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The Hidden Benefits of Short Food Supply Chains: Farmers' Markets Density and Body Mass Index in Italy

Francesco Bimbo[ⓘa], Alessandro Bonanno[b], Gianluca Nardone[c], and Rosaria Viscecchia[d]

[a] *Postdoctoral Researcher, University of Foggia, Department of the Sciences of Agriculture, Food and Environment, Via Napoli 25, Foggia, 71122, Italy*
and
Doctoral Candidate, Business Economics Group, School of Social Sciences, Wageningen University, Hollandseweg 1, Room 6040, P.O. Box 8130, 6706 KN, Wageningen, The Netherlands

[b] *Assistant Professor of Business Economics, Business Economics Group, School of Social Sciences, Wageningen University, Hollandseweg 1, Room 6040, P.O. Box 8130, 6706 KN, Wageningen, The Netherlands*
and
Adjunct Assistant Professor, Department of Agricultural Economics Sociology and Education, Pennsylvania State University, Armsby Building, University Park, Pennsylvania, 16802, USA

[c] *Full Professor, University of Foggia, Department of the Sciences of Agriculture, Food and Environment, Via Napoli 25, Foggia, 71122, Italy*

[d] *Assistant Professor, University of Foggia, Department of the Sciences of Agriculture, Food and Environment, Via Napoli 25, Foggia, 71122, Italy*

Abstract

As more farmers adopt short distribution channels, consumers may benefit from them insofar as they increase access to healthier food options. This may lead to potential societal benefits via a reduction in obesity rates. The relationship between the presence of farmers' markets and adult Italians' Body Mass Index (BMI) was assessed by applying quantile regression on a cross-sectional, individual-level database, matched with regional farmers' markets density figures. Findings illustrate that for most adult Italians, a higher density of farmers' markets is associated with lower BMIs and that this relationship becomes more marked for individuals with higher BMIs facing limited supermarket access.

Keywords: farmers' markets, BMI, obesity, supermarket access, quantile regression

[ⓘ]Corresponding author: Tel: + 1. 39 0881589316
Email: F. Bimbo: francesco.bimbo@unifg.it
A. Bonanno: alessandro.bonanno@wur.nl
G. Nardone: gianluca.nardone@unifg.it
R. Viscecchia: rosaria.viscecchia@unifg.it

Introduction

The term Short Food Supply Chain (SFSC) refers to any form of direct sale from farmers to consumer (Ilbery and Maye 2005), and it is often used in opposition to mainstream global food supply systems based on large-scale production and product standardization. SFSCs encompass multiple sales schemes such as: on-farm direct sales, farmers' shops, farmers' markets (hereafter FMs), and partnerships between producers and consumers, all aimed to minimize the number of intermediaries. On average, farms involved in SFSC activities are small-scale businesses with less than 10 hectares, typically joining in a scheme that involves less than 10 producers (Kneafsey et al. 2013).

Farmers' participation in SFSCs is increasing in developed countries. During the period between 1994 and 2009, the number of FMs in the United States has more than tripled from 1,755 to 5,274 business units (Martinez et al. 2010). The European Union presents growing numbers of SFSC schemes, whose presence varies, however, by country (Kneafsey et al. 2013). Italy presents an interesting case, as it is one of the EU member countries to have introduced a specific legislative decree for the regulations of FMs (Kneafsey et al. 2013), and the demand for products supplied via short channels is growing. According to Coldiretti, the largest Italian farmers' association, the number of Italian consumers shopping at SFSCs is sizeable: about 1 in 6 Italians (circa 9.2 million) shopped at an FM at least once in 2011 (Coldiretti 2012). SFSCs' adoption in Italy is growing: in 2009 in Italy there were circa 63,600 Italian farms practicing on-farm direct sales twice the number recorded in 2001 (Coldiretti 2009), while the number of Italian FMs' doubled between 2009 and 2012 from 550 to 1105 (Coldiretti 2012).

From a business stand point, SFSCs give farmers an opportunity to avoid middlemen and retailers and, as a result, to internalize larger margins, as well as to have direct access to consumers who are more willing to pay for locally produced foods (Gilg and Battershill 1998). Participation in SFSCs may help farmers to survive during periods of crisis since they may retain a higher share of profits compared to those they acquire when taking part in a regular supply chain (La Trobe 2001). Farms' participation in SFSCs seems to have beneficial societal spillovers: for example, shopping at FMs increases customer satisfaction due to freshness and quality of products (Govindasamy et al. 2002), reconnects people to the local community (Gale 1997), and facilitates social interaction, thus promoting the development of trust and social capital (Hunt 2007).

Although there exists a considerable number of analyses of the beneficial societal effects of SFSCs (see Brown 2002; Brown and Miller 2008 for literature reviews), there is only limited research assessing their potential impact on consumers' diets. Pascucci et al., (2011) found that FM shoppers report an increased consumption of organic products, while Hawkes et al., (2012) indicate that SFSCs may have a positive impact on consumers' health. Improved access to FMs leads to an increased consumption of healthy foods such as fruit, vegetables, and wholesome foods, which could, in turn, result in a better nourished population (*e.g.* Frieden et al. 2010). U.S.

studies have shown that higher densities of FMs' and Community Supported Agriculture[1] are inversely related to individual weight outcomes (Berning 2012) and that SFSCs have a negative association with obesity rates and diabetes prevalence (Salois 2012).

If the presence of SFSCs improves access to healthier food options, it may play a role in ameliorating diets in developed countries where growing obesity rates have become one of the biggest health concerns. With increasing overweight and obesity rates, expressed as the percentage of the adult population with a Body Mass Index (BMI)[2] greater or equal than 24.9 and 30 (respectively), policymakers have taken action to reduce the social cost of the phenomenon, due to the growing demand for health-care services and lower labor productivity (Fry and Finley 2005).[3] In spite of the fact that academics have studied the role played by the food environment[4] on diets and obesity, in particular in the United States (see White 2007, for a literature review), the European Commission's actions to prevent and mitigate obesity have downplayed this role. In the context of diet and health measures, Traill (2012) finds that in the European Union, about two thirds of activities focus on supporting informed choices (*e.g.* advertising controls, nutrition education campaigns, and changes in food labelling) and only 2 out of 121 policies are directed to improve food availability for disadvantaged consumers. In spite of the fact that consumers need information, access, and choice to select healthy foods effectively (*e.g.*, Mazzocchi and Traill 2005), little has been done in Europe to improve access to healthy foods.

The goal of this study is to assess whether the presence of FMs is associated with lower values of BMI among adult Italians. We use a cross-sectional database of individual-level observations from the Multipurpose Survey of Households (ISTAT), matched with regional data on FMs' density, measured as the number of establishments per 100,000 inhabitants. As limited access to supermarkets can constitute a barrier to healthy diets and foster obesity (Moore and Diez Roux 2006), variables capturing households' hardship to reach supermarkets were interacted with FMs' density, under the hypothesis that those who have less (more) access to supermarkets may benefit more (less) from the presence of FMs. Following Pieroni and Salmasi's (2014) analysis of the relationship between fast food restaurants' presence and adult BMI in the UK, we used quantile regression to account for the changing relationship between FMs and BMIs at different levels of BMI. As FMs' may locate preferentially in areas of higher produce demand for produce, and since individuals' higher consumption of fruits and vegetables may result in lower BMIs (*e.g.* Lin and Morrison 2004; Rolls et al. 2004), the number of daily portions of fruits and vegetables' consumed are included to mitigate spurious correlation between FMs' density and BMI. Furthermore, the inclusion of socio-economic variables and other behavioral factors, as

[1] Community Supported Agriculture requires contractual agreement between a farm and a group of consumers who purchase a "share" of a farms' production in advance. This allows farmers to plan production for a guaranteed market and have the resources upfront for the purchase of inputs (Cone and Myhre 2009).
[2] The Body Mass Index (BMI) is measured as the ratio of a person's weight in kilograms divided by the square of his height in meters (kg/m2) (WHO, 2007).
[3] The estimated annual direct costs of medical expenses associated with overweight and obesity in the United States are $147 billion while in the EU-15 they amount to circa €100 billion (Fry and Finley 2005; Hammond and Levine 2010).
[4] Cummins and Macintyre (2006) define the food environment as those factors influencing the availability of (or consumers' ability to access to) food that can be consumed at home and ready-to-eat food consumed away from home.

well as regional fixed-effects, reduced further the likelihood of unobserved factors influencing consumers' diets and BMI. Nevertheless, this analysis measures the association between FMs density and BMI without implying the existence of a causal relationship.

The Italian case study was chosen for two reasons. First, only a limited number of analyses exist investigating how the food environment impacts obesity in Europe (*e.g.* Bimbo et al. 2012; Pieroni and Salmasi 2014) and in particular, in Italy (Bimbo et al. 2012). Second, there is a large disparity in the geographic diffusion of FMs in Italy, which mirrors adult BMIs: as shown in Table 1, Southern and Islands' regions present the highest BMIs, the lowest number of portions of fruit and vegetables consumed, and the lowest density of FMs. These patterns are reversed in the North-East.

Table 1. BMI, fruit and vegetables consumption, and farmers' market density across Italian macro-areas.

Area	BMI	Fruit and vegetables[1]	Farmers' market density
North East	24.87	2.34	1.40
North West	24.92	2.30	1.01
Center	25.10	2.35	0.92
South	25.70	2.08	0.56
Islands	25.38	2.19	0.45
Total	25.17	2.25	0.93

Source. Authors' own elaboration from MHS and Coldiretti data.
[1] Daily portions consumed

The next section illustrates the empirical model, followed by a discussion of the data and estimation technique used in the analysis. The empirical results and their discussion follow while a section that includes conclusions and results' implications (and their limitations) will conclude the paper.

Empirical Model

To explore the association between SFSCs and adult Italian BMI, a simple linear empirical relation was posited based upon previous literature (*e.g.* Courtemanche and Carden 2011). The relationship between the BMI of adult Italian *i* in region *r* and a series of covariates explaining it is:

$$BMI_{ir} = \alpha + \sum_{d=1}^{D} \alpha_{AFM_d} ACC_{ir}^{d} FMD_r + \alpha_{FV} FVport_{ir} + \sum_{k=1}^{K} \alpha_{SE_k} SE_{kir} + \sum_{l=1}^{L} \alpha_{BE_l} BE_{irl} + \sum_{r=1}^{R} \alpha_{REG_r} REG_r + \varepsilon_{ir} \quad (1)$$

where αs are parameters to be estimated, ε_{ir} is an error term, and the other terms are explained below.

FMDr measures FMs' density, the number of FMs in region *r* divided by its population. The FMs' presence was expected to be negatively related to adult BMI as long as access to the short supply chain allows consumers to substitute for high caloric food and promote their consumption of healthier options (Berning 2012). As individuals are exposed to a multitude of food outlets, it was hypothesized that the relationship between BMI and FM presence may also be conditional on consumers' access to traditional food stores. The hypothesis is that FMs presence may have, relatively speaking, a larger effect in terms of supporting lower body weight on those who have fewer alternatives regarding where to buy food; that is, it was expected that FMs would have a more pronounced relationship with BMI for individuals with lower levels of access (Larsen and Gilliland 2009). Thus, in equation (1), *FMD* interacts with *i*s' declared level of hardship to reach supermarkets ACC_{ir}^{d} (*d*=1,..,*D*), representing a declared level of hardship, as discussed below, used as a proxy for the lack of access to other food stores.

FVport represents the number of daily portions of fruit and vegetables consumed. Fruit and vegetables consumption affects negatively adult BMI (Lin and Morrison 2004; Key et al. 2006) and it is also included in the model to reduce the spurious correlation between FMs' density and BMI. *SE* is a control vector of consumers' socio-economic characteristics (*e.g.* Drewnowski and Darmon 2005; Loureiro and Nayga 2005; Banterle and Cavaliere 2009). *BE* is a vector of *L* individual behavioral variables that are expected to have an impact on adult BMI, such as smoking habits, practicing sport, and time spent watching television (Lakdawalla and Philipson 2009; WHO 2004). *REG* are regional fixed-effects, to capture unobservable differences in diets across regions, as well as other unobserved factors that may affect adult Italians' BMI.

Data and Estimation

The main database used in our analysis is derived from one year (2009) of individual-level observations of the Multipurpose Household Survey (MHS) collected by the Italian National Bureau of Statistics (ISTAT). This survey uses a paper-and-pencil interview (PAPI) technique and is based on a face to face interview questionnaire and a self-administered questionnaire. The survey has taken place annually since 1993 and collects information on households and individuals characteristics (*e.g.* age, gender, level of education, smoking habits, practicing sport, and time spent watching television, etc.), as well as self-reported data on weight and height, which, for adult respondents, permits the calculation of BMI.[5] The survey sample was designed to be representative of Italian households at the national and regional level. The individual-level MHS data were matched with regional-level data on FMs' locations obtained from the Campagna Amica Foundation by Coldiretti, which encompasses circa 90% of the Italian FMs. FM density, *FMD*, was obtained by dividing the number of FMs by the region-level population in 100,000, from ISTAT. As indicated in the previous section, *FMD* is interacted with perceived access indicators form the MHS, capturing self-reported household-specific hurdles to reach a supermarket, classified as "no hurdles" (ACC^{NH}), "some hurdles" (ACC^{SH}) and "considerable hurdles" (ACC^{CH}).[6]

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[5] As discussed elsewhere in the literature (*e.g.* Hansstein et al. 2009), the self-reported height and weight measures from the MHS are likely to result in downward bias values of BMIs.

[6] MHS respondents are asked to declare their household's level of hardship in reaching a supermarket. The answers allowed are: no hurdles; some hurdles; considerable hurdles; I don't know. Observations for respondents responding "I don't know" were excluded from the data.

The MHS database also contains information on daily portions of fruit and vegetables consumed by each respondent (variable *FVport*). The other variables in the vectors *BE* and *SE* come from the MHS (except income) and are household size, age, age squared, gender (female), respondents' years of education, number of hours spent in front of the TV (as a proxy for inactive time), and indicators capturing marital status, smoking, and practicing sport regularly. As the MHS contains information on each individual's line of employment, a proxy was constructed for per-capita household income matched with regional statistics on net retributions by employment type (from the ISTAT Data warehouse 2009) for each individual, summing across household members divided by household size.[7] Observations with missing values and those of individuals below 18 years of age were dropped, since, for these, weight and height were not recorded. In order to mitigate the inclusion of individuals' misreporting of weight, height, and fruits and vegetables consumption, as well as those who may be dieting, we excluded from the analysis individuals with BMI > 30 (BMI<18.5) who claimed to consume more than 4 (less than 2) daily servings of fruits and vegetables. The total number of observations excluded was 259, less than 1.2% of the entire sample. The final sample contained 21,312 observations. Variables' descriptions and summary statistics are presented in Table 2.

One can obtain estimates of equation (1)'s parameters using Ordinary Least Squares (OLS), however, the estimated parameters would only represent the *average* effect of the explanatory variables related to adult Italians' BMI. As others have shown (*e.g.* Pieroni and Salmasi 2014), the relationship between BMI, the food environment, and individual characteristics may be non-linear: for example, the relationship between FMs and BMI may be more (less) marked for those individuals who have higher (lower) BMI. To obtain estimates of the relationship between FMs (as well as other covariates) and BMI at different points of its distribution, a quantile regression technique was employed (Koenker and Bassett 1978).[8]

$$(2) \quad \min_{\alpha \in \mathbb{R}^k} \left[\sum_{i \in \{BMI_i \geq X'\alpha\}} \theta |BMI_i - X'\alpha| + \sum_{i \in \{BMI_i \leq X'\alpha\}} (1-\theta)|BMI_i - X'\alpha| \right]$$

As is customary in analyses using quantile regression (*e.g.* Atella et al. 2008; Villar and Quintana-Domeque 2009; Pieroni and Salmasi 2014), the model parameters were evaluated at the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentile of the dependent variable distribution. All the estimation and data manipulation were performed in STATA v. 10.

[7] An income proxy was imputed for retirees using individual's "previous line of employment" matched with the average pensions for each profession from ISTAT. Households with zero income were dropped from the database.
[8] Furthermore, quantile regression exploits the differences in the relationship between dependent and independent variables, which, if not accounted for, could lead to issues of heteroskedasticity. In our case, non-constant variance of the error terms obtained via OLS was detected by means of the Breusch-Pagan/Cook-Weisberg test.

Table 2. Variables used in the estimation (N =21312).

Variable	Variable Description	Mean	Std. Dev.	Min	Max
BMI	Body Mass Index	25.31	3.65	15.6	41.7
FMD	Farmers' market density	0.93	0.51	0.0	1.9
ACC^{NH}	No hurdles to access supermarkets	0.70	0.32	0	1
ACC^{SH}	Some hurdles to access supermarkets	0.23	0.42	0	1
ACC^{CH}	Considerable hurdles to access supermarkets	0.07	0.26	0	1
FVport	Daily portions of fruits and vegetables consumed	2.26	1.41	0	16
House size	Number of household members	2.89	1.25	1	12
Age	Respondent's age	51.17	17.22	18.0	102
Age^2	Respondent's age square	2914.32	1846.01	324.0	10404.0
Female	Gender (Female=1)	0.41	0.49	0	1
Educ. Years	Years of education	10.04	4.50	0	21
Married	Marital status (Married=1)	0.61	0.49	0	1
Smoke	Smoking habits (Smoker=1)	0.25	0.44	0	1
Sport	Practice sport regularly (Yes=1)	0.19	0.39	0	1
TV Hrs	Daily hours spent watching television	2.81	1.68	0.0	15.0
Income	Annual income in 10,000€	1.79	0.48	0.8	3.4

Source. Authors' own elaboration from ISTAT and Coldiretti data**.**

Empirical Results and Discussion

Table 3 (see Appendix) presents the estimated parameters of equation 1 obtained via OLS (first column) and at the different percentiles of the BMI distribution (second to sixth columns) obtained using quantile regression, along with bootstrapped standard errors.[9] The R-squared in our models ranges between 7.3%-17.9%; albeit low, given cross-sectional nature of the data used and the finality of our study,[10] such range is acceptable. The values of the test statistics for the equality of the coefficients across quantiles are reported in the last two columns and indicate that for only 4 of the 21 estimated parameters (excluding fixed-effects) the null that they are statistically equal across quantiles cannot be rejected. Thus, the data support the use of quantile regression in place of OLS, as the relationship between the explanatory variables and BMI varies

[9] Two hundred random draws were taken to estimate the standard errors.
[10] Large R-squared would be preferable if one's goal was to make "*correct*" predictions of an individual's BMI. However, the focus of this analysis is to assessing the relationship between adult BMI and FMs' density. We thank an anonymous referee for raising this point.

along the distribution of the latter. The values of Italian adult BMI demarking the percentiles used in quantile regression are: 20.81 (10%); 22.72 (25%); 24.97 (50%); 27.47 (75%); and 30.07 (90%). Thus, the estimated coefficients at the 50^{th} quantile represent the effect of the explanatory variables on the BMI of borderline overweight individuals; those at the 75^{th} quantile represent the effect on the BMI of overweight individuals; while those obtained at the 90^{th} quantile represent the effect on BMI for individuals classified as obese.

The OLS coefficients show that FMD has an inverse relationship with Italian adult BMI, the magnitude of which becomes larger for individuals in households with considerable hurdles in accessing supermarkets (from -0.26 to -0.39). The estimated quantile regression coefficients show patterns similar to OLS ones, although differing across quantiles. At the lowest (10^{th}) quantile of the BMI distribution, FMD does not seem to be related to Italian adults' BMI; negative and statistically significant coefficients are instead found from the 25^{th} percentile onward. It should, however, be noted that we find weak evidence of FMs being related to adults' BMI for those individuals in households declaring some hurdles in accessing supermarkets. For these individuals, FMs have a negative and significant correlation with BMI only at the 75^{th} and 90^{th} BMI percentile (-0.286 and -0.359 points, respectively).

The presence of FMs shows an inverse relationship with the BMI of those individuals living in households with easy access to supermarkets (estimated coefficients are -0.205 and -0.199 for the 25^{th} and 50^{th} BMI percentile, respectively). At the same quantiles, the FM coefficients for individuals living in households with considerable hurdles in accessing supermarkets are one third larger: -0.297 (25^{th} percentile) and -0.279 (50^{th} percentile). For individuals in households with considerable hurdles in accessing supermarkets, the magnitude of the FM density effect is larger, indicating that one additional FM for 100,000 individuals would result in -0.518 and -0.652 BMI points for overweight and obese individuals, respectively. Overall, these results indicate that adult Italians with higher BMIs who are severely underserved by traditional food outlets may benefit the most from the presence of FMs, while those who have lower BMIs and live in households with limited (or no) hurdles in accessing traditional food stores benefit less.

Focusing on the other control variables, the OLS and quantile regression coefficients show signs that are consistent with previous literature. The number of daily portions of fruit and vegetables consumed is associated with lower BMIs, with a negative and statistically significant OLS coefficient (-0.049), and a gradient of quantile coefficients varying from non-statistically significant at BMI percentiles indicating normal weight, to negative and significant and a larger magnitude as one moves toward higher BMIs. The estimated coefficient is -0.03 for borderline overweight individuals (50^{th} percentile), -0.056 for overweight individuals (75^{th} percentile), and -0.16 for obese individuals (90^{th} percentile). Thus, people with an above average BMI may benefit more than others from an extra daily serving of fruit and vegetables, and the benefit grows as the BMI increases. In spite of the fact that the consumption of fruit and vegetables has been shown to promote BMI reduction (see Lin and Morrison 2004; Rolls et al. 2004), results indicated that its effect is likely to vary based on an individual's BMI.

The estimated parameters for the socio-economic and behavioral variables are in line with previous literature (e.g. Costa-Font and Gil 2008; Baum and Ruhm 2009). For brevity, this discussion will focus only on quantile regression estimates. Household size affects positively adult Italians' BMI, however, only for individuals at or above the 50th percentile of the BMI distribution. Furthermore, results show that being female and well educated is inversely related to BMI across all quantiles, while age (age squared) shows a positive (negative) association with it. The effect of years of education on BMI is always negative and statistically significant; the magnitude of this relationship grows from the lowest to the highest percentile (-0.057 to -0.126). Surprisingly, marital status shows a negative and statistically significant correlation with BMI for individuals only above the 75th percentile of the BMI distribution.

Also, smoking and practicing sport were found to have an inverse relationship with BMI; we find the largest negative association between smoking habits and BMI at the 25th and 90th percentiles of the latter's distribution, indicating that some non-linear relationship between smoking and BMI exists. Practicing sport shows a negative correlation with adult Italians' BMI, and the effect becomes larger with the BMI: the estimated coefficient for obese individuals (90th percentile) is -1.13, more than five times that estimated for normal weight individuals (25th percentile, -0.22). Similarly, hours spent watching TV is positively correlated with BMI, and the magnitude becomes larger with the percentiles (0.05 for the 25th percentile and 0.205 for the 90th). Last, income shows a negative and statistically significant relationship with adult BMI only for obese individuals (90th percentile). This result suggests that an increase in income may not necessarily translate into consumption of healthier foods as found by Drewnowski (2007).

Conclusion and Implication

In this paper, we investigated a potential societal benefit of the existence of SFSCs, the relationship between farmers' markets presence, and BMIs among adult Italians, using a cross sectional micro-level database of adult Italians' characteristics and habits (Multipurpose Household Survey - 2009) matched with regional data on farmers' market density and a quantile regression approach. The empirical results point to an inverse relationship between farmers' market density and adult Italians' BMIs, a relationship that strengthens at the higher percentiles of the BMI distribution. Disparity in access to traditional food stores affects this relationship, which becomes more marked for individuals living in households that face considerable difficulties reaching supermarkets compared to those declaring none or some hurdles.

The results support the beneficial effect of SFSCs on human health already found in the literature (Berning 2012; Salois 2012), and they could be used to promote SFSCs in general and FMs in particular. SFSC managers could promote FMs' expansion as a tool to help foster healthy choices and consumers, going beyond the traditional portrayal of them as instruments to increase farmers' income. This strategy may be particularly successful when it is emphasized that the beneficial effects may be larger for individuals who are in need of ways to engage in healthier diets (higher BMIs) or who face hurdles when it comes to accessing traditional food stores.

In light of the results illustrated here, policymakers may pursue the possibility of adopting measures that facilitate the development, performance, and continuity of SFSCs as a means to support consumers' wellbeing. This goal could be pursued in different ways. First, governments may directly support SFSCs by employing public "local" procurement schemes, increasing local food producers' profitability, as well as the nutritional quality of food served in public institutions and people's wellbeing. Public procurements are already regulated by law (EU

Procurement Directive 2004/18) and promoted as a policy tool to curb obesity, and some national and regional authorities in Italy are experimenting with a minimum share of products "locally sourced" or of "local origin" with the aim of improving people's health and local farmers' income (ENRD 2012). Second, institutions may indirectly sustain the diffusion of SFSCs' products by offering farmers education and extension services to help them with risky events (*i.e.* adverse weather conditions, infestants, and compliance with standards), which often prevent products' marketability and consumer acceptance (Gregoire et al. 2005; Tropp and Barham 2008; Shipman 2009). Third, local and regional institutions may help farmers to develop managerial skills, such as communication ability, market analysis, and commercial management (Hass et al. 2013). Promoting farmers' managerial mindsets will increase the level of their independence from public support systems that SFSCs tend to have and promote the long term persistence of SFSCs (Knickel et al. 2008).

In spite of their usefulness, the reader should be aware that the results discussed in this paper, as well as the methods used, are not free from limitations. At least two caveats should be kept in mind. First, the cross-sectional nature of the data and the type of estimation technique adopted does not allow for causal inference but is meant to be an exploration of the relationship between the presence of farmers' markets and adult Italians' BMI. Even though the potential endogeneity of FMs' location decisions should be appropriately taken into account to have unbiased estimates (Berning 2012; Salois 2012), the data available did not allow for such a refinement of the results. Thus, even though we controlled for potential confounding factors (i.e. consumption of fruit and vegetables) as well as other unobservables (regional fixed-effects), our results indicate only that a relationship exists between FMs' presence and lower BMIs among the adult Italian population, and no claims of causality can be made. Second, the fact that the level of detail of the FM data is regional means we can only measure the average impact of these variables across the population of a region. Although using quantile regression and the interaction of the FMD variable with the access indicators may capture the relationship between FMs and adult BMI at a more minute level, our data does not allow us to observe where consumers actually purchase their food, and the inferences we can make are, therefore, limited.

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Appendix

Table 3. Equation 1: OLS and quantile regression estimated parameters.

	OLS		Quantile Regression: Quantiles										Coef. equality test	
			0.10		**0.25**		**0.50**		**0.75**		**0.90**		$F_{(4, 21312)}$	Prob>F
FMD*ACC^{NH}	-0.263	***	-0.102		-0.205	**	-0.199	*	-0.436	***	-0.533	***	1.670	0.154
	(0.095)		(0.113)		(0.092)		(0.115)		(0.132)		(0.199)			
FMD*ACC^{SH}	-0.168		-0.104		-0.124		-0.117		-0.286	**	-0.359	*	0.600	0.665
	(0.103)		(0.116)		(0.104)		(0.126)		(0.144)		(0.215)			
FMD*ACC^{CH}	-0.390	***	-0.192		-0.297	**	-0.279	*	-0.518	***	-0.652	**	0.990	0.411
	(0.125)		(0.145)		(0.143)		(0.156)		(0.185)		(0.257)			
FVport	-0.049	***	-0.007		-0.010		-0.030	*	-0.056	**	-0.160	***	4.900	0.001
	(0.017)		(0.020)		(0.016)		(0.017)		(0.025)		(0.033)			
House size	0.093	***	0.039	*	0.036		0.071	***	0.077	**	0.180	***	2.100	0.079
	(0.022)		(0.022)		(0.022)		(0.027)		(0.030)		(0.052)			
Age	0.238	***	0.178	***	0.200	***	0.225	***	0.255	***	0.302	***	9.160	0.000
	(0.009)		(0.011)		(0.008)		(0.009)		(0.013)		(0.022)			
Age^2	-0.002	***	-0.001	***	-0.002	***	-0.002	***	-0.002	***	-0.002	***	5.270	0.000
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)			
Female	-1.974	***	-2.452	***	-2.486	***	-2.234	***	-1.790	***	-1.379	***	23.950	0.000
	(0.049)		(0.061)		(0.049)		(0.058)		(0.080)		(0.126)			
Educ. Years	-0.099	***	-0.057	***	-0.076	***	-0.102	***	-0.126	***	-0.126	***	10.770	0.000
	(0.006)		(0.007)		(0.007)		(0.008)		(0.010)		(0.014)			
Married	-0.144	**	0.066		0.018		-0.021		-0.161	*	-0.481	***	4.000	0.003
	(0.058)		(0.069)		(0.058)		(0.072)		(0.088)		(0.129)			
Smoke	-0.446	***	-0.400	***	-0.463	***	-0.335	***	-0.322	***	-0.535	***	2.410	0.047
	(0.056)		(0.068)		(0.060)		(0.067)		(0.078)		(0.122)			
Sport	-0.521	***	-0.072		-0.218	***	-0.433	***	-0.728	***	-1.130	***	15.870	0.000
	(0.063)		(0.066)		(0.054)		(0.063)		(0.079)		(0.133)			
TV Hrs	0.110	***	0.019		0.051	***	0.092	***	0.168	***	0.205	***	8.880	0.000
	(0.015)		(0.020)		(0.014)		(0.018)		(0.022)		(0.035)			
Income	-0.148	**	0.020		0.007		-0.031		-0.109		-0.326	**	0.980	0.415
	(0.069)		(0.081)		(0.069)		(0.083)		(0.110)		(0.160)			
Constant	20.623	***	18.081	***	19.063	***	20.206	***	22.089	***	23.729	***	19.570	0.000
	(0.298)		(0.319)		(0.275)		(0.296)		(0.449)		(0.649)			
Adj. R2	0.179		0.149		0.149		0.117		0.086		0.073			

Note. *, ** and ***, are 10, 5, and 1% significance levels – Bootstrapped standard errors in parenthesis. Region-level fixed-effects omitted for brevity.