

We have two objectives. The first is to investigate the program's effects on total produce sales at participating grocery stores. We use weekly store-level sales data collected in February 2016 and 2017 at a DUFB-implemented store and two comparable stores that served as controls. A difference-in-difference (DID) model was conducted to analyze the differences in the before and after outcomes of store sales after the DUFB. Data is then adjusted to price-per-unit to determine if there were strategic price hikes. The second objective is to evaluate the impact DUFB on the local food systems in Arkansas. We do this by simulating the demand and supply side reaction, given a demand shock caused by DUFB. Total revenue of FMs in Arkansas was estimated and separated low-income and high-income segments.

We find that DUFB had a positive impact in both sales and the local food system There is an increase at the supermarkets in terms of sales and quality. We also conclude that $1 in DUFB was able to generate as high as $2.23 when the supply was perfectly inelastic. To our knowledge, this is the first study to evaluate DUFB in Arkansas. Our findings may inform policymakers in decision-making related to the program and other similar assistance programs.

Data and Methods

Data

To analyze the effect of the program on produce sales at grocery stores, data was collected during February 2016 and February 2017 at stores where DUFB was implemented. February 2016 was the control period and lasted four-weeks. February 2017 was the treatment period and lasted the same amount of time. Three stores were chosen from the same regional chain with one serving as the treated store and the others as controls. Store-level sales data was collected regarding total produce sales and total quantity sold. The same data was also recorded for selected produce. The selected produce items included tomatoes, peaches, cantaloupes, cucumbers, green bell peppers, zucchinis, cabbages, cauliflower, roma tomatoes, sweet potatoes, turnip greens, jalapeño peppers, yellow squash, red potatoes, and russet potatoes. Tomato, peaches, zucchinis, cabbage, roma tomatoes, sweet potatoes, jalapeño peppers, and yellow squash sales were measured in terms of total pounds sold. Cantaloupes, cucumbers, green bell peppers, cauliflower, turnip greens, red potatoes, and russet potatoes sales were recorded in terms of total number of units sold. These produce items were chosen due to their popularity and the stores ability to locally source the items during the DUFB period. Table 1 shows the harvest dates from the Arkansas Extension Service for the selected produce. The harvest times all fall when DUFB is active in the state (Fair Food Network, 2019). As noted above, the two testing periods were in February and that month is usually an off-season for growing. However, that month was chosen for the DUFB pilot due to there being no major holidays (i.e., Christmas or Thanksgiving) during that time. A major holiday would impact grocery shopping behavior and lead to a bias.

To achieve Objective II, the total revenue for Arkansas FMs had to be estimated. The average revenue for U.S. FMs was sourced from the 2016 Farmers Market Promotion Program Report (USDA, 2017). The average was then multiplied by the number of Arkansas FMs. This value is the estimated total revenue for all FMs in the state. The resulting estimate is used in evaluating the simulated demand shock stemming from DUFB implementation. For our evaluation, the allocated amount of DUFB funding available in 2016 was the amount used in the analysis. The amount of funding available at the time was $51,600.

Methods

A difference-in-differences (DID) model was used to evaluate the impact of DUFB on produce sales at grocery stores. The model compares the outcomes before and after the program implementation in the treated store to the before and after outcomes of the controls stores for both periods to estimate the effect of the treatment (Imbens and Wooldridge 2009). In other words, we look to see how total produce sales with DUFB compare to the control stores' sales. We examine the before and after differences from the implementation of DUFB in the treated store and the differences in the control stores without having the program. Steele-Adjognon and Weatherspoon (2017) employ a DID model in their study of DUFB. The model used was:

$$\text{DID}=E\left(Y_1^T - Y_0^T \middle| T_1=1\right)-E\left(Y_1^C-Y_0^C \middle| T_1=0\right) \tag{1}$$

where T=1 represents the treated group. T=0 indicates the control group. Y_0^T and Y_0^C are the F&Vs purchases during the control period for the treated and control groups. Y_1^T and Y_1^C are the purchases during the treatment period. We see in this model that the expected DUFB sales value from the treated group during the control period is subtracted from the expected value during the treatment period. This is the same for the control store. The DID estimate is found by then subtracting the expected value of the control store sales from the expected value of the treated store. The model we employ in our study is shown as:

$$Y_{it} = \alpha_i + \beta_1 I_i + \beta_2 DUFB_i + \beta_3 (I_i * DUFB_i) + \epsilon_{it} \tag{2}$$

where Y_{it} is the estimate for the outcome variable being tested (i.e. produce sales and quantity sold). I_i represents which study period is being evaluated. $DUFB_i$ indicates that the treated store is being analyzed; I_i*$DUFB_i$ is the difference in outcome after implementation of DUFB the minus the difference in outcomes for the control stores. Lastly, β_3 is the DID coefficient. A positive β_3 would be expected if DUFB is effective in increasing produce sales and quantity sold, while a negative β_3 would mean that these values declined after the program's implementation.

Once the DID coefficients were found for the store-level, the same evaluation was done for the selected produce for comparison among the three stores. This is done to attempt to deduce how DUFB impacted individual local produce. After comparisons, we attempt to see if the chosen stores planned a strategic price change between the two study periods. A difference in price is expected due to factors such as fluctuations in market cost or if a shortage is being incurred. The change in price, however, would be small if this were to happen. Therefore, we want to fully ensure that the treated store did not raise price drastically to strategically increase their revenue from an expected increase in sales. A high price could lead to us finding negative DID coefficients due to less recipients purchasing the good due to its high price and their budgetary constraints. We do this by first finding the unit price of each produce during the two periods. We then regress the price on the DID estimate for a specific produce to see if there was a significant price change. The rest of this section will discuss objective II.

Objective II is to evaluate the impact of DUFB on the total revenue for all Arkansas FMs. A simulated demand shock caused by DUFB was utilized to simulate the response from the local food system. ow-income households' F&V expenditures had to first be calculated. Total F&V expenditures for all U.S. households were sourced from the 2017 Consumer Expenditure Survey (U.S. Bureau of Labor Statistics, 2017). For this study, Low-income households were categorized as having an annual income <= $39,999. Households with an annual income > $39,999 were categorized as high-income households. Low-income households' expenditures were divided by the total F&V expenditures for all households to calculate the percentage of low-income F&V expenditures. This percentage was multiplied by the value of Arkansas FMs sales to find the value of sales that stemmed from low-income households. The remaining amount of sales are sales that came from high-income households. The value of allocated DUFB funding for 2016 was divided by the amount of low-income sales to calculate the percentage of the sales that came from funding. The amount of funding at the time was $51,600. This percentage was used to calculate the average price recipients would pay on produce items when using DUFB. The average price is used in the simulation of the demand shock. Therefore, the demand shock is:

$$D_S = (P_{DUFB} - 1) * \varepsilon_{SE} \quad (3)$$

D_s is the simulated demand shock. P_{DUFB} is the average produce price with DUFB. ε_{SE} is the average low-income F&Vs own-price elasticity from Dong and Lin (2009). This is the most recent information we could source on F&Vs own-price elasticities for a national scale. -0.61 is the value of the average F&Vs own-price elasticity for SNAP-eligible households.

We then use D_s to calculate the change in revenue from the use of DUFB. The change in revenue is calculated from the changes in price and quantity. Since we cannot find a credible source of how the local supply side responds to price in Arkansas, we simulate price elasticity on the supply side. Elasticities were selected to reflect perfectly inelastic, relatively inelastic, unit elastic, elastic, relatively elastic, and highly elastic. Equilibrium was found where supply meets the demand based on classic economic theory.

The change in price is then:

$$\text{dlnP} = \frac{D_s}{\varepsilon_S - Q_1 \times \varepsilon_{SE} - Q_0 \times \varepsilon_{NS}} \quad (4)$$

Where D_s is the calculated demand shock. ε_s is the elasticity of the supply. Q_1 is the low-income share of sales. ε_{SE} is the average own-price elasticity for low-income households. Q_0 is the high-income share of sales. ε_{NS} is the average own-price elasticity for high-income households. The average own-price elasticity for high-income households also comes from Dong and Lin (2009). The average was -0.58 for high-income households.

Change in quantity is found by:

$$\text{dlnQ} = \varepsilon_s \times \text{dlnP} \quad (5)$$

The change in quantity supplied is the change in price times the supply elasticity. Quantity supplied changes relative to the supply elasticity. New sales after DUFB is then calculated by:

$$PQ_2 = PQ_1 * (1+dlnP) * (1+dlnQ) \quad (6)$$

PQ_2 is the new value of Arkansas FMs after implementation of DUFB. PQ_1 is the original value of FMs. dlnP is the change in price. dlnQ is the change in quantity. The change in dollars from the demand shock is found by subtracting PQ_1 from PQ_2. The resulting change in dollars is divided by the corresponding PQ_1 to calculate the percentage change to the local food system.

Results

Objective I

An assumption of DID is that the treated and control's average outcomes would follow a parallel trend in the absence of treatment (Abadie, 2005). However, it is difficult to meet this assumption with two time periods. Instead, data from the American Community Survey 2014-2018 5-year estimates were used to compare changes in population and household SNAP participation for all three study sites (U.S. Census Bureau, 2018a; U.S. Census Bureau, 2018b). It is assumed that there was not a drastic change in population at any site that could lead to bias in the results. Sales from the two control stores were not influenced by DUFB. Any changes in sales should stem from natural spending. DUFB impacts sales at the treated store, therefore, a significant change should originate from the implementation of DUFB. Comparing the estimates reveals that the treated site experienced an estimated population decrease while the control sites had an increase. The population estimate for the treated site decreased 0.20%. Control store 1 had an estimated increase of 14.53% and control store 2 had a 0.19% increase. The change for the location of control store 1 is significant, however it should be noted that this location resides in a small, rural town. The estimate increased from 1,659 in 2016 to 1,900 in 2017. This change is high due to the small location. The location for control store 2 saw an estimated increase from 36,711 to 36,780.

The change in population estimates here would not be significant since the increase is not that large. The treated store resides in the largest area with an estimated change from 87,712 to 87,537. As with control store 2, this change is insignificant based on the size of the area. It is safe to assume that a significant change in estimated population did not have any impact on sales at any location. This was also the case for the estimated amount of SNAP households. The treated site had an estimated decrease of 3.46%, while the two control sites had a 22.86% increase for site 1 and a 6.43% decrease at site 2. Again, this change is significant at the location for control store 1, however it is still due to the small population. The estimated number of households increased from 70 in 2016 to 86 in 2018. This leads to the higher more significant percent change. The location for control store 2 saw a decrease from 3,158 households to 2,955 in the treatment period. 6.43% could be considered an insignificant decrease. An estimated 6,472 households received SNAP in 2017 compared to 6,697 in 2016. The assumption still holds that a significant increase in the estimated number of participating households did not influence the sales during the treatment. Instead, we see what may be considered a significant decrease. It should be noted that any of the increases in sales at the control stores could be contributed to increases in population or SNAP receiving households. The rest of the results will cover the results of the DID model and the findings from the demand shock simulation.

Table 2 presents the total average produce sales for the stores during the two study periods. We see that DUFB did indeed increase the total produce sales at the treated store. Average weekly produce sales during the control period were $1,701.33. This average increased to $2,413.48 during the treatment period, a 41.86% increase. The average was greater than both control stores during the same period. The control stores had average weekly sales of $2,142.83 for store 1 and $1,729 for store 2 during the treatment period. Interestingly, one of the control store's average sales decreased from the control period. Control store 1's average sales dropped from $2527.88 during the control period to $2,142.83. As stated above, this location had an increase in estimated population. This suggest that an increase in average sales should be seen, However, a decrease is seen which could indicate that consumers were purchasing less expensive items or shopping at different locations. The average sales for this control store were surprisingly higher in the control period compared to the treated store. After the implementation of DUFB, the average sales for this control store was lower than the average for the treated store. It should be stated that the average sales from control store 2 could stem from the increase in population.

Table 3 shows the average weekly total quantity sold for the three stores for both periods. The average weekly quantity sold at the treated store increased from the control period and treated period after the administration of DUFB. Average quantity sold increased from 967.99 units sold to 1709.79 units sold, a 76.63% increase. Again, the average was greater than the averages for the control stores during the same period. One control store saw an average of 1391.14 and the other had an average of 1084.55 units sold. Both control stores also saw an increase in averages between the two periods. One control store had a higher average during the control period then the treated store with 1315.16 units sold compared to the 967.99 units sold. This was the same store that saw a decrease in sales between the two periods. Some of this increase for quantity sold may come from the increase in population. It can be assumed that it was not a significant amount, but it should still be assumed that it was partially. It is also still safe to assume that the changes to population and SNAP household estimates did not have a significant impact on the results for the treatment store. The increase in quantity sold indicates that it was highly influenced by the start of DUFB.

Table 4 reports the total store sales DID coefficient along with the estimates for each selected produce item. As expected, DUFB positively influenced store-level sales. The DID estimate was shown to be significant at 843.00 (p-value < 0.10). This estimate indicates that DUFB increased total sales by $843, a 12.4% increase. DUFB accounted for 30.0% of the difference in sales between the two periods. Almost all individual produce had a positive DID coefficient. In other words, DUFB increased their sales. DUFB had the largest impact on russet potatoes with a coefficient of 192.97. This suggests DUFB increased the sales of russet potatoes by $192.97 from the control period. The increase was not significant, however, with a p-value of 0.41. DUFB significantly increased sales of cantaloupes (DID: 41.854; P-value: 0.02), cucumbers (DID: 70.447; P-value: 0.03), green bell peppers (DID: 53.214; P-value: 0.04), jalapeño peppers (DID: 23.122; P-value: 0.002), peaches (DID: 187.332; P-value: 0.031), turnip greens (DID: 23.48; P-value: 0.021), and yellow squash (DID: 90.1; P-value: 0.001). Tomatoes and red potatoes were the only produce selected that did not incur positive DUFB. Sales of these produce decreased after the implementation of DUFB. Tomatoes had a DID estimate of -42.27, or a decrease in sales by $42.27. Red potatoes had an estimate of -19.97, or a $19.97 decrease from the control period. Neither of these estimates were statistically significant.

Table 4 also shows the DID coefficients for total quantity sold. The total quantity sold increased after the start of DUFB as expected. The DID estimate was found to be 632.14. An additional 632.14 units, or a 16.3%. increase, of produce were sold during the treatment period, 21.3% of the new sales in the control period were created from DUFB. As with the sales analysis, almost all tested produce had a positive DID estimate. Cucumbers had the highest coefficient with 82.15. This estimate was significant at the 95% level with a p-value of 0.03. Since cucumbers were measured by the number of individual units sold, this means an additional

82.15 cucumbers were sold during the treatment period. DUFB significantly impacted the units sold of cantaloupes (13.90, P-value: 0.017), green bell peppers (DID: 66.638, P-value: 0.007), green cabbage (DID: 71.253; P-value: 0.066), jalapeño peppers (DID: 18.699; P-value: 0.000), peaches (DID: 62.24, P-value: 0.023), turnip greens (DID: 15.645; P-value: 0.021), yellow squash (DID: 55.385, P-value: 0.008), and zucchinis (DID: 46.862; P-value: 0.000). Green cabbage, jalapeño peppers, peaches, yellow squash, and zucchinis are all sold by the pound. The DID coefficient would represent the number of pounds sold. For example, the DID estimate for green cabbage would indicate that an additional 71.25 pounds were sold due to DUFB. Tomatoes and red potatoes were the only two items to not see a positive estimate. Tomatoes had an estimate of -49.27 and red potatoes had an estimate of -5.01. Tomatoes were sold by the pound, so 49.27 less pounds of tomatoes were sold during treatment. Red potatoes were sold by the individual item, meaning the store sold 5.01 less red potatoes during treatment.

As noted above, we find that DUFB did negatively impact certain produce. In this case, it was tomatoes and red potatoes. Both the sales and quantity DID coefficient were negative for these two items. We calculate the price of these produce for the two study periods to determine if there was a price change between the two. The price change for these items and the other produce are found on Table 5. We find that this produce did indeed have an increase in price between the two periods. Tomatoes increased in price by $0.35 and red potatoes saw an increase of $0.19. These changes were not statistically significant. It should be stated that cucumbers ($0.10), green bell peppers ($0.03), and yellow squash ($0.02) also had an increase in price. These items had a positive DID for both sales and quantity. These price changes are not as high, which could be the cause of their positive DID values, but it is still interesting to note. All other produce, except sweet potatoes, saw a decrease in price between the two periods. Sweet potatoes did not incur a price change. Russet potatoes had the largest decrease in price with a change of -$1.51. This could be the cause of them having the largest DID value. Customers may have bought more of them to take advantage of the lower price. Cauliflower had the next largest decrease with a change in price of -$0.43. Cauliflower, however, had the smallest DID values for both sales and quantity with 3.94 and 3.04, respectively. Peaches had a smaller price decrease with -$0.32 but had significantly larger DID values. This could be due to more consumers preferring peaches over cauliflower even with the lower price compared to last year. Another reason could be that it was still cheaper to purchase peaches even with cauliflower having the higher price decrease. We find that there was a large increase in price for tomatoes and red potatoes between the two periods, which could be the cause of their negative values. Nonetheless, we cannot safely assume this price change was a strategic one. This change could be due to fluctuating market costs or changes to costs for the store. The rest of the section will discuss the results of the demand shock simulation.

Objective II

Average revenue was $178,026.45 per market in the U.S. in 2016 (USDA, 2017). At the time, there were 100 markets located throughout Arkansas. This leads to an estimated $17,802,645 in revenue for all Arkansas FMs in 2016. Sales from low-income households accounted for an estimated 23.28% of the revenue (USDA,2017). This is equal to $4,145,141 in sales stemming from low-income households. The current funding was 1.24% of the estimated revenue from low-income households. On average, low-income visitors paid an average of $0.99 (assuming unit price to be $1) when using the program, whereas high-income people paid an average of $1.99. This suggests that high-income shoppers are willing to pay higher for F&V and therefore may be less price elastic.

Table 6 reports the estimated change in dollars from the implementation of the program. A positive change in dollars was found for each simulated supply. Revenue was shown to have the possibility change by as high as $115,188   This is a 0.65% increase from the original value. In a perfectly inelastic system, one dollar of allocated funding would generate up to $2.23 in revenue. Perfectly inelastic supply indicates that a change in demand leads to a change in price, but no change in quantity supplied. Output does not respond due to supply being set at a fixed level. Compared to the other supply systems, the perfectly inelastic generated the highest amount of revenue per dollar of DUFB. Local producers in this system would benefit from this demand shock due to not experiencing increased production costs. This benefit does not hold in a supply that is perfectly elastic. Perfectly elastic supply indicates a demand change results in price and quantity changing at an equal level. A one-unit increase in price would raise quantity by the same amount. Analysis showed a $84,852 increase in revenue, or a 0.48% increase to the local system. One dollar of funding could create up to $1.64 in revenue. This indicates that if supply becomes more elastic, the change in price begins to decrease and the change in quantity expands.

A supply system that is relatively elastic has estimated change of $77,967/ This suggests a 0.44% change to the local food system. One dollar in funding would create up to $1.51 in revenue. Supply that is relatively more elastic sees a. revenue increase of $ $72,099. Up to $1.40 in revenue could be generated for one dollar of funding. Supply that is extremely elastic sees change in revenue of $68,411. This would be a 0.38% change to the local food system. One dollar of funding could return $1.33 in revenue. This assumption also holds for supply that is relatively inelastic. A relatively inelastic system incurs a $93,045 increase in revenue, or a 0.52% change.

Conclusions

This study focuses on understanding how DUFB effects sales and revenue in participating grocery stores and FMs in Arkansas. To evaluate the impact on grocery store sales, total weekly sales from three stores were recorded in February 2016 and 2017 for a set of selected produce that can be grown locally in Arkansas. A difference-in-difference analysis was conducted using the weekly store-level data. We discover DUFB does indeed increase total produce sales and quantity sold at the store-level. DUFB also increased sales and quantity sold for almost all the produce. DUFB had the largest impact on the sales of cantaloupes, cucumbers, green bell peppers, jalapeño peppers, peaches, russet potatoes, turnip greens, and yellow squash. In terms of total quantity sold, DUFB generated significant increase for cucumbers, green bell peppers, green cabbage, jalapeño peppers, peaches, turnip greens, yellow squash, and zucchinis.

Our second objective was to evaluate how DUFB effects total revenue for FMs in the state. We simulate how a demand shock from DUFB changes total value of the markets. Supply systems were used in the simulations with multiple hypothetical elasticities. Hypothetical elasticities were used due to the rigorous nature of their calculation. Results shows DUFB raised the total value for each tested supply. One dollar of funding toward DUFB generated on average over $1.60 in revenue. Perfectly inelastic supply had the greatest change in revenue. This system sees an increase in price, but not quantity supplied from the demand shock. Suppliers would be able to sell at a higher price at the same supply level and not see increased production costs. The change in revenue shrunk as supply became more elastic. The change in price became smaller the more elastic the supply. Change in quantity supplied was larger as supply became more elastic. Suppliers would now need to increase their quantity relative to price. We also developed a map to further guide where DUFB should be offered in Arkansas based on counties that have high SNAP participation and low access to produce

This is the first meticulous evaluation of DUFB in Arkansas using econometrics of program evaluation. We find evidence that DUFB could be successful in Arkansas. We also add to the existing literature from other states that also shows that DUFB can be efficient in its goal (Cohen et al., 2017; Cohen et al., 2018; Durward et al., 2018; Savoie-Roskos et al., 2016; Steele-Adjognon and Weatherspoon, 2017). Nationally, financial incentive programs aimed at low-income households have shown to be successful. A double-dollar program similar to increased total weekly F&V expenditures for participants, with the largest increase being fresh F&V expenditures (Polecsek et al., 2018). SNAP sales increased in FM from a bonus incentive program in Philadelphia (Young et al., 2013). Rhode Island residents reported a higher mean intake for F&Vs after participating in an incentive program (Bowling et al., 2016).

This study does have some limitations that must be mentioned. First, a longer time period would be preferred for the DID model. It is challenging to fulfill the parallel trend assumption with only two years of data. Having more years would allow the trend to be seen and evaluated. Secondly, the demand elasticities for non-eligible and eligible SNAP participants could be an issue. The elasticities used are from 2009. It is plausible that these elasticities may have increased or decreased since the study. A further study would need to be conducted to determine this. The last, but possibly most important, limitation is the amount of DUFB funding. DUFB has a finite amount of funding. If the program exhausts its budget, the program period is over until the next period or more funding allocation. Local producers may be benefitting from increased revenue during the program period. increase could end if DUFB funding diminishes mid-season. Nonetheless, we do see that the current funding amount does increase revenue.

DUFB has been shown to succeed in Arkansas at increases sales at participating grocery stores and FMs. This can provide valuable information to policymakers and local producers. Policymakers can use these findings to decide how to fund and expand DUFB. These findings could also be used by policymakers to determine if programs with a similar goal should also be implemented and funded. Local suppliers can use the results to determine if they should begin to sell at locations that offer DUFB. They can also use it to determine if there is certain produce they should grow.

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Appendix

Table 1: Arkansas Harvest Dates for Selected Produce

	May	June	July	Aug	Sept	Oct
Tomatoes						
Peaches						
Cantaloupes						
Cucumbers						
Green Bell Peppers						
Zucchinis						
Green Cabbage						
Cauliflower						
Roma Tomatoes						
Sweet Potatoes						
Turnip Greens						
Jalapeño Peppers						
Yellow Squash						
Red Potatoes						
Russet Potatoes						

Source: University of Arkansas Extension Service. "Locally Grown Produce." Retrieved from https://www.uaex.edu/publications/order.aspx

Table 2. Average total sales for control and treatment periods

Store	Control Period	Treatment Period
Treatment Store	$1,701.33	$2,413.48
Control Store 1	$2,527.88	$2,142.83
Control Store 2	$1,606.36	$1,729.78

Table 3. Average quantity sold for control and treatment periods

Store	Control Period	Treatment Period
Treatment Store	967.99	1709.79
Control Store 1	1315.16	1391.14
Control Store 2	941.20	1084.55

Table 4. DID estimates for sales and quantity sold

	Sales DID	**Quantity DID**
Store	843.00*	632.14*
Tomatoes	(42.27)	(49.27)
Peaches	187.33**	62.25**
Cantaloupes	41.85**	13.90**
Cucumbers	70.45**	82.15**
Green Bell Peppers	53.21**	66.64**
Zucchinis	80.14***	46.86***
Green Cabbage	45.59	71.25*
Cauliflower	3.94	3.04
Roma Tomatoes	42.60	40.38
Sweet Potatoes	4.53	3.51
Turnip Greens	23.48**	15.65**
Jalapeño Peppers	23.12***	18.70***
Yellow Squash	90.10***	55.39**
Red Potatoes	(19.97)	(5.01)
Russet Potatoes	192.97	41.17

Note: Asterisks (*, **, ***) denote statistical significance at the 10%, 5%, and 1% levels, respectively. N=24. Each row is separate DID regression.

Table 5. Changes in price for tested produce between test periods

Produce	**Price Change**
Tomatoes	0.35
Peaches	(0.32)
Cantaloupes	(0.12)
Cucumbers	0.10
Green Bell Peppers	0.03
Zucchinis	(0.18)
Green Cabbage	(0.01)
Cauliflower	(0.43)
Roma Tomatoes	(0.28)
Sweet Potatoes	0.00
Turnip Greens	(0.03)
Jalapeño Peppers	(0.12)
Yellow Squash	0.02***
Red Potatoes	0.19
Russet Potatoes	(1.51)***

Note: Asterisks (*, **, ***) denote statistical significance at the 10%, 5%, and 1% levels, respectively. N=24. Each row is separate DID regression.

Table 6. Demand shock simulation

Supply Elasticity (Value)	2016 Revenue	New Revenue	Change in Revenue	DUFB Return	% Change
Perfectly Inelastic (0)	$17,802,645	$17,917,833	$115,188	$2.23	0.65%
Inelastic (0.5)	$17,802,645	$17,895,690	$93,045	$1.80	0.52%
Unit Elastic (1)	$17,802,645	$17,887,497	$84,852	$1.64	0.48%
Elastic (2)	$17,802,645	$17,880,612	$77,967	$1.51	0.44%
Relatively Elastic (5)	$17,802,645	$17,874,744	$72,099	$1.40	0.40%
Highly Elastic (20)	$17,802,645	$17,871,056	$68,411	$1.33	0.38%