**Appendix**

*Introduction*

In this Appendix, we present two sections of supplemental materials. In the endogeneity sections, we investigate that possibility that SFAs’ market channel choices are endogenous. To do this, we first describe the mechanisms by which market channel choice could be an endogenous variable based on the design of the survey questions. Second, we describe the instruments we use in two-step instrumental variable (IV) probit regressions, and within this section we discuss the plausibility of our validity assumption. Third, we outline a falsification test we undertake to assess the validity of the instrument. Fourth, we present the results of our instrumental variable regressions. We then summarize the results in the discussion section. Finally, in the *Correlation Matrices* section, we present correlation matrices for two sets of explanatory variables: variables that reflect F2S programming activities and procurement problem variables.

*Endogeneity*

To briefly summarize, we use two instruments: the county-level number of farmers market per 10,000 residents and the county-level number of farms that sell directly-to-retailers per 10,000 residents. We present instrumental variable regression results when using the direct-to-retail farmer instrument only and when using both instruments. For brevity, we do not report the instrument variable regression results for the farmers market density instrument since we find that it is not relevant. Similarly, we report the falsification test results for the direct-to-retail farmer instrument only since that is the instrument that is relevant.

We conclude that endogeneity is unlikely to exist when SFAs purchase exclusively from intermediaries based on the results of our instrument variable regressions. Our instrumental variable results enable us to compare SFAs that procured from intermediaries exclusively and those that purchased at least some products directly from farmers under the assumption that market channel choice is exogenous. However, while one of our instruments is correlated with the probability that SFAs source local foods exclusively from intermediaries, both of our instruments are uncorrelated with the probability that schools source local foods from both intermediaries and farmers. While we cannot conclude that this market channel is exogenous from our instrumental variable results, it is plausible that if one market channel is exogenous then the others are as well.

### Sources of Endogeneity

Whether the market channel coefficients in the probit regression have causal interpretations depends, in part, on whether our control variables mitigate the possibility of omitted variable bias. As we discuss extensively in the main text, we address this by controlling for challenges that SFAs experience in local sourcing, activities that SFAs implement in F2S programming, SFA characteristics like size and socioeconomic attributes, and their external food environment.

Simultaneity could be another source of endogeneity. Simultaneity would be present if SFAs choose market channels for local procurement as a function of whether they reduce school meal costs. However, the plausibility of simultaneity is unclear due to the structure of the survey. One reason simultaneity may be unlikely is that SFAs may be motivated to procure directly from farmers by non-pecuniary factors. SFAs are commonly motivated to source locally to improve to the quality and nutrition of school meals, as well as to support local farmers (Colasanti, Matts, and Hamm 2012, Motta and Sharma 2016). Conner et al. (2014) found that price was not a dominant consideration among schools that source locally. Instead, they found that non-pecuniary values motivated local sourcing, such as food security, supporting local production, education, and health objectives. Following this logic, conditional on the decision to source locally, SFAs could make the decision to procure directly from a farmer independent of cost considerations. For example, a school may want to procure directly from a local farm due to the farm’s standing in the community or because they want the farmer to visit the school.

Nonetheless, SFAs are budget-constrained, and they may select market channels due to an interest in reducing costs. However, even if this occurs, it is unclear the extent to which endogeneity is a concern given the structure of the survey. SFAs make their market channel selection prior to observing and reporting costs in the F2S survey. Since many of these costs are administrative, it may be challenging to anticipate what these costs will be *a priori*. For instance, an SFA may have anticipated that procuring local foods from a distributor would lower costs. If, however, the distributor was inexperienced with sourcing locally, costs may have been higher than anticipated, and vice versa. This suggests that if the anticipated costs were uncorrelated with realized costs, then endogeneity would be less of a concern. Alternatively, if SFAs could anticipate costs with a high degree of accuracy and chose market channels in part to reduce costs, then endogeneity could be present.

### Testing for Endogeneity

While there are several scenarios by which endogeneity is unlikely in the survey, we nonetheless investigate this issue in further depth by estimating two-step IV probit regressions. The first-stage of a two-step IV probit regression consists of an ordinary least squares regression of market channel choice on the instruments.

We use two instruments: the county-level number of farmers markets in 2016 per 10,000 residents and the county-level number of farmers selling directly to retail outlets in 2012 per 10,000 residents (USDA 2017, USDA ERS 2017). These variables represent the opportunities available to SFAs to procure foods directly from farmers. While the number of farmers selling directly to retailers in a county is a more accurate representation of proximate farmers, some of those farmers may not be marketing products within the county in which they reside. Alternatively, the number of farmers markets is more representative of the vibrancy of local food markets within closer proximity to the school, which could include the participation of farmers from outside of the county. The county-level density of farmers markets is a variable that has been used in other F2S studies, although in different contexts (Ralston et al. 2017, Botkins and Roe 2018).

Instruments should first, be associated with the treatment variable; second, not be caused by confounding variables that also cause the outcome variable; and third, only affect the outcome variable through its influence on the treatment variable (i.e., the exclusion restriction) (Angrist and Pischke 2009). We discuss each of these criteria below.

First, we hypothesize that our instruments are positively correlated with the probability that an SFA within that county has procured local foods directly from a farmer. This is because a greater number of farmers markets and/or farmers selling to retail outlets close to the school could increase the probability that schools can identify farmers from which to procure food products directly. We test whether this relationship holds with the first-stage regression results.

Second, regional-level variables can be used as instruments for potentially endogenous independent variables in individual-level equations under the assumption that an action by an individual does not influence conditions in regions in which there are many individuals. However, our assumption that SFA-level variables do not influence the number of local farmers at the county-level does not ensure that an instrument is valid. This is because there could be other confounding county-level variables that influence both the SFA-level changes in school meal costs and the county-level number of local farmers.

However, in our probit regression results, we did not find county-level variables to influence whether SFAs reduced school meal costs from F2S programming. In Table 3 in the main text, the coefficients associated with county-level population, county-level per capita income, the percentage of the county with a bachelor’s degree, the county-level number of restaurants per capita, the ratio of the county-level milk price with the national price, and county-level farm income are each statistically insignificant. The statistical significance of the county-level number of grocery stores per capita is inconclusive. It is significant with p-value of 0.097 in Regression I (Table 3), but otherwise insignificant. So, the possibility of confounding variables is less likely since several plausible county-level variables do not influence changes in school meal costs from F2S programming. Instead, our results show that SFA-level attributes predominately influence whether school meal costs declined from F2S programming. It is intuitive that changes in school meal costs that result from F2S programming would be contextual and specific to the SFA given the idiosyncratic nature by which F2S programs are implemented.

Third, an SFAs’ ability to reduce school meal costs from F2S programs could be influenced by local agricultural characteristics in other ways besides the market channel that an SFA uses. So, whether our instruments are valid depends on whether we adequately control for ways by which the density of local farmers influences school meal costs through mechanisms other than the market channels that SFAs use.

Our control variables address several mechanisms by which the density of local farmers could influence whether school meal costs declined outside of the market channel that SFAs use. The pricing challenge variable helps mitigate the possibility that an increased density of local farmers reduces school meal costs due to a greater overall supply of local foods (irrespective of market channel). The county-level ratio of local milk prices to national prices also helps control for the possibility that variation in local food prices is correlated with both the density of local farmers and lowered costs. The on-site preparation challenge variable mitigates the possibility that school staff have greater capacity to prepare local foods in areas with more local farmers (irrespective of market channel). Similar explanations are applicable to the transaction, product, and distribution procurement challenge variables. We also control for F2S extracurricular activities, like taste tests and farm visits, to mitigate the possibility that more local food farmers lead to greater enthusiasm by staff for local sourcing, which in turn would be associated with reduced school meal costs.

*Falsification Test*

It is still possible that our validity assumption does not hold despite a) our inability to find county-level variables that influence changes in school meal costs from F2S programming and b) controlling for mechanisms by which local farmers could influence school meal costs outside of market channel choice. For example, measurement error could exist with some of our control variables. This is because some of our variables are proxy variables and may not be perfect measures of the mechanisms we are seeking to control.

While our validity assumption cannot be tested, a falsification test is a robustness exercise that provides corroborating evidence about the plausibility of the validity assumption. One type of falsification test is to regress the outcome variable on the instrument and other covariates among an alternative population that is not impacted by the treatment variable. In this regression, the exclusion restriction is not rejected if the instrument does not have a statistically significant impact on the outcome for this population (Pizer 2016).

A falsification that we undertake in this vein is to regress whether school meal costs are reduced from F2S programming on the density of local farmers for the subset of SFAs that source from intermediaries exclusively. It is not possible for the instrument to influence market channel choice among this subset since the SFAs in this subset are sourcing exclusively from intermediaries. We estimate analogous falsification tests for the other market channel variables. We would conclude that the exclusion restriction is violated if the coefficients associated with the density of local farmers are statistically significant in these regressions.

*Results*

In Table A1, we report the first-stage regression results when we include both instruments. In the first-stage regression, the density of direct retail farmers has a statistically significant impact (with a coefficient of -0.005) on the probability that schools source exclusively from intermediaries (Regression I). The elasticity of this parameter estimate is -0.04. The density of direct retail farmers has a positive influence on the probability that SFAs source locally exclusively from farmers (Regression III) and does not affect the probability that SFAs source locally from both intermediaries and farmers (Regression II). Also, in Table A1, the farmers market density variable is statistically insignificant in Regressions I and II. The farmers market coefficient is negative with statistical significance in Regression III.

For Regression I, the endogeneity test statistic indicates that we cannot reject the null hypothesis that purchasing exclusively from intermediaries is exogenous. The endogeneity test statistic is irrelevant in Regression II since the instruments are statistically insignificant in the first-stage regression. We also find that purchasing exclusively from farmers is exogenous in Regression III, although this is not of practical significance since purchasing exclusively from farmers does not influence reductions in school meal costs. We test whether our model is overidentified using the Amemiya-Lee-Newey (ALN) test (Baum, Schaffer and Stillman 2003). The null hypothesis of the ALN test is that both instruments are exogenous, and the alternative hypothesis is that either or both instruments are endogenous (Guevara 2018). In each of the three regressions, the over-identification test statistics are statically insignificant. For example, in Regression I, the Amemiya-Lee-Newey minimum chi-square statistic with 1 degree of freedom is 0.07 with a p-value equal to 0.79. Our results indicate our model is not overidentified, as the p-value of the ALN chi-squared tests are each above 0.1.

We next present results when we only use the county-level density of direct retail farmers as an instrument in Table A2. For brevity, we focus on this instrument since it is the only instrument that is correlated with market channel choice in Regression I in Table A1, whereas the farmers market density instrument is not relevant. The county-level density of direct retail farmers has a negative impact on the probability that SFAs purchase local foods exclusively through intermediaries in the first-stage regression (Table A2). The first-stage coefficient magnitude is similar between Tables A1 and A2, which indicates that this finding is robust. The endogeneity test statistic in Regression I is statistically insignificant in Table A2, as in Table A1. Again, we cannot reject the null hypothesis that purchasing exclusively from intermediaries is exogenous. This instrument’s coefficient is statistically insignificant in the first-stage regressions corresponding to Regressions II and III.

In Table A3, the density of local farmers has a statistically insignificant impact on whether SFAs reduce school meal costs among the subset of SFAs that buy local foods exclusively from intermediaries (Regression I). This result also holds for Regressions II and III. So, we fail to reject the null hypothesis that our instrument does not have a direct effect on the dependent variable (i.e., the density of retail farmers does not have a direct effect on lower costs). Thus, the falsification test results support our assumption that our instrument is valid, since they fail to show that the density of local farmers influences whether school meal costs decline outside of its influence on market channel choice.

These falsification tests may not be uncovering a relationship between the density of local farmers and school meal costs due to the control variables we include. Further, our probit regression results indicate that SFA-level characteristics have a greater influence on whether school meal costs declined than county-level characteristics. The lack of an impact of county-level local farmers on school meal costs is consistent with the absence of evidence that other county-level variables influence school meal costs.

### Discussion

The results from our instrumental variable regressions fail to reject the null hypothesis that purchasing local foods exclusively from intermediaries is exogenous. As we discussed previously, this is a reasonable outcome given the structure of the survey, in which SFAs make a choice of market channel strategy prior to experiencing costs and returning a F2S survey indicating whether F2S programming lowered costs. Another possible explanation for this finding could be that SFAs do not source directly from producers due to cost considerations, but instead do so for non-pecuniary reasons.

While our instrument is correlated with SFAs that procure local foods exclusively from intermediaries, it is uncorrelated with SFAs that do so either from farmers exclusively or both intermediaries and farmers. It would be logical that if one of the market channel variables was exogenous, then the other market channels would be as well. Further, the survey structure also supports the rationale that the market channel variables are exogenous. However, we are more measured in concluding whether procuring from farmers and intermediaries is exogenous due to the absence of the statistical significance of the instrument in the first-stage regression. In either case, comparing SFAs that source local foods exclusively from intermediaries with those that source at least some foods locally is informative. This is because only 10% of SFAs that procure local foods from farmers do so exclusively from farmers.

*Correlation Matrices*

We report the correlations among two subsets of control variables: procurement problems that SFAs experience with local sourcing (Table A4) and F2S activities that they undertake (Table A5). We include these tables to document the positive correlation that exists among these control variables that we discussed in the main text. Thus, it may be challenging from our model to isolate the impact that any of these individual variables has on lower costs given the positive correlation that exists for these variables within these two subsets.

**Table A1. Endogeneity Test Results for Market Channel Choice – Two Instruments**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Purchased Intermediate Exclusive | Purchased Both Direct & Intermediate | Purchased Direct Exclusive |
| Regression | I | II | III |
| Two-Step IV Probit First Stage Regression Results | | | |
| County-level Farmer to Retail Per 10,000 | -0.005\*\* | 0.002 | 0.003\* |
|  | (0.003) | (0.003) | (0.002) |
| County-level Farmers Markets Per 10,000 | -0.003 | 0.026 | -0.023\* |
|  | (0.021) | (0.022) | (0.014) |
| Other Controls | YES | YES | YES |
| Regression F Statistic | 8.11\*\*\* | 4.87\*\*\* | 4.07\*\*\* |
| Regression R-Squared | 0.25 | 0.16 | 0.14 |
| Observations | 2,102 | 2,102 | 2,102 |
| Wald Exogeneity Test Chi-square | 0.55 | 0.54 | 0.02 |
| Wald Exogeneity Test P-Value | 0.46 | 0.46 | 0.89 |
| Amemiya-Lee-Newey (ANL) Overid Chi-square | 0.07 | 0.09 | 0.41 |
| ANL Overid Restrictions Chi-square P-Value | 0.79 | 0.77 | 0.52 |
| Parameter estimate (standard error) |  |  |  |
| \*\*\* -- Significant at 0.01 level. \*\* -- Significant at 0.05 level. \* -- Significant at 0.1 level. | |  |  |

**Table A2. Endogeneity Test Results for Market Channel Choice – Density of Farmers as Instrument**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Purchased Intermediate Exclusive | Purchased Both Direct & Intermediate | Purchased Direct Exclusive |
| Regression | I | II | III |
| Two-Step IV Probit First Stage Regression Results | | | |
| County-level Farmer to Retail Per 10,000 | -0.005\*\* | 0.002 | 0.003 |
|  | (0.002) | (0.003) | (0.002) |
| Other Controls | YES | YES | YES |
| Regression F Statistic | 8.21\*\*\* | 4.91\*\*\* | 4.08\*\*\* |
| Regression R-Squared | 0.25 | 0.16 | 0.14 |
| Observations | 2,102 | 2,102 | 2,102 |
| Wald Exogeneity Test Chi-square | 0.52 | 0.49 | 0.34 |
| Wald Exogeneity Test P-Value | 0.47 | 0.48 | 0.56 |
| Parameter estimate (standard error) |  |  |  |
| \*\*\* -- Significant at 0.01 level. |  |  |  |
| \*\* -- Significant at 0.05 level. |  |  |  |
| \* -- Significant at 0.1 level. |  |  |  |

**Table A3. Falsification Test Results**

|  |  |  |  |
| --- | --- | --- | --- |
| Dependent Variable: Reduce School Meal Costs from F2S Programming | | | |
| Subset of SFAs that: | Purchased Intermediate Exclusive | Purchased Both Direct & Intermediate | Purchased Direct Exclusive |
| Regression | I | II | III |
| County-level Farmer to Retail Per 10,000 | 0.014 | -0.019 | -0.054 |
|  | (0.020) | (0.013) | (0.041) |
| Other Controls | YES | YES | YES |
| LR Chi-Square Test (Global Signif.) | 168\*\*\* | 213\*\*\* | 85\*\*\* |
| Observations | 898 | 985 | 219 |
| Parameter estimate (standard error) |  |  |  |
| Since they predict reduced costs perfectly: |  |  |  |
| CO, FL, KY, MD, ME, MN, MT, ND, NE, SD, UT, VA, and VT omitted from I. | | |  |
| LA, NH, NV, RI, and UT omitted from II. |  |  |  |
| AL, CT, GA, KY, MT, ND, NH, NJ, NM, RUCC5, OK, OR, SC, UT, VA, and WA omitted from III. | | | |
| \*\*\* -- Significant at 0.01 level. \*\* -- Significant at 0.05 level. \* -- Significant at 0.1 level. | | |  |

**Table A4. Correlation Matrix for Procurement Problem Variables**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Transaction | Product | Distribution | On-Site | Pricing |
| Transaction | 1.00 |  |  |  |  |
| Product | 0.42\*\*\* | 1.00 |  |  |  |
| Distribution | 0.33\*\*\* | 0.28\*\*\* | 1.00 |  |  |
| On-Site | 0.29\*\*\* | 0.22\*\*\* | 0.25\*\*\* | 1.00 |  |
| Pricing | 0.29\*\*\* | 0.36\*\*\* | 0.30\*\*\* | 0.27\*\*\* | 1.00 |
| Calculated from 2,102 observations. | |  |  |  |  |
| \*\*\* -- Significant at 0.01 level. |  |  |  |  |  |

**Table A5. Correlation Matrix for F2S Activity Variables**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Taste Test | School Garden | Trip to Farm | Farmer Visit SFA | Themed Promotion | Integrated F2S Curriculum |
| Taste Test | 1.00 |  |  |  |  |  |
| School Garden | 0.31\*\*\* | 1.00 |  |  |  |  |
| Trip to Farm | 0.25\*\*\* | 0.30\*\*\* | 1.00 |  |  |  |
| Farmer Visit SFA | 0.36\*\*\* | 0.27\*\*\* | 0.32\*\*\* | 1.00 |  |  |
| Themed Promotion | 0.44\*\*\* | 0.23\*\*\* | 0.14\*\*\* | 0.30\*\*\* | 1.00 |  |
| Integrated F2S Curriculum | 0.31\*\*\* | 0.35\*\*\* | 0.31\*\*\* | 0.29\*\*\* | 0.21\*\*\* | 1.00 |
| Calculated from 2,102 observations. |  |  |  |  |  |  |
| \*\*\* -- Significant at 0.01 level. |  |  |  |  |  |  |