Can Increasing Fuel Costs Make Locally Produced Food More Competitive?

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Background

Fresh produce in the United States often travels thousands of miles in diesel operated semi-trucks before arriving to market. Under a high fuel cost scenario, the current low cost, efficient supply chain could become a high cost organizational structure for US food distribution. Rising transportation costs of food sourced from distant locations may provide competitive opportunities for small- and mid-sized local producers if transportation costs are a smaller portion of their total costs. Farmers selling fresh produce in east Tennessee farmer markets are surveyed to obtain baseline information on their transportation energy use to deliver their products to market. Local farmers' energy use is compared to three conventional transportation scenarios for fruits and vegetables grown in California, Texas, and Florida. A comparative analysis of conventional and local transportation energy consumption serves as an indicator of whether local farmers' locational advantage in accessing nearby markets could open competitive opportunities over the conventional food supply chain in a high fuel cost scenario.

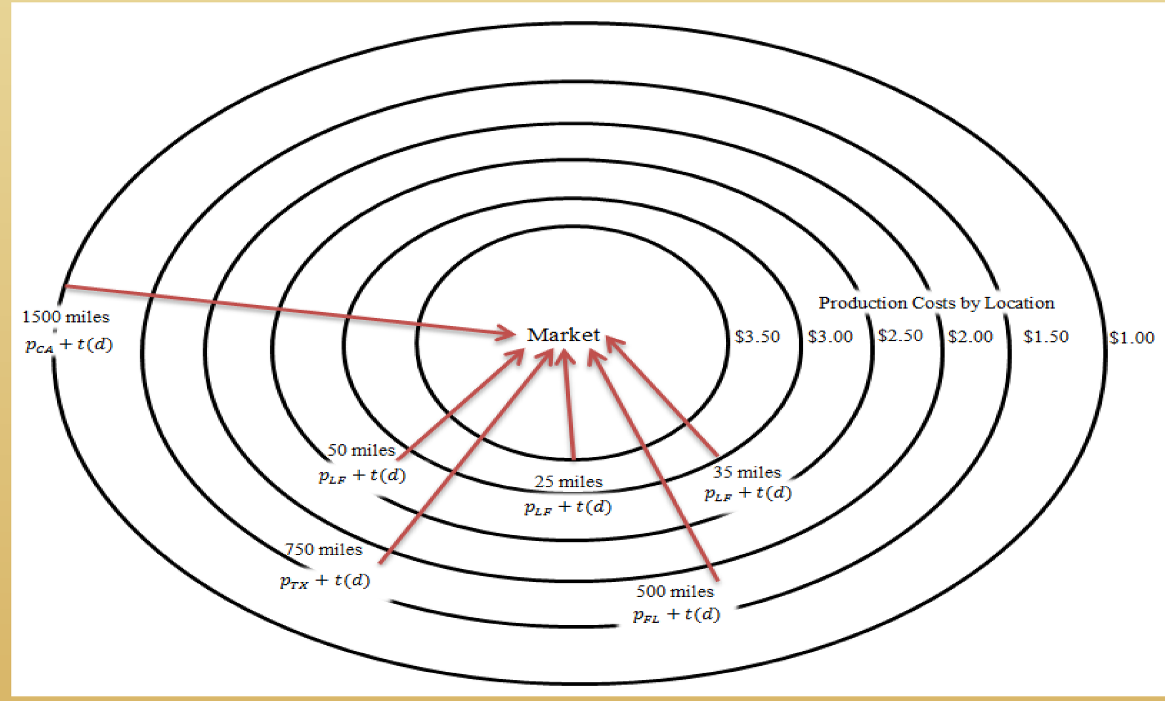
Research Objectives

- Obtain information on energy use of transporting locally grown products for sale in nearby markets in east Tennessee.
- Compare the transportation energy use of local producers with the transportation energy uses of producers of similar crops using conventional, long-distance sourcing practices.
- Determine optimal production and distribution scales for local farmers to achieve a per-unit supply chain efficiency that is competitive with conventional agriculture food networks.

Conceptual Framework

Comparative Advantage in Production vs Locational Advantage in Transportation

Weber Location-Production Model



Left: If production costs, product quality, and quantity are equal among local and conventional farmers, the per unit transportation costs in delivering food to market determine the lowest cost option of sourcing fresh produce. However, the Weber location-production diagram illustrates that production costs of farms located 1,500 miles from market are lower than for farms within 50 miles of market.

Above: Fruits and vegetables are sourced from more distant locations because the cost of purchasing these foods is sufficiently low to compensate the additional transportation costs.

- Conventional producers of fruits and vegetables in distant locations often have comparative advantages and scale economies in production compared to small, local food producers.
- If rises in fuel prices were to increase transportation rates sufficiently, the savings of purchasing fruits and vegetables from the more distant locations may be reduced because of higher transportation costs of the conventional transportation system.
- Local farmers less dependent on fuel for transportation may not be as affected by fuel price increases, if their transportation fuel use is lower than food shipped conventionally.
- Marketing opportunities may become available to farmers due to their locational advantage in delivering their produce to nearby consumer markets.

$$\begin{array}{l} P_{CA} + t(d, p_{fuel}) \\ P_{TX} + t(d, p_{fuel}) < P_{LF} + t(d, p_{fuel}) \\ P_{FL} + t(d, p_{fuel}) \end{array} \rightarrow \Delta t(d, \uparrow p_{fuel}) \rightarrow \begin{array}{l} P_{CA} + \frac{\partial t}{\partial p_{fuel}} \\ P_{TX} + \frac{\partial t}{\partial p_{fuel}} \\ P_{FL} + \frac{\partial t}{\partial p_{fuel}} \end{array} \leq P_{LF} + t(d, p_{fuel})$$

Food is grown and shipped in CA, TX, and FL at lower cost than local farmers (LF).

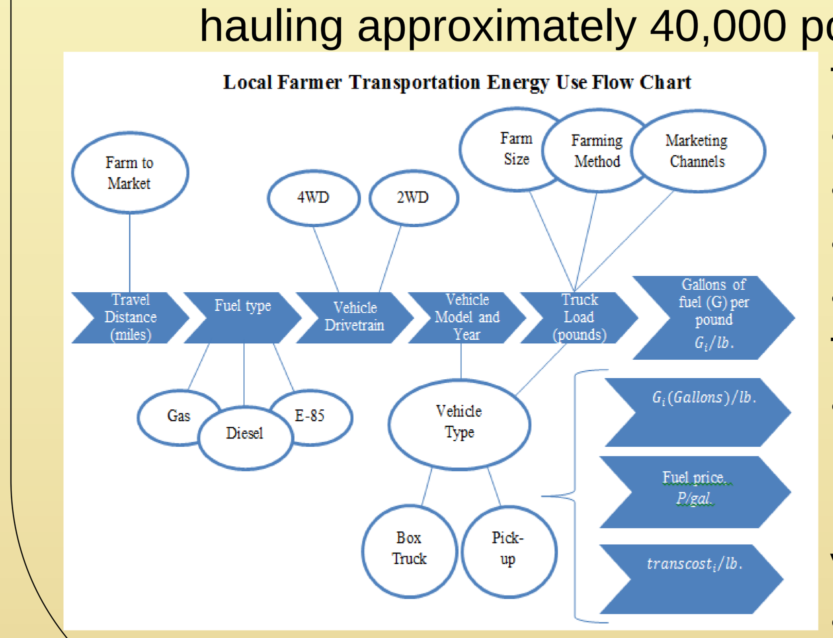
Increase in transportation costs due to increase in p_{fuel}.

Higher fuel prices give local farmers more marketing opportunities.

Methods

Transportation fuel use efficiency is measured as the total transportation fuel use (gallons) per one hundred pounds (cwt.) of produce delivered to market (*g/cwt*).

- To estimate local farmers' transportation fuel use efficiency:
  - A survey of farmers selling fruits and vegetables in direct-to-consumer local markets in east Tennessee is conducted.
  - 29 farmers are interviewed on their travel route to market, vehicle characteristics, truckload weight, size of operation, and marketing strategies.
- To estimate the transportation fuel use efficiency for the conventional food supply chain:
  - 3 Scenarios : Shipping points from Palm Beach County, FL., Hidalgo County, TX., and San Joaquin Valley, CA.
  - Terminal market location in all scenarios is Knoxville, TN.
  - Fruits and vegetables are shipped in 48-53 foot, diesel operated semi-trucks hauling approximately 40,000 pounds of produce per trip at 5.7 MPG.



Transportation fuel use efficiency depends on:

- Travel distance to market
- Truckload weight
- Vehicle fuel economy (MPG)
- Delivery logistics.

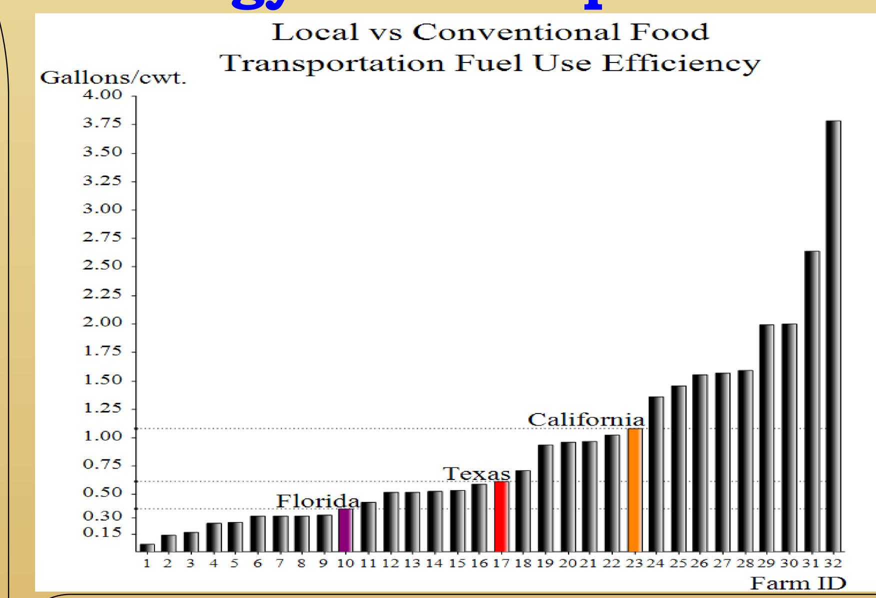
Truckload weight affected by:

- Acres planted in fruits and vegetables, farming practices, vehicle size, alternative marketing channels per week.

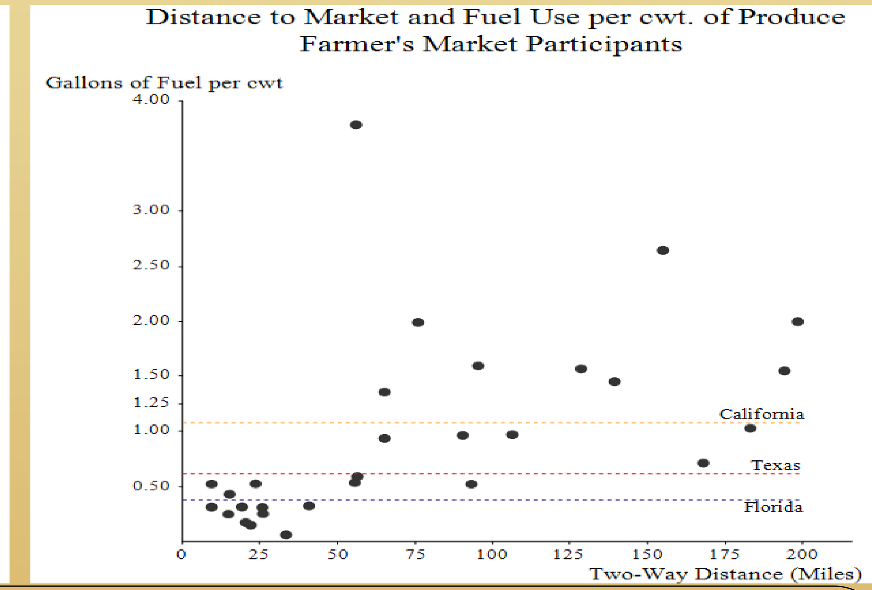
Vehicle fuel economy is estimated by:

- Vehicle model and year, fuel type, and drivetrain.

Energy Use Comparison



Food Miles to Fuel Use

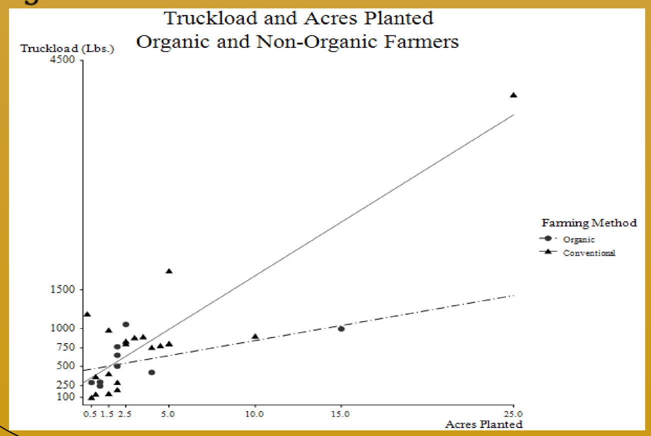


Left: 69% of the surveyed farmers' *g/cwt.* is lower than produce shipped from California. However, the same percent of farmers' *g/cwt.* is greater than produce sourced from Florida. **Right:** Farmers traveling less miles to market tend to consume less fuel per unit compared to farms farther from the market. Farmers with longer travel distances to market can improve their fuel efficiency by either increasing their truckload weights or using more fuel efficient vehicles.

Transportation Fuel Use Efficiency

The Impact of Scale

- There is growing interest in scaling up local food production and distribution so that it has similar transportation efficiencies to the conventional food supply chain.
- Most cited way to improve efficiencies is by increasing truckload weight.
- An exploratory, ordinary least squares (OLS) regression model tests hypotheses on how local farmer production and distribution scales affect truckload weights transported to market.
- $truckload_i = \beta_0 + \beta_1 acres_i + \beta_2 organic_i + \beta_3 acresorg_i + \beta_4 boxtruck_i + \beta_5 mktchannels + e_i$



- OLS model accounts for differences in truckload weights among the surveyed farmers with different farming practices.
- Coefficients of most interest:
  - *acres* and *acresorg:* Production scale (acres planted in fruits and vegetables)
  - *boxtruck:* Distribution scale (Vehicle type: pick-up or box truck

OLS Results

Larger Farms, Larger Trucks, Larger Loads

Table. Regression Output for Average Truckload (Lbs.) Per Market For Farmer's Market Participants

Variable	Coefficient	*t*-statistic (Standard error)	*P*-value
intercept	215.56	1.915 (112.54)	0.068
acres	128.67	10.623 (12.11)	0.0000**
organic	209.65	1.503 (139.48)	0.146
acresorg	-119.65	-4.909 (24.37)	0.0000**
boxtruck	574.81	4.892 (117.49)	0.0000**
mktchannels	-30.95	-0.553 (55.96)	0.586

n=29

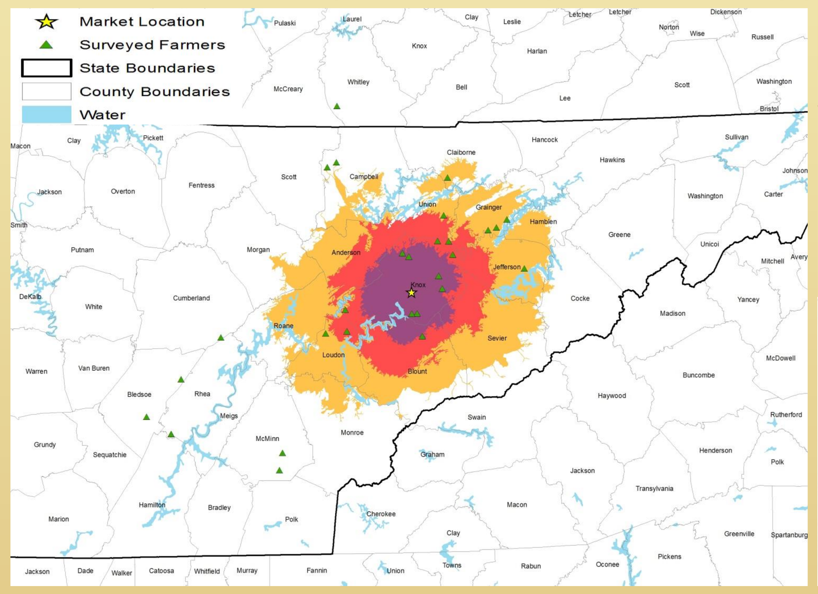
- An additional acre planted in fruits and vegetables for a surveyed non-organic farm adds, on average, 129 lbs. more weight to truckloads.
- A farmer using a box truck carries 575 lbs. more produce to market than a farmer using a pick-up truck, controlling for all other variables.

Sensitivity Analysis

Travel Distance Thresholds: Maintaining a Locational Advantage

Using the truckload regression coefficients and average miles per gallon (MPG) estimates of farmers' vehicles, a sensitivity analysis is conducted to observe how variations in truckload and vehicle fuel economy affect local farmer travel distance thresholds - the maximum travel distance to market before the local farmer loses his/her locational advantage over conventionally transported food in terms of fuel use per unit of produce shipped.

Scenario 1



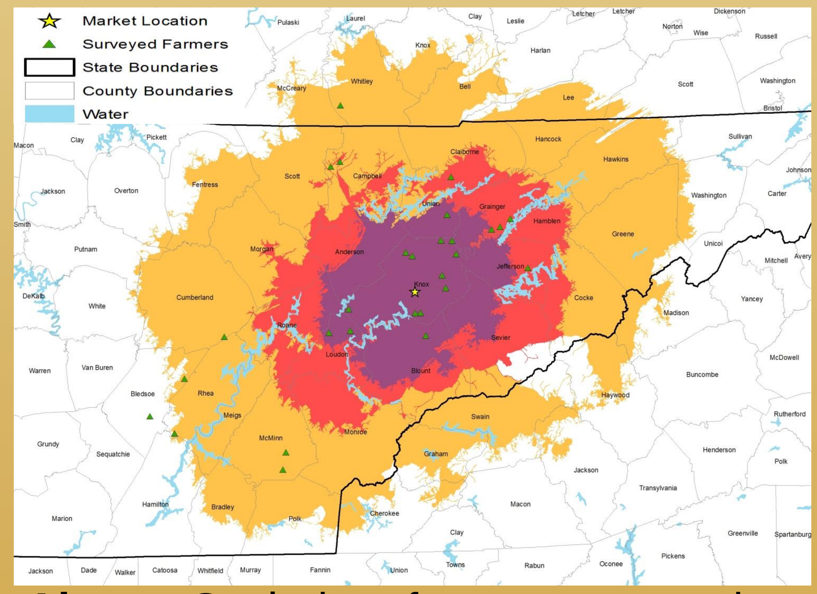
Scenario 1	
Area Planted in Fruits and Vegetables	2.25 acres
Farming Method	Conventional
Vehicle Type	Pick-up, 2-WD, Gas
Estimated Truckload Weight	443
Vehicle Fuel Economy	18.6 MPG

Threshold Travel Distances

Locational Advantage over Food Shipped from:	Miles to Market
Florida, Texas and California	<= 15.5 Miles
Florida and Texas	<= 25.5 Miles
California	<= 44.0 Miles

Above: Because the farm's production and distribution scale is small, the travel distance to market must be low in order for the farmer to compete with conventionally transported produce.

Scenario 2



Scenario 3	
Area Planted in Fruits and Vegetables	6 acres
Farming Method	Conventional
Vehicle Type	Box Truck, 2-WD, Gas
Estimated Truckload Weight	1501
Vehicle Fuel Economy	10.7 MPG

Threshold Travel Distances

Locational Advantage over Food Shipped from:	Miles to Market
Florida, Texas and California	<= 30.0 Miles
Florida and Texas	<= 49.5 Miles
California	<= 86.0 Miles

Above: Scaled-up farmers can market their products up to 86 miles from market.

Conclusions

If local farmers hope to compete with the conventional food supply chain in a high fuel cost scenario, they must at least capitalize in the area of transportation for which they potentially have a locational advantage. Yet when evaluating local farmer transportation fuel use, many surveyed farms have higher per unit transportation energy consumption than conventionally sourced food from CA, TX, or FL.

One strategy local farmers could utilize to improve their transportation fuel use efficiency is to increase their production and distribution scales. Results from the sensitivity analysis show that as farms increase their acreage in production and vehicle size, the number of farms inside the competitive transportation zones increases. Calculations of travel distance thresholds and competitive zones of local food distribution may be useful to local farmers, regional governments, and others interested in building resilient local food economies.