Urban-Rural Differences in Consumer Demand for Local and Organic Food

Abstract: This study assesses consumer demand and willingness to pay for various attributes of eggs, including local and organic designations, using IRI consumer panel data and discrete choice demand methods. By constructing an alternative but practical definition of local food based on where the product is sold rather than where it originates from, this study is able to use household-level scanner data to assess the demand and willingness to pay for product attributes related to both local and organic foods. In addition, we use the geographic location of these households to investigate how our willingness-to-pay estimates vary across the urban-rural spectrum. We confirm that consumers are generally willing to pay a premium for organic eggs and while we show that consumers generally expect a discount for local eggs, more rural consumers and those who live in more agricultural areas are more willing to pay for local eggs.

Keywords: Local foods, organic foods, urban-rural differences, discrete choice demand, control function

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I. Introduction

Development of local and organic food systems is often looked to as an engine for economic growth in urban and rural communities (see, for example, Clancy and Ruhf, 2010; Feenstra, 1997; and Marasteanu and Jaenicke, 2019). For local food systems, Martinez et al. (2010) report mixed findings on the impact of local food systems on local economic development. For example, these authors find some prior research that documents positive employment and community income from expanding local food systems, but insufficient other research on diet quality, food security, or environmental benefits from local food systems. Likewise, Schmidtmer et al. (2012) and Marasteanu and Jaenicke (2016 and 2019) and identify geographic hotpots of organic agriculture in Germany and the U.S., with the former (i.e., Schmdtmer et al., 2012) concluding that agglomeration effects create favorable economic environment and the later (i.e., Marasteanu and Jaenicke, 2019) actually documenting organic hotspots' positive effect on local economic conditions. These and other studies, however, note that analyses of local and organic food systems' economic impact are sparse.

One big difference between local and organic agriculture is the rigor of their definitions. Whereas organic agriculture in Europe and the U.S. is defined by government standards and programs (i.e., USDA's National Organic Program and the European Commission's Directorate-General for Agriculture and Rural Development), there is no widely accepted definition of local food. For example, in a meta study of local food price premiums, Printezis, Grebitus, and Hirsch (2019) note that various studies label local food (a) using "locally grown" text, (b) with a local brand name, (c) using a label related to a certain city, state, or region, (d) specifying the distance the food has traveled, or (e) using a marketing program label such as "PA Preferred" for products originating in Pennsylvania. Furthermore, micro-level food purchase data sets (i.e., so-called scanner datasets constructed by Nielsen or IRI) often have identifiers for organic food but not for local food.

Another big difference between local and organic is the degree to which positive premiums or willingness to pay has been documented. This potentially higher valuation, well documented for organic but not necessarily local, can be an important driver of local economic

benefits. As organic standards coalesced and became standardized by government programs, studies for survey-based willingness to pay were replaced with studies of market-based organic price premiums. For example, Jaenicke and Carlson (2015) and Carlson and Jaenicke (2016) document organic price premiums for a variety of retail-level food products using hedonic price models applied to the Nielsen scanner data. On the other hand, studies investigating price premiums or willingness to pay for local food use a wide range of survey-based or experimental methods, which can be hypothetical or actual using experimental auction method (Chenarides et al., 2022; Printezis, Grebitus, and Hirsch (2019)). To our knowledge, no research to date investigates local food price premiums using food-purchase scanner data sets.

By constructing an alternative but practical definition of local food based on where the product is sold rather than where it originates from, this study is able to use household-level scanner data to assess the demand and willingness to pay for product attributes related to both local and organic foods. In addition, we use the geographic location of these households to investigate how our willingness-to-pay estimates vary across the urban-rural spectrum. To preview our results, our study confirms a strong, positive willingness to pay for the organic product attribute, and we further find that this willingness to pay estimate does not vary much across the geographic landscape. Using our alternative, practical definition of locally sold food, however, we find a negative willingness to pay, on average, for the local food attribute. However, here we find that this willingness to pay various considerably across the landscape. For example, households living in less densely populated areas or by high shares of agricultural land have much less negative willingness to pay for local.

II. Data and Methods

Our analysis focuses on Pennsylvania, a U.S. state in the Mid-Atlantic region, which includes metropolitan counties, non-metropolitan counties adjacent to metro areas, and completely rural counties. Agriculture in this region is of great interest to researchers and policymakers because of its economic importance as well as its longstanding contribution to water-quality issues in the Chesapeake Bay and other waterways and ecosystems. For now, we also confine our study to household demand for eggs. Pennsylvania is a major agricultural state and also a large producer of eggs, producing 8.1 billion eggs in 2021, the fourth most among all other U.S. states (USDA 2022).

The primary dataset for this project is the IRI consumer panel, which provides detailed purchase information for a large panel of U.S. households. For each household in the dataset, we observe detailed information on their food purchasing behavior: UPCs of products purchased, price paid, and quantity purchased as well as the date of the trip and the store in which it took place. We also observe demographic information such as income. At the product level we observe many important pieces of information which are relevant in consumers demand for eggs. For example, organic, private label, and cage-free designations are described in the data. We limit our analysis to purchases of chicken eggs sold by the dozen, by far the most common way for eggs to be sold in our dataset. Currently, we use data from the 2018 IRI consumer panel; however, future iterations otf this research will add data from additional years. We gather data on 312,804 purchases by 3,847 households in every county and almost every census tract in the state of Pennsylvania.

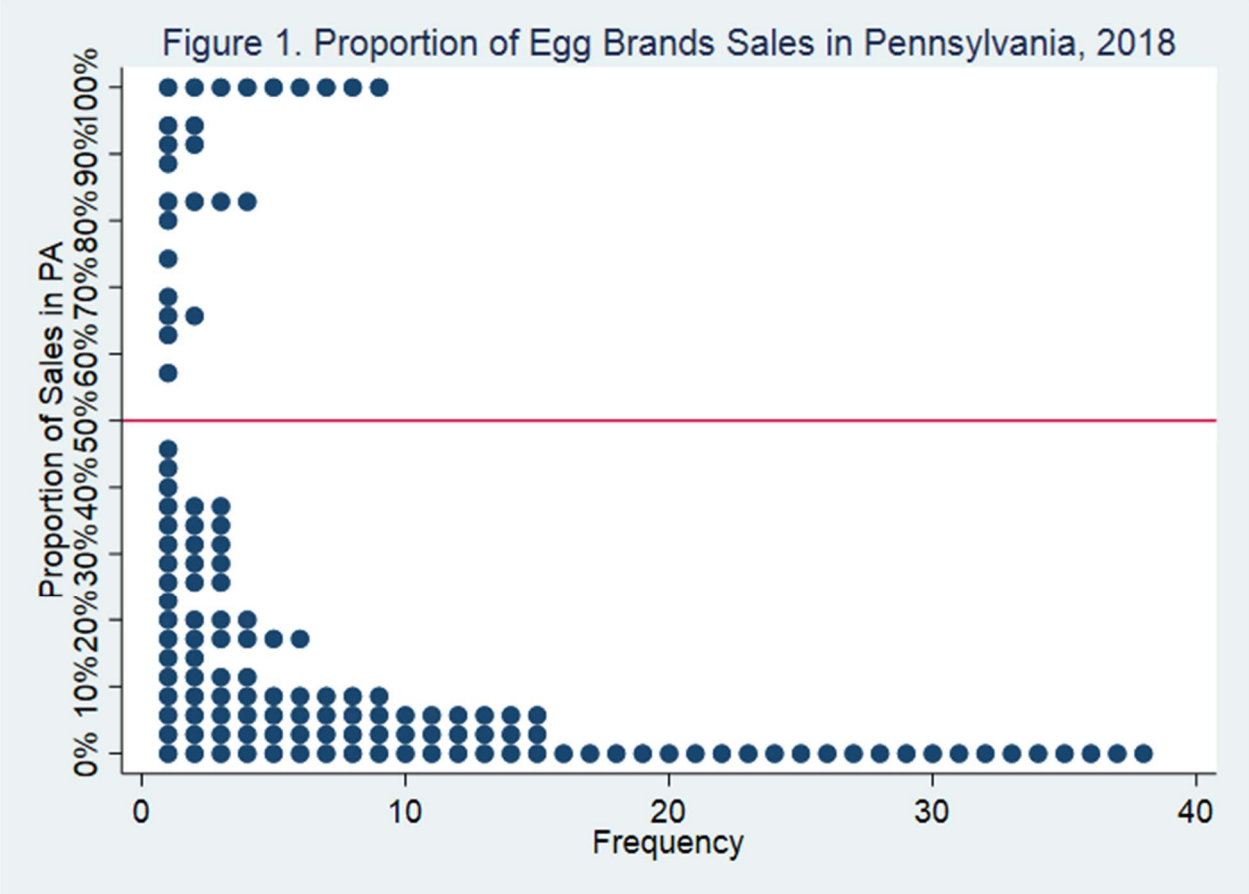
One important designation not in the IRI data is an indicator of localness. This omission is not at all surprising given (a) the complete lack of standardized definition of local foods and (b) a general lack of product origin information in any scanner data. To overcome this data obstacle, we construct an unorthodox but practical definition based not on where food product originates from, but rather where it is sold. Simply put, if a product is exclusively or intensively sold within a single state, we define that brand as local or, more accurately, as a locally sold product. We chose a state as the selling intensity region because many food and agricultural marketing programs are run by states (such as PA preferred) and many consumer studies link a state as the geographic boundary for localness; however, our method is flexible enough to use a smaller (or larger) region as the selling intensity region.

Our locally sold definition can be regarded as an algorithm: For each brand in the IRI data, we observe sales by state. From there, we identify the proportion of brand sales in each state relative to sales nationwide. Finally, we identify brands as locally sold if the state-level proportion of nationwide sales is above an arbitrarily assigned cutoff. We start with a 50 percent cutoff, but this percentage can be adjusted in robustness checks. Additionally, we cross reference the results of the algorithm using web-based, subjective brand identification searches to double check that our identified brands do appear to be marketed as local. Applying this algorithm to this paper's topic, eggs, we use the 50 percent cutoff to identify locally intense brands of

(chicken) eggs sold in Pennsylvania and assign this designation to relevant egg purchases in the IRI dataset.

Figure 1 shows the proportion of sales in Pennsylvania for each brand of eggs in the data. While 50% of a brands' sales in Pennsylvania seems like a natural cutoff, it is worth noting that for most national or even regional brands, the proportion of sales within a given state is likely to be quite small, often under 10%, as shown in figure 1. Meanwhile, many products which are marketed as "local" are sold in quite a small area and therefore likely to have a very large portion of their sales concentrated within the state. Therefore, any cutoff roughly between 20% and 80% identifies a relatively similar set of local brands.

Using all the various designations of eggs (i.e., locally sold, organic, cage free, private label) we calculate the market shares for each relevant combination. Table 1 presents these



market shares. Locally sold egg brands command a small portion of the market (3%), and we suspect that small, local grocery chains might also be perceived by consumers to be selling "local foods." Therefore, we also note the market share for locally sold private label eggs (8%). The

largest market shares for eggs are naturally held by national (21.4%) and private label (59.0%) brands of eggs with organic and cage free eggs holding small market shares with a large degree of intersection.

Table 1. Market Share by Attribute for Eggs Purchased in Pennsylvania, 2018

Designation	Market Share
Local Non-Organic	3.0%
National Brand Non-Organic	21.4%
National Brand Organic	0.4%
Local Private Label Non-Organic	8.0%
Private Label Non-Organic	59.0%
Private Label Organic	0.1%
Private Label Local Organic	0.1%
Cage Free National Brand Non-Organic	3.2%
Cage Free National Brand Organic	0.9%
Cage Free Private Label Organic	1.8%
Cage Free Private Label Non-Organic	2.1%

The IRI consumer panel also contains a large amount of demographic information, including income and other household characteristics. We also make use of a household's location at the census tract level. Using this information, we can match the household with a two key measures of rurality: population density and the amount of surrounding agricultural land. First, from the American Community Survey, a survey similar to the Census in its scope but on a smaller scale, we collect a measure of census tract population (U.S. Census Bureau, 2018). Then to construct a measure of population density, population per square mile by census tract, we measure area in square miles by census tract, defined by the 2010 Census (U.S. Census Bureau, 2010). The higher the population density, the more urban a household. We also measure the local agricultural environment by matching the household with a county, larger administrative regions in the U.S. which are not bisected by census tracts. We use a measure of the percentage of

agricultural land by county from the USDA's 2017 Census of Agriculture to measure the household's local agricultural environment USDA (2019). Figures 2 and 3 show how these measures describe the rural environment within the state of Pennsylvania. Here, one can see the densely populated urban centers of Philadelphia and Pittsburgh in the east and west respectively with very little surrounding agricultural land, the smaller cities and suburbs with some surrounding agricultural land surrounding throughout the state, the southern rural agricultural heartland, and the rural non-agricultural national and state forests in the north of the state.

We utilize a conditional logit for demand estimation (McFadden, 1973). This method

Figure 2. Population Density by Cenus Tract, Pennsylvania 2018

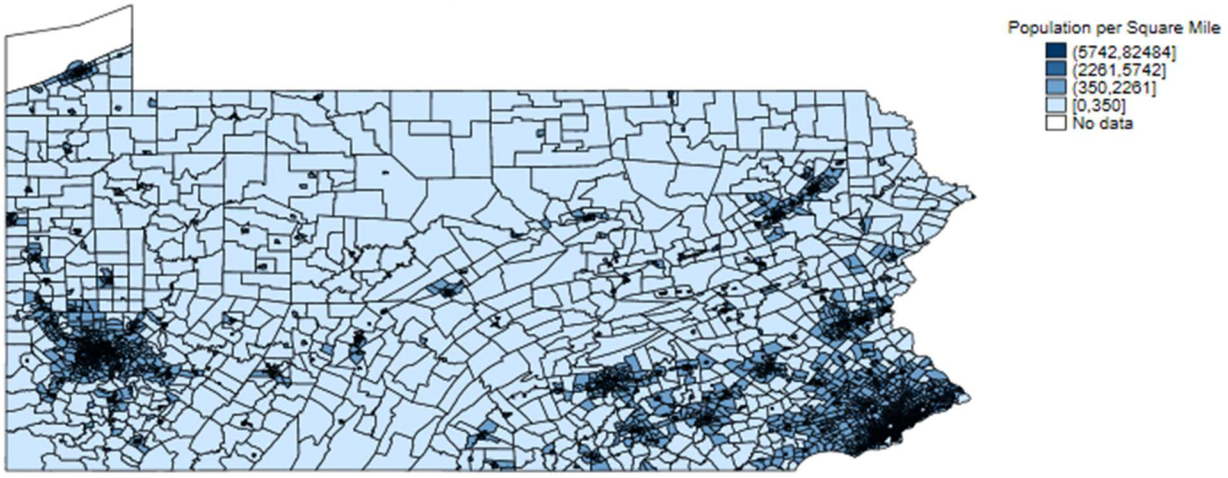
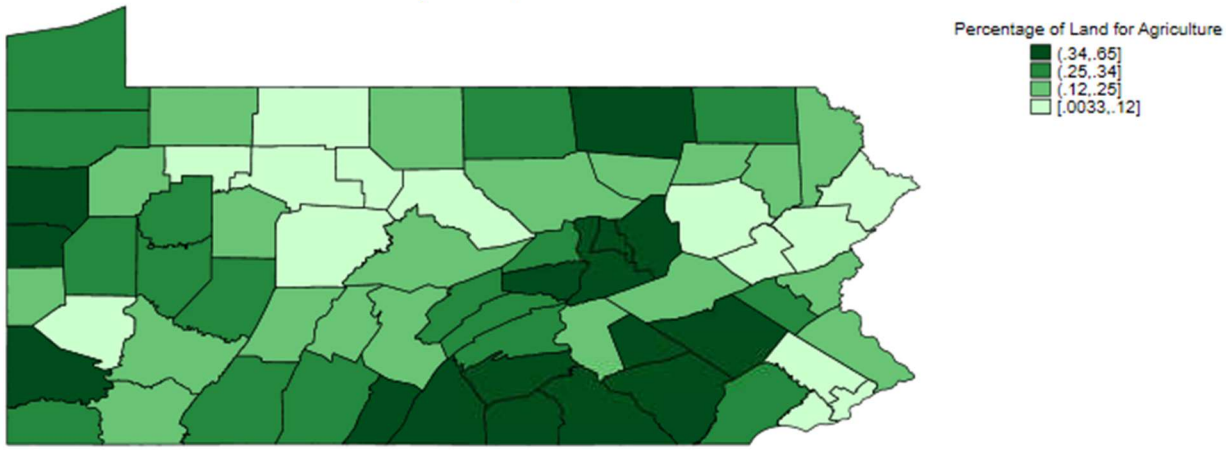


Figure 3. Percent of Land for Agriculture by County, Pennsylvania, 2017



constructs a choice set from which households are modeled to choose between alternatives. Utility is assumed to be a linear function of product attributes for products j in the choice set C_i

that can also vary across consumers i, $X_{i,j}$. In this case the primary attributes of interest include the product price and dummy variables for whether the eggs are local, organic, private label, or cage free. Households are assumed to choose each egg alternative with the following probability:

$$P(y_i = j) = P[X'_{i,j}\beta + \epsilon_{i,j} \geq max_{k \in C_i, k \neq j}(X'_{i,k}\beta + \epsilon_{i,j})] = \frac{exp(X'_{i,j}\beta)}{\Sigma_{k \in C_i} exp(X'_{i,k}\beta)}$$

We solve for the values of β which maximize the likelihood of observing purchase events in the data using maximum likelihood. We extend this model to measure urban-rural differences in demand by interacting the dummy variables for various attributes of eggs with our measures of population density by census tract and percentage of land for agriculture.

Constructing the choice set for this method is somewhat challenging. If we were to allow consumers to choose from every single unique UPC of eggs sold in Pennsylvania there would be thousands of choices which would be computationally infeasible. Thus, we assume that consumers choose milk from 11 unique combinations of alternative specific qualities (local, organic, cage free, and private label) and that unobserved error associated with the effect of specific products on choice is independently and identically distributed Type I extreme value and can thus be absorbed into the random error term. Additionally, if the choice set were to include every possible combination of different quantities of egg alternatives it would be effectively infinite. Thus, we limit each choice to a single container of eggs and assume that each choice of egg purchase is independent of others, even if they occur in the same shopping trip. However, we do correct for bias in standard errors due to purchases made by the same household by using cluster robust standard errors at the household level. While these assumptions regarding the choice set are powerful simplifications of the market for eggs, they allow us to capture the forces which are relevant for our analysis and allow computational feasibility.

Constructing prices under this choice set can also be problematic as it can be difficult to know which prices are available to which consumers across geography and time. There are many methods for dealing with prices in scanner data which may be appropriate in this context. For the current analysis, we construct a simple definition of price: the average annual price of the specific alternative in Pennsylvania which only varies across alternatives and not across geography and time in our sample. To construct this price, we divide the sum of total dollars

spent by all households in our sample per alternative and divide by the total unit quantity of each alternative. While this measure of price does not capture seasonal variation or variation across geography it does capture variation in price across alternatives which is most important for this analysis.

Table 2. Average Prices by Attribute for One Dozen Eggs Purchased in Pennsylvania, 2018

Designation	Average Price	Standard Deviation
Local Non-Organic	$2.08	$0.18
National Brand Non-Organic	$2.15	$0.20
National Brand Organic	$4.86	$0.14
Local Private Label Non-Organic	$1.69	$0.19
Private Label Non-Organic	$1.62	$0.05
Private Label Organic	$3.76	.
Private Label Local Organic	$3.74	.
Cage-Free National Brand Non-Organic	$3.45	$0.17
Cage-Free National Brand Organic	$4.97	$0.28
Cage-Free Private Label Organic	$3.94	$0.30
Cage-Free Private Label Non-Organic	$2.77	$0.13

Table 2 shows how these prices vary across designations, while organic and cage-free eggs clearly enjoy a price premium and private label eggs clearly demand a discount there is not a significant difference between the average price of local and non-local eggs among either private label or non-private label brands.

There is potentially an endogenous relationship between a product's unobserved qualities (e.g., taste, packaging attractiveness) and its price. This relationship can make it difficult to identify consumers' willingness to pay for local eggs independently of unobserved product attributes. For this reason, we employ an instrumental variables strategy to identify variation which is correlated with the price of the product but not correlated with the unobserved product characteristics. Hausman instruments which rely on the price of the product (or in this case product-attribute combination) in other markets and can be easily constructed from the IRI data. For initial estimation of these instruments, we take the alternative specific average price a neighboring state to Pennsylvania, New York state. This instrument is highly correlated with the price of milk in Pennsylvania. Ideally, Hausman instruments pick up common supply shocks

associated with producing and distributing different types of milk which are correlated with price. However, this would not be a valid instrument if demand shocks are common across markets. While this likely to hold for local products which are exclusive to a given market, it is less likely to hold for the case of national egg brands which likely set their price at the region level. Overall, this instrument is not ideal but provides a plausible partial solution to the problem of price endogeneity. We implement this instrumental variable approach using a control function following Petrin and Train (2010), to correct for error in estimation of standard errors associated with using constructed 1st stage residuals in the control function we use a bootstrap method.

III. Results

Table 3 shows the results from our conditional logit demand estimation as described above. This table includes estimates of willingness to pay for each local, organic, cage free and private label eggs. Willingness to pay can be easily calculated recognizing that the coefficient estimates for each attribute represent marginal utilities, the willingness to pay for a given attribute is simply the negative of the marginal utility of the attribute over the marginal utility of price. Model (1) shows the results of the estimation which does not include the control function to control for price endogeneity. There are some strange results in this estimation, namely a negative coefficient for local and organic and cage free products which would imply a negative willingness to pay for these attributes. However, adding the control function and Hausman price instruments seems to be a rather effective solution to the problem of price endogeneity, and in model (2) consumers are shown to be much more price sensitive than shown in model (1).

Using model (2), our preferred specification, we find that households' willingness to pay for organic and cage free eggs is positive and substantial. However, while the magnitude has shrunk, households' willingness to pay for local eggs is still negative, at least on average. When we consider the interaction between local and private label products, we see that, overall, households are willing to pay slightly less for private label products from local grocery stores than for eggs from slightly larger grocery chains. Overall, these results suggest that instead of households viewing local eggs as a premium product like they do for organic and cage-free eggs, they view them as an inferior substitute to other eggs. Potential explanations for the negative willingness to pay for locally sold eggs include the possible perception by households' that local eggs are lower high quality, possible lower-quality marketing or advertising for local eggs,

and/or the possible perception that local eggs should have a lower price because of their lower transportation costs.

Table 3. Conditional Logit Demand Estimation Pennsylvania Eggs 2018

	(1)	(2)
Local	-2.226***	-2.898***
	(0.0970)	(0.156)
Organic	-0.00849	3.742***
	(0.178)	(0.289)
Cage Free	-0.599***	0.851**
	(0.0930)	(0.277)
Private Label	0.00316	-1.241***
	(0.0501)	(0.223)
Local X Private Label	-1.855***	.614***
	(0.071)	(0.125)
Price	-1.554***	-4.066***
	(0.0672)	(0.435)
Alternative Specific Controls	Yes	Yes
Control Function	No	Yes
Change in Willingness to Pay for One Dozen Eggs		
Local	-$1.43	-$0.71
Organic	-$0.01	$0.92
Cage Free	-$0.39	$0.21
Private Label	$0.00	-$0.31
Local X Private Label	-$2.62	-$0.87

Notes: Standard errors in parentheses
* p<0.05 **p<0.01 ***p<0.001

We also assess how consumer demand for local eggs changes across different levels of rurality. It may be the case that proximity to and/or awareness of local agriculture makes rural households more (or less) willing to pay for local eggs, or it may be the case that urbanites perceive more benefits from local agriculture and have a stronger desire to "shop local". Table 4 presents results where we interact the various attributes of eggs with our two measures of rurality, population density by census tract and percentage of land for agriculture by county. More specifically we use the log of population density, as this variable is distributed with many households in areas of fairly low population density and a small number of households in areas

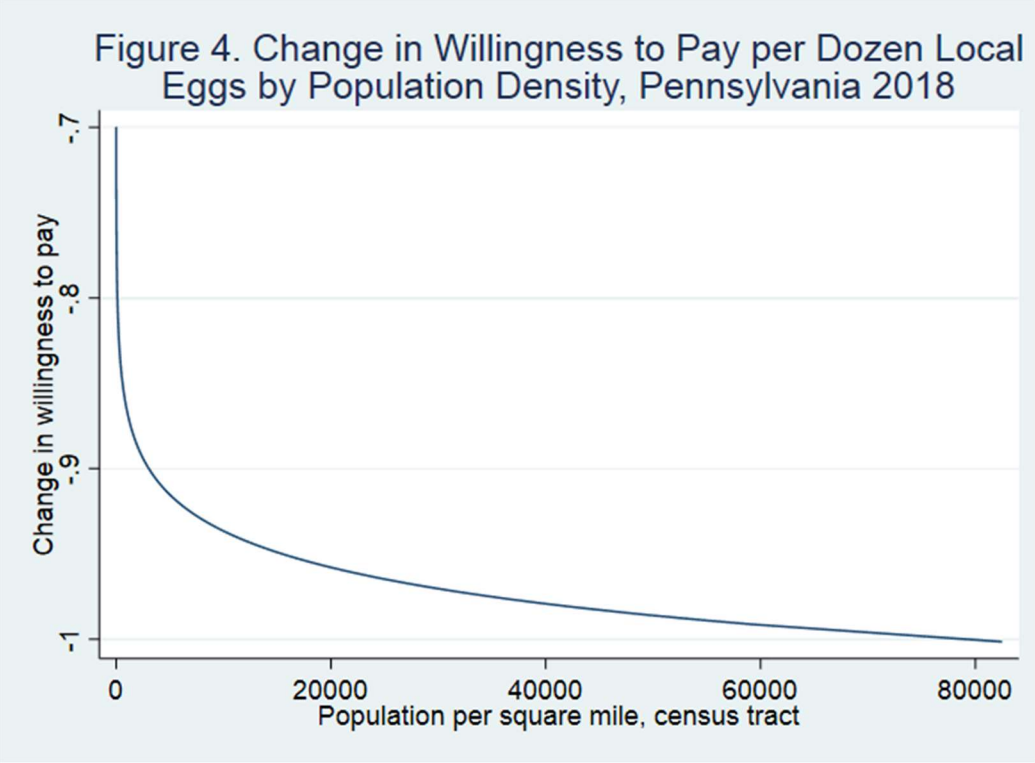
of very high population density. Throughout this analysis we control for the household's level of income to ensure that our results are not driven by the related dynamics of urban-rural differences in income; however, our income-related results not reported here.

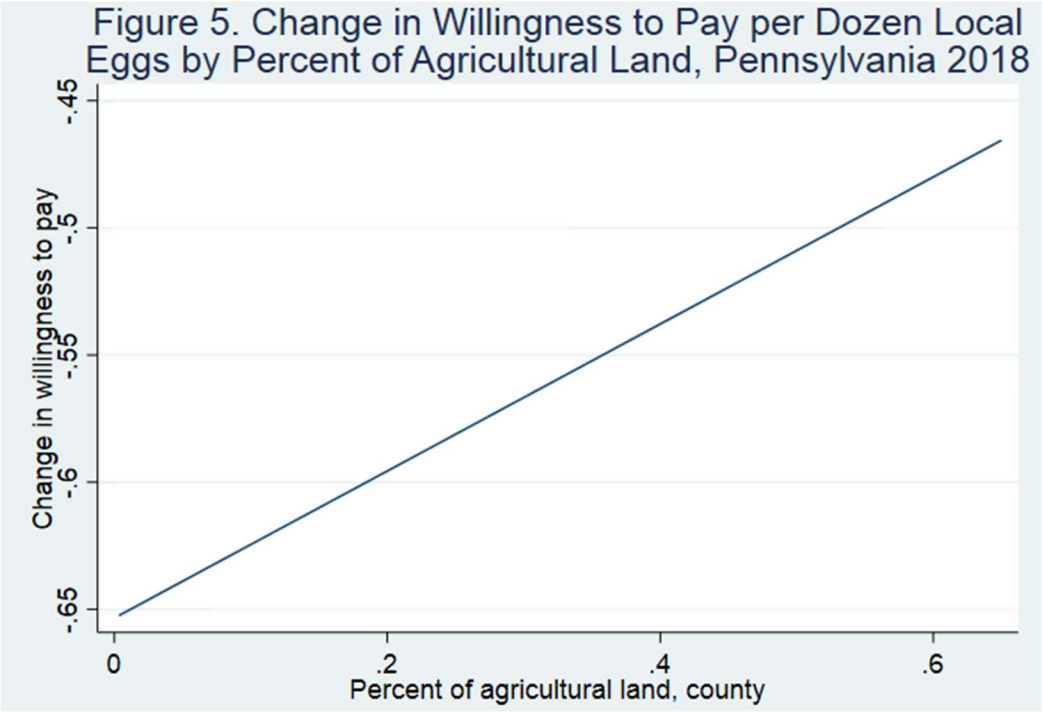
We see some interesting patterns with respect to the interactions between a households urban and agricultural environment and their demand for various attributes of local eggs. First, with respect to population density we see that demand for local eggs decreases with population density but not with a strong level of statistical significance. While we do not see much change in the demand for organic or private label eggs, the demand for cage-free eggs increases significantly with population density. Turning now to the effect of the local agricultural environment on demand. We see a positive relationship between the demand for local eggs and the percentage of land for agriculture in the household's home county, a result that implies that a stronger connection to the local agricultural environment increases households' willingness to pay for local eggs. We also observe some interesting patterns in the interaction between other attributes and the local agricultural environment. The demand for organic eggs decreases with the percentage of land for agriculture while the demand for private label eggs increases. Possibly, as we are already controlling for income effects, these results are capturing subtle geography-based preferences for thrift. Overall, with respect to local foods, we see that households who live in more rural areas and those that live in more agricultural regions of the state show more willingness to pay for local eggs; however, they do still expect a discount when purchasing local eggs as opposed to other eggs.

Table 4. Conditional Logit Demand Estimation by Pennsylvania Eggs 2018	
Local	-4.510*** (0.573)
X Log Population Density	-0.0769† (0.0407)
X Percentage of Land for Agriculture	2.449*** (0.411)
Organic	4.296 (2.193)
X Log Population Density	0.0586 (0.0573)
X Percentage of Land for Agriculture	-1.668** (0.598)
Cage Free	-0.367 (0.536)
X Log Population Density	0.107** (0.0351)
X Percentage of Land for Agriculture	0.196 (0.481)
Private Label	-1.592*** (0.378)
X Log Population Density	-0.0371 (0.0274)
X Percentage of Land for Agriculture	1.045*** (0.237)
Local X Private Label	0.632** (0.122)
Price	-4.877*** (0.424)
Alternative Specific Controls	Yes
Income Controls Control Function	Yes Yes
Notes: Standard errors in parentheses †p<0.1 * p<0.05 **p<0.01 ***p<0.001	

In figures 4-6 we estimate the average local willingness to pay for local eggs across the state of Pennsylvania based on the population density of the census tract and percentage of land for agriculture in the county, based on our coefficient estimates in table 3 and holding all else equal.

In figure 4, we plot the willingness to pay for local products across the various levels of population density in the state. Those in the most rural areas consumers are willing to pay about $0.70 less for a dozen local eggs than a nationally branded alternative, whereas those in the most urban areas are willing to pay about $1.00 less. In figure 5, we plot the willingness to pay for local products across various levels of agricultural land. Here we see that in the most agricultural areas we expect consumers to be willing to pay about $0.45 less for a dozen local eggs than a nationally branded alternative, while in the least agricultural areas we expect consumers to be willing to pay about $0.65 less.





In many areas of Pennsylvania, we expect a reinforcing effect between these two measures of rurality. That is, in many areas with a large amount of agricultural land there is low population density and in many areas of low agricultural land there is high population density. In figure 6, we plot our estimates for the average willingness to pay for local eggs by the population density of the census tract and the percentage of agricultural land in the county. Here we see the highest willingness to pay for local eggs in the most agricultural areas of the state with low-population density, the southern agricultural heartland, especially in Lancaster County. (Lancaster County, the darkly shaded region in the Southeast portion of Figure 6, is perhaps the best example of the reinforcing effect mentioned above. Lancaster county has both a large share of agricultural land and generally low population density.) We predict the lowest willingness to pay for local eggs in the state's major cities, Philadelphia and Pittsburgh. While we do not see any areas where the willingness to pay for local eggs is higher than the willingness to pay for national brands, we see a strong increase in willingness to pay for local eggs in more rural and more agricultural areas.

Figure 6. Willingness to Pay for Locally Sold Eggs by Population Density and Percent of Agricultural Land, Pennsylvania 2018

IV. Discussion

This paper contributes to the literature in two important ways: First, it attempts to solve the empirical and conceptual problem of not being able to study local food using micro-level scanner data by proposing an unorthodox yet practical definition that works well empirically. More specifically, we propose a local food definition based on the concept of how intensively local a product is sold rather where it is produced. If consumers equate the localness of the product's origin with its marketing area, then our practical definition will perform similarly to more traditional definitions of local food. Of course, this equivalency is not observed in our dataset. However, even if consumers do not make a perfect equivalence between production origin and local sales intensity, it still may be a useful workaround that allows common micro-level scanner datasets to be used in studies of local food.

The second contribution involves not just estimating consumers' willingness to pay for particular product attributes (such as organic, local, and cage free), but allowing the willingness-to-pay measures to vary across the rural-urban landscape. By investigating this variation in our estimated models, we find that (a) the positive willingness to pay for organic is not sensitive to population density but does decrease as the amount of agricultural land increases, (b) the willingness to pay for the cage-free attribute depends on population density, with consumers in more densely populated areas having higher valuations, and (c) the willingness to pay for our unorthodox definition of local is negative, gets more negative as population density increases,

but less negative as the amount of agricultural land increases. This last result, that consumers do not positively value locally sold food is an important result, as many studies either assume that valuation is positive or find a positive valuation in surveys and choice experiments. Unfortunately, there is no scanner data-based research on local foods to compare our results with.

Because the current study has several important limitations, we view these empirical results as just the start of intensive research on locally sold foods using the scanner data. First, from a modeling perspective, a conditional logit may not be the best choice. Future work will focus on random coefficient mixed logits. Second, our study focuses on just one U.S. state (Pennsylvania) and one consumer product (eggs). While results for Pennsylvania and for eggs hold for other places and products, future work will attempt to confirm this by expanding our analysis to other states and to other products. Third, this paper makes some powerful simplifying assumptions about the choice set and prices for eggs. A more complex treatment of these factors may lead to more robust results.

We would caution against reading from this study that local eggs and local products in general are not valuable to consumers, producers, marketers, and policymakers. From a consumer perspective we show that as consumers are more exposed to local foods, their willingness to pay for them increases. It is not impossible that for some products, or with a more robust model specification, we may see positive willingness to pay for local products at least among some consumers. Producers are likely aware that locally branded eggs do not sell as well as nationally branded eggs; however, taking advantage of transportation cost savings, local eggs and other local products could be competitive and profitable at a lower price point. Marketers should be aware that we observe an increase in willingness to pay for consumers who are more exposed to local products through their local agricultural environment. This passive exposure could be augmented through better marketing. Indeed, in many local egg brands we have seen the packaging has not done a good job of informing consumers that the product is locally produced. Finally, from a policymaker point of view, local foods present an opportunity to grow local economies and exercise tighter control over production methods and environmental considerations. For more rural areas, local foods present a marketing opportunity with limited extra costs. As willingness to pay for local food seems to grow with proximity to agriculture,

urban agricultural systems present an opportunity to expose consumers to local agriculture and thus increase their demand for local foods.

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