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MEASURING STOCKS OF COMMUNITY WEALTH AND ITS ASSOCIATION WITH FOOD SYSTEMS EFFORTS IN RURAL AND URBAN PLACES

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Measuring stocks of community wealth and its association with food systems efforts in rural and urban places

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Abstract
Healthy, sustainable communities depend on cumulative investments in a broad range of capital assets, yet little research sets forth comprehensive measures of their stocks or the relationships of capital assets to community outcomes or policy efficacy. We develop a comprehensive set of indicators associated with stocks of community-based wealth at the county level. Including such indicators when evaluating community outcomes addresses a missing-variables problem of prior efforts and allows one to control for and quantify the importance of community capital assets in concert with traditional modeling efforts. To illustrate their use, we evaluate the association between the percentage of farms selling through direct local food markets and community capital stocks for both metro and nonmetro counties. In so doing, we demonstrate clear differences across metro and nonmetro classifications and the need for public and/or private planning efforts to consider preexisting levels of community capitals in appropriately framing food system interventions, policies, and strategies for development.

Keywords: community capitals, wealth, food systems, local food, rural development

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Introduction

Although rural areas cover 97 percent of the land mass in the United States, they contain less than 20 percent of the population (US Census Bureau 2016). Headlines following the 2016 presidential election highlighted a growing rural-urban divide becoming increasingly polarized (e.g., Badger et al. 2016; Gamio 2016). However, a renewed interest in rural America has highlighted to the general population that rural people and places face unique challenges relative to their urban counterparts.[1] For example, rural employment has not returned to its pre-recession level, median incomes remain below those of urban areas, and poverty rates are higher (Cromartie 2017).

A growing body of interdisciplinary research calls for a more comprehensive evaluation of the impacts resulting from community investments to inform and guide policy decisions. It also suggests that the continued dominance of purely economic or market measures (e.g., gross regional product, labor income, or employment) to evaluate development policies is outdated (Arrow et al. 2012; Pender et al. 2012a). There is growing recognition of the limitations of these measures, as they reveal little about nonmarket settings that also contribute to societal well-being; e.g., air & water quality, health education, and social community activities (e.g., Kubiszewski et al. 2013; Wolverson 2013).

Implicitly, healthy, sustainable communities depend on cumulative investments in a broad range of capital assets to generate wealth (Arrow et al. 2012; Managi and Kumar 2018; World Bank 2006, 2011), whereby wealth is defined as the stock of all capital assets (net of liabilities) that contribute to people's well-being (Pender et al. 2012a). Considering existing stocks of capital assets in evaluating the success of policy goals results in a more informed analysis. Outcomes associated with employing similar strategies are likely to vary with differing stocks of community wealth, particularly across rural and urban areas. These capital stocks are commonly characterized as social, cultural, human, political, physical, natural, and financial.

A growing literature has provided evaluations of suitable measures of capital assets when considering community and/or regional performance measures, although some report flows of benefits over a period of time rather than stocks of existing assets (Bryden et al. 2012; International Integrated Reporting Council 2013; Pender et al. 2012b; Ringwood et al. 2017; Managi and Kumar 2018; Yellow Wood Associates 2010). Distinguishing between stocks and flows is important; household income is a flow of dollars generated from employment, while household net worth is the stock of financial assets minus liabilities. Although attention is often focused on income, net worth is a better measure of true wealth or financial health. That said, data on flows, and particularly trade flows, are more readily available than data on stocks (Weber and Rahe 2010). The European Union, for example, has made progress with the construction of natural capital satellite accounts to augment economic indicators, but even here they are limited to annual physical flows, such as air emissions and environmental production taxes (Eurostat 2018). A similar decrease in air emissions for two regions is likely to have very different impacts on community outcomes if one region is already heavily polluted while the other is more pristine. Measures such

[1] Note that there is no single agreed upon definition of 'rural.' Herein we refer to rural as nonmetropolitan counties (Cromartie and Parker 2017).

as gross regional product, a flow, also ignore key tradeoffs. For example, a region may benefit economically in the short run from clear-cutting its forests, but this may imperil its long-term future.

It is also likely that associations among capital stocks, in addition to their individual levels, are important. However, analyses focused on capital stocks and community indicators of interest have generally focused on only one type of capital (e.g., social capital: Putnam 1995, 2001, 2007; Rupasingha et al. 2006; natural capital: Arrow et al. 2012; Costanza and Daly 1992; Marré and Pender 2013; Managi and Kumar 2018; World Bank 2006, 2011; Wu et al. 2017; cultural capital: Bourdieu 1986; Throsby 1999; and intellectual capital: Romer 1986; Schmit et al. 2017). Little research has focused on investigating the dynamics of investment in these different capital assets (Pender et al. 2014; Pigg et al. 2013), yet this may be particularly important given that the success of a community development strategy may depend on capital interactions and their strategic complementarities or tradeoffs.

In the United States, local and regional food policies have become ubiquitous, with more than 370 food policy councils across the country. Despite heterogeneity across place, the priorities of these councils are often very similar; e.g., healthy food access, anti-hunger, and local food production and procurement (Bassarab et al. 2019). Similarly, blanket policies are often pursued without consideration of the comparative advantages of specific local contexts. For example, most food policy councils have promoted direct-to-consumer (DTC) markets, as they have been identified as a vehicle to increase access to healthy food (e.g., Black and Mackinko 2008; Dubowitz et al. 2008; Essex et al. 2016). In 2013, 30 state laws enacted farmers market expansion legislation, 14 laws enacted farmers market access, and 11 enacted farmers market nutrition programs (Low et al. 2015). There has also been substantial and increasing support at the Federal level for direct market interventions; two more familiar initiatives are the Farmers Market Promotion Program (FMPP) and the Value Added Producer Grant Program (VAPGP). FMPP was established in 2002 with $33 million in funding; by 2014, funding was $150 million (NSAC 2014). The VAPGP includes increasing access to local markets as part of its mission. The program was started in 2001 and, through 2015, provided over 2,300 grants valued at over $300 million to farmers and ranchers (Rupasingha et al. 2018). The 2018 Farm Bill includes permanent and mandatory funding for both programs (NSAC 2018).

Despite broad promotion of direct markets, there is evidence of heterogenous spatial performance. Previous research has found that factors including population density and transportation options at market locations affect famers market sales and, thus, market success as measured by vendor and consumer participation (e.g., Schmit and Gomez 2011; Stephenson et al. 2008; Varner and Otto 2008). However, no research has comprehensively assessed the relationship between the success of direct market policies and existing community capital assets, or how the influence of those assets might differ in rural and urban areas.

This paper contributes to the literature along two important dimensions. First, we extend the research on wealth creation and community capital by implementing a comprehensive approach to measure stocks of community wealth at the county level based on a multivariable empirical approach using publicly available data. Second, we illustrate the use of the capital stock indicators by empirically testing their association with development policies supporting expansion of direct local foods markets vis-á-vis the percentage of farms selling through DTC markets. Our empirical approach allows for nonlinearities in these relationships and interaction effects among capital stocks. We pay particular attention to differences across rural and urban locales to emphasize how policymakers might utilize information on community wealth to both deepen and broaden the impacts of their food policies and strategies.

The article continues with more formal definitions of community capital stocks, as derived from the literature, and our methodological approach to estimate their levels at the county level. Subsequently, we utilize the indices within a regression analysis to test the association between direct local food system activity and stocks of community-based wealth. We close with policy implications of our work and identification of opportunities for future research.

Defining Community Capitals

Previous research depicts five to eight forms of community capital (e.g., Emery and Flora 2006; Flora and Flora 2008; Green and Haines 2016; Pender et al. 2012a, 2012b). Although there are debates about the number, they are less important than the recognition of a broader definition of wealth to more comprehensively evaluate inclusive and sustainable development principles (Pender and Ratner 2014). For the purposes of this paper, we categorize six types of capital: built, cultural, financial, human, natural, and social.

Built capital, sometimes referred to as physical or produced capital, includes outputs produced by firms, infrastructure to reduce costs of commerce, services provided by public agencies, and durable goods used by households for either production or consumption (Pender and Ratner 2014). Communities with well-managed, high-quality built capital are more likely to successfully sustain and attract economic development opportunities (Crowe 2008).

Cultural capital is the stock of practices that reflect values and identities rooted in place, class, and/or ethnicity (Pender and Ratner 2014). Cultural capital can take either tangible forms, such as museums, libraries, heritage buildings, sports venues, and unique tourism attractions, or intangible forms, such as sets of ideas, practices, beliefs, traditions, and ethnicities (Throsby 1999).

Financial capital includes the stock of money and other financial assets (net of liabilities) that can be readily converted to money (Pender and Ratner 2014). Financial capital is different from other types of capital in that it does not directly contribute to production or well-being. Rather, financial assets represent direct or indirect ownership of other capitals and can be allocated to consumption or investment in other capitals (Johnson et al. 2014).

Human capital has been a central concept in economic theory for decades. Becker (1962) defined human capital as the resources embedded in people, while Romer (1986) famously emphasized its role in modern economic growth theory. Key components of human capital include the stock of education, skills, and physical and mental health of people (Pender and Ratner 2014).

Natural capital is the stock of natural resources that yields a flow of valuable goods and services into the future (Costanza and Daly 1992). It includes both renewable resources, such as ecosystems, and nonrenewable resources, such as fossil fuels and mineral deposits.

Finally, social capital is the stock of trust, relationships, and networks that support civil society (Pender and Ratner 2014), with most definitions culminating around the formation of groups and other forms of collective civic activity (Rupasingha et al. 2006). Using this definition, political capital can be viewed as a special type of social capital.

Methodology

A comprehensive literature review identified multiple variables associated with measures of capital stocks. Unfortunately, there is not a commonly accepted theoretical or conceptual economic framework for measuring different forms of capital (Sobel 2002). Glaeser et al. (2002) suggest that this is due, in part, to the lack of consensus around the unit of analysis with regard to capital. While some argue for the consideration of capital aggregated at the community level (e.g., Bowles and Gintis 2002; Coleman 1990; Putnam 1995), economists often find it difficult to think of communities as decision makers. In their meta-analysis of social capital, Westlund and Adam (2010) found that levels of analysis varied across firm levels and geographic regions. With no consistent set of indicators or levels of analysis, comparisons across study results are difficult, if not impossible.

Principal Component Analysis

To overcome these shortcomings, we build on an empirical approach developed by Rupashingha et al. (2006) to create comprehensive indices of capital stocks with a multivariable indexing approach. In so doing, we derive measures for each of the capitals from county-level data using Principal Component Analysis (PCA). Previous research has found that anything larger than the county-scale fails to adequately capture wealth and wealth creation in rural places. Additionally, there is a widespread belief that development activity is fundamentally a local phenomenon (Rupasingha et al. 2006). We standardized the variables used by dividing them by their mean in order to avoid variances being too dissimilar across variables. Descriptive analyses identified variables with larger numbers of missing observations or large correlations across the variable sets by capital.

PCA is a data-reduction method used to express multivariate data into fewer dimensions. The goal is to reorient the data so that the original variables can be summarized with relatively few components that capture the maximum possible information (variation) from the original variable set. PCA produces uncorrelated components $\mathbf{z} = [z_1, z_2, \ldots, z_p]$ that are a linear combination of $\mathbf{u} = [u_1, u_2, \ldots, u_p]$ of the original variables $\mathbf{x} = [x_1, x_2, \ldots, x_p]$ that achieve maximum variance (i.e., maximize variance of $\mathbf{z} = \mathbf{xu}$ such that $\mathbf{u}'\mathbf{u} = 1$). The solution is obtained by performing an eigenvalue decomposition of the correlation matrix and finding the principal axes of the shape formed by the scatter plot of the data. The eigenvectors represent the direction of these principal axes.

We follow Kaiser's rule and retain only factors with eigenvalues exceeding unity. Additionally, we rotate the factor-loadings matrix to obtain the highest possible correlations on the fewest possible factors. We use oblique rotation, as it allows for correlation between the rotated factors and facilitates interpretation of the results. We scaled the resulting components from zero to 100 as indices. Where multiple components are retained for a given capital, we created an aggregate index by taking the average across components.

Variables Comprising Capital Indices

Our initial focus included all 3,068 counties in the lower 48 states, but some areas were excluded due to missing data from one or more sources utilized in constructing the indices.[2] The final number of counties included is 2,682. Summary statistics for each of the variables included within a capital stock are presented in Table 1. The most recent data were included across variables, although they do not necessarily align with the same year. In the sense that most variables are relatively stable over shorter time horizons, this is not problematic.

[Table 1 here]

To account for private built capital, we incorporate the number of food and beverage manufacturing establishments (NAICS 311 and 3121) and other manufacturing establishments (NAICS 31-33 minus 311 and 3121) from the U.S. Census Bureau (2015). Public infrastructure variables relate to access to both fixed advanced telecommunications (i.e., high-speed internet access (FCC 2016)) and proximity to interstate highways (Dicken et al. 2011).

Variables associated with tangible cultural capital include the prevalence of public libraries, museums, and creative industry businesses (Kushner and Cohen 2018), as well as the share of workers employed in the arts (U.S. Census Bureau 2014).[3] For intangible cultural capital, we consider the extent of racial diversity within communities by including the proportion of the population identified as nonwhite (U.S. Census Bureau 2015).

Financial capital is defined over stocks of both private and public wealth (Fannin and Honadle 2014). For private wealth, we include the number of owner-occupied units without a mortgage (U.S. Census Bureau 2015) and the level of deposits to FDIC-insured institutions (FDIC 2016). For public wealth, we use county government cash and security holdings net of government debt (U.S. Census Bureau 2012).

We use the proportion of the adult population with a bachelors, graduate, or professional degree to measure educational and skills components of human capital (U.S. Census Bureau 2015), while *Health Outcomes* (today's health) and *Health Factors* (tomorrow's health) variables are included from the Robert Wood Johnson Foundation (2013) to represent physical and mental health.[4] We also include the percent of the population defined as food secure and having health insurance (Robert Wood Johnson Foundation 2017) and the number of primary care physicians (HRSA 2014) as access to food and healthcare is an important dimension of human capital provision.

To capture renewable and nonrenewable aspects of natural capital, we include the National Amenities Scale designation (McGranahan 1999), the percentage of acres defined as prime farmland (USDA NRCS 2012), and the percentage of acres covered by easement (National Conservation Easement Database 2016). Additionally, we include the percentage of acres included

[2] Excluded areas are shown visually in the maps presented in Appendix A. Ultimately, FIPS codes were matched across data sources for index construction purposes.

[3] Kushner and Cohen's (2018) creative industry businesses are taken from the Americans for the Arts (n.d.), which defines creative industries as arts-centric businesses that range from nonprofit museums, symphonies, and the theaters to for-profit film, architecture, and advertising companies. Creative Industries data are based on active U.S. businesses that have registered with Dun & Bradstreet (Americans for the Arts n.d.).

[4] We used 2013 over more recent data because it was the last year that reported scores for each county.

in the following programs/classifications: Conservation Stewardship Program, Community Reserve Program, Environmental Quality Incentives Program, Grassland Reserve Program, Wetland Bank Reserve, Wetland Reserve Program, and Wildlife Habitat Incentive Program, as well as areas containing emergency watershed/floodplain designations, trees for timber, wildlife food plots, or woodland/native understory (USDA FSA 2017). Finally, we include the percentage of acres owned and managed by the U.S. Forest Service (2017). Finally, our measure of social and political capital follows Rupashinga et al. (2006, with updates) based on the number of social business establishment per capita, voter turnout, Census response rate, and the number of nonprofit organizations (excluding those with an international focus).[5]

Regression Analysis

To illustrate one use of the community capital stock indices, we use them as regressors to associate with variation in a food system outcome (*FSO*); in our particular case, this is the percentage of farms with DTC sales. To allow for nonlinear effects, we include each capital in a level (*K*) and quadratic form (K^2). As shown in equation 1, we also include state-level fixed effects (*S*) and Rural-Urban Continuum Codes (*RUCC*) to capture unobservable differences in state-level factors and factors related to the level of urbanism of a given county, respectively. RUCCs are a classification scheme to distinguish metropolitan counties by population size of the metro area and nonmetropolitan counties by degree of urbanization and adjacency to a metro area (USDA ERS 2016). We estimated the model with separate samples distinguished by metro (RUCCs 1, 2 and 3) and nonmetro (RUCCs 4 through 9) counties.

As mentioned above, the association of one particular capital to our dependent variable may depend on preexisting levels of other capital stocks (i.e., interaction effects). While one cannot be sure *a priori* of the sign of such effects, one would generally expect positive signs for beneficial stocks (*ceterus paribus*) unless resource constraints exist, implying tradeoffs in their growth and differential capital effects at the margin. The model incorporating these additional pairwise interactions is shown in equation 2. All models are estimated using Ordinary Least Squares (OLS).

$$(1)\ FSO_i = \alpha + \sum_{j=1}^{6} \beta_j K_{ij} + \sum_{j=1}^{6} \delta_j K_{ij}^2 + \sum_{n=1}^{N} \gamma_n S_{ni} + \sum_{r=1}^{R} \theta_r RUCC_{ri} + e_i$$

$$(2)\ FSO_i = \alpha + \sum_{j=1}^{6} \beta_j K_{ij} + \sum_{j=1}^{6} \delta_j K_{ij}^2 + \sum_{\forall j;-j} \delta_{j,-j} K_{ij} K_{i-j} + \sum_{n=1}^{N} \gamma_n S_{ni} + \sum_{r=1}^{R} \theta_r RUCC_{ri} + e_i$$

Empirical Results

First, we present results from the PCA and resulting indices of capital stocks. The regression results follow on the association between the percentage of farms with DTC sales and the stocks of capital assets.

[5] Rupashinga et al.'s (2006) social business establishments include religious organizations, civic and social associations, business associations, political organizations, professional organizations, labor organizations, bowling centers, fitness and recreational sports centers, golf courses and country clubs, and sports teams and clubs.

Capital Stocks

We completed PCA with Stata/IC 14.2. The main results are shown in Table 2, while the promax component loadings follow in Table 3. We follow with a description of the variables that make up each of the components, by capital, including those most strongly correlated with each component (i.e., with eigenvalues exceeding unity). For the interested reader, we include a visual representation of the stock levels across counties in Appendix A.

[Table 2 and 3 here]

We retained two components for built capital. The first component captures manufacturing business concentration (*foodbev_mfg, other_mfg*), while the second captures highway and wireless communication infrastructure (*highway, broad*). For cultural capital, we retained two components. The first primarily captures concentrations of arts and cultural institutions (*pub_lib, museums*), while the second focuses on the stock of people and firms associated with creative industries (*create_jobs*, *create_industry*).

We retained one principal component for financial capital that reflects the stock of financial solvency within a county in both public and private dimensions (*localgovfin, deposits*). We retained two components for human capital. The first captures health-related aspects (*health_outcome*, *health_factor*), while the second is reflective of food security and risk management (*food_secure*, *insured*).

We retained two components for natural capital. The first is correlated with the natural amenity scale and acres in national forests (*natamen, acre_FSA*), while the second component is strongly correlated with the percentage of acres in prime farmland (*prime_farmland*). Finally, we retained two components for social capital. The first is strongly correlated with social business establishments per capita and the number of nonprofit organizations (*assn14*, *nccs14*). The second component is captured by census response and voter turnout (*respn10, pvote12*).

Descriptive statistics for each of the capital stock indices, by metro and nonmetro county, are shown in Table 4. We computed means difference t-tests assuming unequal variances across samples. In all cases, the t-value is statistically significant, rejecting the null hypothesis that the difference in means is zero. Notably, this result is true for both 1- and 2-tailed tests. The 1-tailed test is appropriate when an *a priori* expectation is held regarding the sign of the difference. If there are potential explanations for either sign, then the 2-tailed test is more appropriate. From another perspective, significant differences under the more conservative 2-tailed test can be viewed as stronger evidence than the 1-tailed test. In any event, while the ranges in capital stocks are wide for both metro and nonmetro counties, there are statistically significant differences between them when evaluated at their means.

[Table 4 here]

On average, capital stocks are higher in metro counties for all capitals except *financial* (Table 4). That said, the minimum *financial* capital level in metro areas (72.474) is relatively close to the mean (75.678), suggesting more concentration in levels across metro counties. To that end, the coefficient of variation (CV) is lower in metro counties for all capitals except *human* capital.

Indeed, the maximum index for *human* capital in nonmetro counties is just under 70. Interestingly, while *cultural* capital in metro areas is larger than in nonmetro areas on average, it is constrained from above at just under 60 for metro counties.

The CVs for *built* capital are the highest, suggesting that this capital has the most volatility across counties (Table 4). While one may expect higher *built* capital, on average, for metro counties, recall that three of the four variables that make up the index are expressed in per capita and/or percentage terms, so it is not necessarily the case. Interestingly, *natural* capital, on average, is higher in metro counties, likely reflecting natural amenities included within their boundaries by design; e.g., tree canopy covers 21% of New York City (Nowak et al. 2018) or national forests located near large cities; e.g., Mt. Hood National Forest near Portland, OR. That said, the maximum index in metro counties is bounded from above at 75 and variation around the mean is substantially higher for nonmetro counties. In any event, the figures in Appendix A and descriptive statistics suggest substantial variation in capital stocks across the United States, both between and among metro and nonmetro counties.

Association with DTC Market Participation

Table 5 provides the regression results associating capital stocks to the percentage of farmers participating in DTC marketing channels. Model 1 (Model 2) excludes (includes) capital interaction effects. We included state-level and RUCC fixed effects in all specifications. Adjusted R^2 levels show relatively strong results in explaining the variation in farm DTC market participation associated with changes in capital stocks. Model 2 for both the metro and nonmetro increase the explained variation of the dependent variable, particularly for nonmetro counties. Accordingly, for ease of exposition, much of the discussion that follows focuses on the Model 2 results. In short, interaction effects among capital stocks matter when considering the percentage of farms participating in DTC markets, particularly for more rural areas.

[Table 5 here]

It is clear that stocks of capital assets have important (and statistically significant) associations with the percentage of farms with DTC sales, particularly in nonmetro counties. For Model 1, *built*, *human*, and *natural* capital stocks show statistically significant associations in metro counties, while *cultural*, and *natural* capital are significant in nonmetro counties. The number of significant capital stock associations increases in both types of counties when interaction effects are included (Model 2). Specifically, the set of significant capitals in metro counties expands to include *financial* (in its interaction with *built*), *cultural* (in its interaction with *human*), and *social* capital (in its interactions with *built* and *natural*). For nonmetro counties, *built*, *financial*, *human*, and *social* are added to the set of significant capital effects in nonmetro counties (in either level, quadratic, or interaction forms).

The statistical significance of *built* capital for metro counties in Model 1 (level and quadratic) are extended to include the interaction effects with *financial*, *human*, and *social* capital in Model 2. Both *financial* and *social* capitals appear to have complementary associations with *built* capital (positive signs), while a modest tradeoff (and only marginally statistically significant) exists for *human* capital. In other words, larger built environments are associated with more farmer participation in DTC markets where the stock of *financial* and *social* capital is also strong. While *natural* capital is no longer statistically significant in its level and quadratic forms, the positive *natural***social* interaction effect identifies its importance contingent on the stock of *social* capital. This makes sense for metro areas, where some social activities are organized around parks and other open spaces. Farmers markets (a DTC market channel) in larger cities would be a useful example, and they constitute a social activity as much as a food shopping trip in the eyes of many customers.

For nonmetro counties, the interaction model (Model 2) reveals that all types of capital stocks (in some form) are statistically associated with changes in farmer participation in DTC markets. Statistically significant and positive signs exist in five interaction effects: *built***cultural*, *built***natural*, *financial***natural*, *human***social*, and *natural***social*, while a negative effect is given by *financial***human*. The latter negative effect may accrue due to a strategic tradeoff to utilize (i.e., decrease) financial wealth to invest in (i.e., increase) human capital formation. *Human* capital shows a strong association with DTC farm participation in nonmetro areas (large level effect), albeit at a decreasing rate as its capital stock grows (negative quadratic effect).

The regression results highlight numerous statistically significant associations between community capital stocks and farm participation in DTC markets in the counties in the study. Interaction effects are important and useful in analyzing specific capital interactions but, with a larger number of interaction terms, provide less clarity on community capital investment priorities to best achieve a stated goal (through policy or otherwise). To better address this issue, we compute marginal effects for each capital and evaluate them at their sub-sample means. Following from equation (2), the marginal effect (*ME*) on an FSO for any capital *j* can be expressed as:

$$(3)\ ME_{FSO,j} = \beta_j + 2\delta_j K_j + \sum_{\forall j;-j} \delta_{j,-j} K_{-j}$$

Setting equation 3 equal to zero and solving for K_j defines the level of capital *j* where the total effect on FSO is either a maximum or minimum (depending on the signs of β_j and δ_j). We present the marginal effects in Table 6. Notably, the marginal effect for *financial* capital is not statistically significant in any model and is consistent with this capital's differing definition from the others (see capital definitions above). Further, the similarities in marginal effects across Models 1 and 2 support the robustness of our findings.

[Table 6 here]

Marginal effects are significant in metro counties for *built*, *cultural*, *human*, *natural*, and *social* capitals. At the margin and sample means, the primary influences on farm participation in DTC channels in metro counties are *natural* and *built* capitals, followed more distantly by *cultural* and *human* capitals. *Natural* capital has the largest marginal effect in nonmetro counties but with *cultural* capital nearly as high. The marginal effect for *built* capital is also positive at the sample means for nonmetro counties, but far below those of *natural* and *cultural* capital.

Social capital has a relatively small downward influence on DTC participation at the sample means for both metro and nonmetro counties. This may be explained by a crowding out effect if, for example, other social activities preclude opportunities for farmers markets sales (the largest DTC marketing channel), which are often considered a social experience.

Another way to consider marginal capital effects, particularly as they relate to county investment priorities, is evaluating them across a range in capital levels. We present these effects in Figures 1 and 2 for metro and nonmetro counties, respectively. In this case, the stock level for the capital of focus (K_j) is allowed to vary over the index range, while the other capital stocks (K_{-j}) remain at their sample means.

For metro counties, marginal effects are positive and increasing for *built* capital on [14, 100], suggesting that metro areas with high stocks of built capital are likely most amenable to farmers in participating in DTC channels in their boundaries (Figure 1). The success of GrowNYC's 50-plus farmers markets in NYC would seem a suitable example and, to the degree that built capital is also correlated with high population densities, this makes sense as a strong demand location. In deference, marginal effects for *natural* capital are decreasing in their level in metro counties, suggesting that counties with modest, but not extreme, levels of *natural* capital provide the most suitable environment for DTC channel participation by farmers. Marginal effects for *natural* capital are positive on [1,74]; the mean in metro counties was around 40. The marginal effect for *human* capital is positive throughout its range for metro counties, but relatively small and nearly constant. While the marginal effect for *cultural* capital looks promising at levels beyond its mean (24), it is not statistically significant; a similar argument holds for *financial* capital on [1,63]. The relatively small negative marginal effects for *social* capital throughout its range suggest only a modest tradeoff for farm DTC participation.

With the exception of *social* capital, marginal capital effects trend inversely in nonmetro counties to their metro counterparts (Figure 2). *Natural* capital is clearly the most strongly associated with higher levels of farm DTC participation, which would seem consistent with most consumer messaging in rural areas. Marginal effects are positive throughout its range and increasing with the size of the stock. The marginal effect for *cultural* capital is also positive throughout its range but decreasing in magnitude, suggesting diminishing effects as investments accrue. Marginal effects for *built* capital are increasingly negative on [22,100], but more modest (in absolute value), then the positive result for metro counties. Marginal effects for *social* capital are similar to those in metro areas – negative but modest.

Policy Implications

This paper builds on the community capitals and wealth creation literatures and is the first research to provide a database of community capital stock indices at the county level for nearly all U.S. counties. Capital stocks were shown to vary widely both within and across metro and nonmetro counties. By utilizing these indices, a more comprehensive evaluation of impacts resulting from programming initiatives will better inform the efficacy of community economic development efforts and guide policy decisions. Local, state, and Federal governments, as well as philanthropic organizations, are making substantial investments to support community economic development, including food system programming. Using community capital stocks allows for the testing of their relationships and increased efficacy of policy outcomes.

In the case of farm participation in DTC marketing channels (as promoted through the work of many food policy councils and the Federal government), we show clear empirical evidence that 'success' is associated with existing stocks of community capitals. For communities setting priorities for this type of food system innovation, our results importantly inform community capital investment and related activities and differ considerably across metro and nonmetro counties. While consideration of *natural* capital stocks with regard to farm DTC market participation is important in both metro and nonmetro counties, the association is much stronger for nonmetro areas and increasing in the level of the stock, whereas in metro areas extending too far in its *natural* stock is associated with reductions in farm participation in DTC markets, perhaps from a diversion of consumer demand to other natural area activities. Metro areas interested in increasing farm DTC participation should consider what types of the *built* environment are most amenable in reaching their objective as this is where the largest marginal effects accrue. Growing *human* capital stocks in metro areas would also make sense, but only to the degree that the cost of such investments are relatively low. Conversely, improving *natural* capital stocks in nonmetro counties should be prioritized, while also considering improvements in their stocks of *cultural* capital. To the intent of improving farm participation in DTC markets, minimizing *built* capital stocks would appear most salient in nonmetro counties.

Our empirical results clearly show important differences for metro and nonmetro counties in the relationship between community capital stocks and farm participation in DTC markets. Accordingly, an important step for future research includes examining potential differences within the metro and nonmetro classifications utilized here. Better understanding the differences across urban and rural locales will help to more effectively target and evaluate policy outcomes. Further, consideration of spatial dependence with respect to capital stocks in neighboring counties or within defined regional economic areas would be useful, particularly in areas where farm sales commonly extend beyond county boundaries from farm locales.

We show in our application that interaction effects among types of community capitals are important in identifying complementary outcomes and strategic tradeoffs. Accordingly, our measurement of the capital stocks can contribute to an enhanced understanding of how to incorporate satellite accounts with nonmarket items into systems of national accounts, thus building on the work of National Research Council (2005). Having a standardized measure of capital stocks provides an important step in incorporating nonmarket items into more traditional economic frameworks that extend far beyond a focus on food system outcomes. Finally, community investments in increasing capital stocks likely comes with a cost, which may be substantial. Future research should consider not only the association of achieving policy goals relative to their levels of capital stocks, but in the cost of alternative approaches to increasing capital stocks to support policy goals. Our database of county-level capital stocks is available for public use for these and other important applications.

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Table 1. Variables included in principal component analysis to derive county-level capital stock indices

Variable	Description	Source	Mean	Std. Dev	Minimum	Maximum
Built Capital						
foodbev_mfg	Food & beverage manufacturing estab. per 10,000 people, 2015	U.S. Census Bureau (2015)	1.746	5.128	0.000	183.674
other_mfg	Other manufacturing estab. per 10,000 people, 2015	U.S. Census Bureau (2015)	10.637	31.225	0.000	1,084.711
broad	% of population with access to fixed advanced telecomm., 2016	FCC (2016)	63.461	32.254	0.000	100.00
highway	Inverse of population-weighted distance (km) to nearest interstate highway ramp, 2007	Dicken et al. (2011)	0.109	0.126	0..004	1.839
Cultural Capital						
create_jobs	% of workforce employed in the arts, 2013	U.S. Census Bureau (2014)	15.970	5.866	0.540	50.182
nonwhite_pop	% of population identifying as non-white, 2015	U.S. Census Bureau (2015)	15.868	16.022	0.000	95.057
pub_lib	Public libraries per 100,000 people, 2012	Kushner & Cohen (2018)	18.342	24.608	0.540	360.58
create_indus	Creative industry businesses per 100,000 population, 2014	Kushner & Cohen (2018)	139.310	96.927	0.000	1,478.800
museums	Museums per 100,000 people, 2015	Kushner & Cohen (2018)	25.072	30.192	1.110	686.500
Financial Capital						
localgovfin	Cash & security holdings less government debt per capita, 2012	U.S. Census Bureau (2012)	0.271	5.410	-262.276	64.933
deposits	Bank deposits per capita at FDIC-insured institutions, 2016	FDIC (2016)	22.084	50.176	0.000	2,362.710
owner_occupied	Owner-occupied units without a mortgage per capita, 2012	U.S. Census Bureau (2015)	0.132	0.044	0.024	0.325
Human Capital						
ed_attain	% of adult population with at least a Bachelor's degree, 2015	U.S. Census Bureau (2015)	21.098	9.281	2.434	75.069
health_factor	Health Factors Z-Score, 2013	Robert Wood Johnson Foundation (2013)	0.005	0.471	-2.098	2.203

Variable	Description	Source	Mean	Std. Dev	Minimum	Maximum
health_outcome	Health Outcome Z-Score, 2013	Robert Wood Johnson Foundation (2013)	0.008	0.710	-2.821	2.797
food_secure	% of population food secure, 2017	Robert Wood Johnson Foundation (2017)	85.353	4.121	62.500	95.700
insured	% of population with health insurance, 2017	Robert Wood Johnson Foundation (2017)	82.873	6.190	53.989	96.724
primary_care	Primary care physicians per 10,000 people, 2015	HRSA (2014)	5.467	3.505	0.000	65.441
Natural Capital						
natamen	Natural Amenities Scale, 1999	McGranahan (1999)	0.054	2.290	-6.400	11.170
prime_farmland	% of farmland acres designated as prime, 2012	USDA NRCS (2012)	0.061	0.142	0.000	5.561
conserve_acre	% of all acres under conservation easement, 2016	NCED (2016)	1.410	2.775	0.000	28.371
acre_FSA	% of total acres in conservation programs and woodlands, 2017	USDA FSA (2017)	1.488	2.632	0.000	25.445
acre_NFS	Percent of total acres in National Forests, 2017	USFS (2017)	4.734	12.471	1.111	93.595
Social Capital						
assn14	Social establishments per 1,000 people, 2014	Rupasingha et al. (2006)	1.379	0.703	0.000	6.887
pvote12	% of eligible voters that voted, 2012	Rupasingha et al. (2006)	66.849	9.131	34.942-	111.596
respn10	% response rate to U.S. Population Census, 2010	Rupasingha et al. (2006)	70.505	11.161	0.000	95.000
nccs14	Number of nonprofit organizations per 1,000 population, 2014	Rupasingha et al. (2006)	6.923	19.466	0.000	757.655

Table 2. Principal component analysis results with promax rotation, components with eigenvalues above unity retained ($N = 2{,}682$)

	Unrotated				Promax Rotated	
Capital	**Component**	**Eigenvalue**	**Proportion**	**Cumulative**	**Eigenvalue**	**Proportion**
Built	Comp1	1.895	0.473	0.474	1.888	0.470
	Comp2	1.346	0.336	0.810	1.360	0.340
	Comp3	0.639	0.160	0.970		
	Comp4	0.120	0.030	1.000		
Cultural	Comp1	1.866	0.373	0.373	1.873	0.375
	Comp2	1.323	0.265	0.638	1.336	0.267
	Comp3	0.878	0.176	0.813		
	Comp4	0.609	0.122	0.935		
	Comp5	0.324	0.065	1.000		
Financial	Comp1	1.054	0.351	0.351	1.054	0.0.351
	Comp2	0.996	0.332	0.684		
	Comp3	0.949	0.316	1.000		
Human	Comp1	2.801	0.467	0.467	2.412	0.402
	Comp2	1.727	0.288	0.755	2.076	0.346
	Comp3	0.890	0.148	0.903		
	Comp4	0.346	0.058	0.961		
	Comp5	0.216	0.036	0.997		
	Comp6	0.020	0.003	1.000		
Natural	Comp1	1.590	0.318	0.318	1.595	0.319
	Comp2	1.033	0.207	0.525	1.046	0.209
	Comp3	0.998	0.200	0.724		
	Comp4	0.832	0.166	0.891		
	Comp5	0.547	0.109	1.000		
Social	Comp1	1.195	0.299	0.299	1.126	0.282
	Comp2	1.015	0.254	0.553	1.081	0.270
	Comp3	0.946	0.236	0.789		
	Comp4	0.844	0.211	1.000		

Table 3. Promax component loadings on indicator variables and residual unexplained variation ($N = 2{,}682$)

Capital	Variable	Comp1	Comp2	Unexplained
Built	foodbev_mfg	**0.706**	-0.014	0.061
	other_mfg	**0.707**	0.015	0.060
	broad	-0.027	**0.703**	0.322
	highway	0.027	**0.710**	0.316
Cultural	pub_lib	**0.639**	-0.141	0.226
	museums	**0.639**	0.044	0.235
	create_jobs	-0.278	**0.648**	0.322
	create_indus	0.115	**0.682**	0.351
	nonwhite_pop	-0.312	-0.313	0.678
Financial	localgovfin	**0.686**		0.504
	owner_occupied	**0.690**		0.499
	deposits	0.231		0.943
Human	health_factor	**0.601**	-0.090	0.163
	health_outcome	**0.555**	-0.112	0.295
	food_secure	-0.038	**0.684**	0.037
	insured	-0.040	**0.687**	0.030
	ed_attain	0.492	0.157	0.256
	primary_care	0.298	0.138	0.690
Natural	natamen	**0.643**	-0.201	0.313
	acre_NFS	**0.577**	-0.035	0.474
	prime_farmland	-0.082	**0.922**	0.117
	conserve_acre	0.197	0.018	0.938
	acre_FSA	-0.461	-0.336	0.536
Social	assn14	**0.665**	-0.020	0.502
	nccs14	**0.619**	-0.194	0.558
	pvote12	0.394	**0.528**	0.465
	respn10	-0.144	**0.828**	0.265

Table 4. Capital index descriptive statistics by metro and nonmetro status

Capital	County[a]	Mean	Std Dev	CV[b]	Min	Max	|t| value[c]
Built	Metro	19.772	9.030	0.456	0.828	100.000	
	Nonmetro	11.906	6.684	0.561	0.000	88.368	25.240
Cultural	Metro	23.748	6.055	0.255	2.080	58.513	
	Nonmetro	22.251	7.719	0.347	0.000	100.000	5.794
Financial	Metro	75.678	1.589	0.021	72.474	99.782	
	Nonmetro	77.405	2.489	0.032	0.000	100.000	23.247
Human	Metro	33.025	11.743	0.356	0.653	100.000	
	Nonmetro	24.301	7.898	0.325	0.000	69.561	21.880
Natural	Metro	40.081	7.312	0.182	12.526	75.112	
	Nonmetro	38.201	10.167	0.266	0.000	100.000	5.902
Social	Metro	60.656	11.252	0.186	13.643	100.000	
	Nonmetro	56.077	14.131	0.252	0.000	99.597	9.870

[a] Counties with RUCC codes less than four are classified as metro and counties with RUCC codes greater than or equal to four are classified as nonmetro.
[b] CV = Coefficient of Variation, a measure of variation in the data with respect to the mean level (i.e., Std Dev/Mean).
[c] A two-sample t-test with unequal variances was conducted using the ttest function in Stata for each capital between metro and nonmetro samples. In all cases, the t-value is statistically significant (using Satterthwaite's degrees of freedom), rejecting the null hypothesis that the difference in means is zero for both one- and two-tailed tests (all p values < 0.0001).

Table 5. Regression results for association of percentage of farmers participating in direct-to-consumer local food markets and community capital stocks, by county classification

	Metro				Nonmetro			
Variable	**Model 1**		**Model 2**		**Model 1**		**Model 2**	
Constant	47.509		-80.226		0.194		48.802	
	(57.391)		(121.405)		(3.571)		(31.638)	
Built	-0.155	***	-2.668	**	0.050		-0.009	
	(0.057)		(1.122)		(0.038)		(0.705)	
$Built^2$	0.007	***	0.009	***	-0.001		-0.002	
	(0.001)		(0.002)		(0.001)		(0.001)	
Cultural	0.031		1.941		0.189	***	0.974	
	(0.098)		(1.411)		(0.037)		(0.680)	
$Cultural^2$	0.001		0.006		-0.002	***	-0.001	
	(0.002)		(0.003)		(0.000)		(0.001)	
Financial	-1.326		1.660		0.020		-0.617	
	(1.404)		(2.409)		(0.110)		(0.445)	
$Financial^2$	0.007		-0.008		-0.000		0.005	***
	(0.009)		(0.012)		(0.001)		(0.002)	
Human	0.118	**	1.229		-0.050		2.545	***
	(0.048)		(1.041)		(0.042)		(0.667)	
$Human^2$	-0.001	*	0.000		0.001		-0.003	***
	(0.000)		(0.001)		(0.001)		(0.001)	
Natural	0.495	***	0.437		0.039		-1.324	***
	(0.137)		(1.176)		(0.037)		(0.496)	
$Natural^2$	-0.003	**	-0.003		0.001	***	0.001	***
	(0.001)		(0.002)		(0.000)		(0.000)	
Social	-0.009		-0.089		0.027		-0.701	*
	(0.093)		(0.902)		(0.036)		(0.382)	
$Social^2$	-0.000		-0.000		-0.001		-0.000	
	(0.001)		(0.001)		(0.000)		(0.000)	
Built*Cultural			0.006				0.008	***
			(0.004)				(0.002)	
Built*Financial			0.030	**			-0.003	
			(0.014)				(0.009)	
Built*Human			-0.003	*			-0.003	
			(0.002)				(0.002)	
Built*Natural			-0.004				0.004	***
			(0.003)				(0.001)	

	Metro			Nonmetro		
Variable	**Model 1**	**Model 2**		**Model 1**	**Model 2**	
Built*Social		0.004	**		0.000	
		(0.002)			(0.001)	
Cultural*Financial		-0.027			-0.013	
		(0.018)			(0.009)	
Cultural*Human		-0.007	**		0.001	
		(0.003)			(0.002)	
Cultural*Natural		-0.001			0.002	
		(0.004)			(0.001)	
Cultural*Social		0.001			0.001	
		(0.003)			(0.001)	
Financial*Human		-0.012			-0.033	***
		(0.013)			(0.008)	
Financial*Natural		-0.002			0.014	**
		(0.015)			(0.006)	
Financial*Social		-0.002			0.007	
		(0.015)			(0.006)	
Human*Natural		0.001			0.000	
		(0.002)			(0.001)	
Human*Social		-0.001			0.002	**
		(0.002)			(0.001)	
Natural*Social		0.004	*		0.003	***
		(0.002)			(0.001)	
State fixed effects	Yes	Yes		Yes	Yes	
RUCC fixed effects	Yes	Yes		Yes	Yes	
N	1,032	1,032		1,650	1,650	
Adjusted R-squared	0.700	0.704		0.729	0.749	

Standard errors in parentheses; ***, ** and * represent estimated parameters statistically different from 0 at the 99%, 95%, and 90% significance levels, respectively.

Table 6. Marginal effects of percentage of farmers participating in direct-to-consumer local food markets by capital stock and county classification[a]

Variable	Metro Model 1		Metro Model 2		Nonmetro Model 1		Nonmetro Model 2	
Built	0.107	***	0.110	***	0.035	**	0.032	**
	(0.020)		(0.020)		(0.015)		(0.015)	
Cultural	0.075	**	0.069	**	0.118	***	0.122	***
	(0.032)		(0.033)		(0.021)		(0.021)	
Financial	-0.197		-0.204		-0.034		0.014	
	(0.135)		(0.142)		(0.073)		(0.071)	
Human	0.058	***	0.052	***	-0.009		-0.019	
	(0.017)		(0.018)		(0.014)		(0.014)	
Natural	0.228	***	0.213	***	0.128	***	0.128	***
	(0.028)		(0.029)		(0.012)		(0.011)	
Social	-0.042	**	-0.033	*	-0.029	***	-0.033	***
	(0.021)		(0.022)		(0.010)		(0.010)	

[a] Marginal effects evaluated at capital stock sample means by county classification. Standard errors in parentheses; ***, ** and * represent estimated parameters statistically different from 0 at the 1%, 5%, and 10% significance levels, respectively.

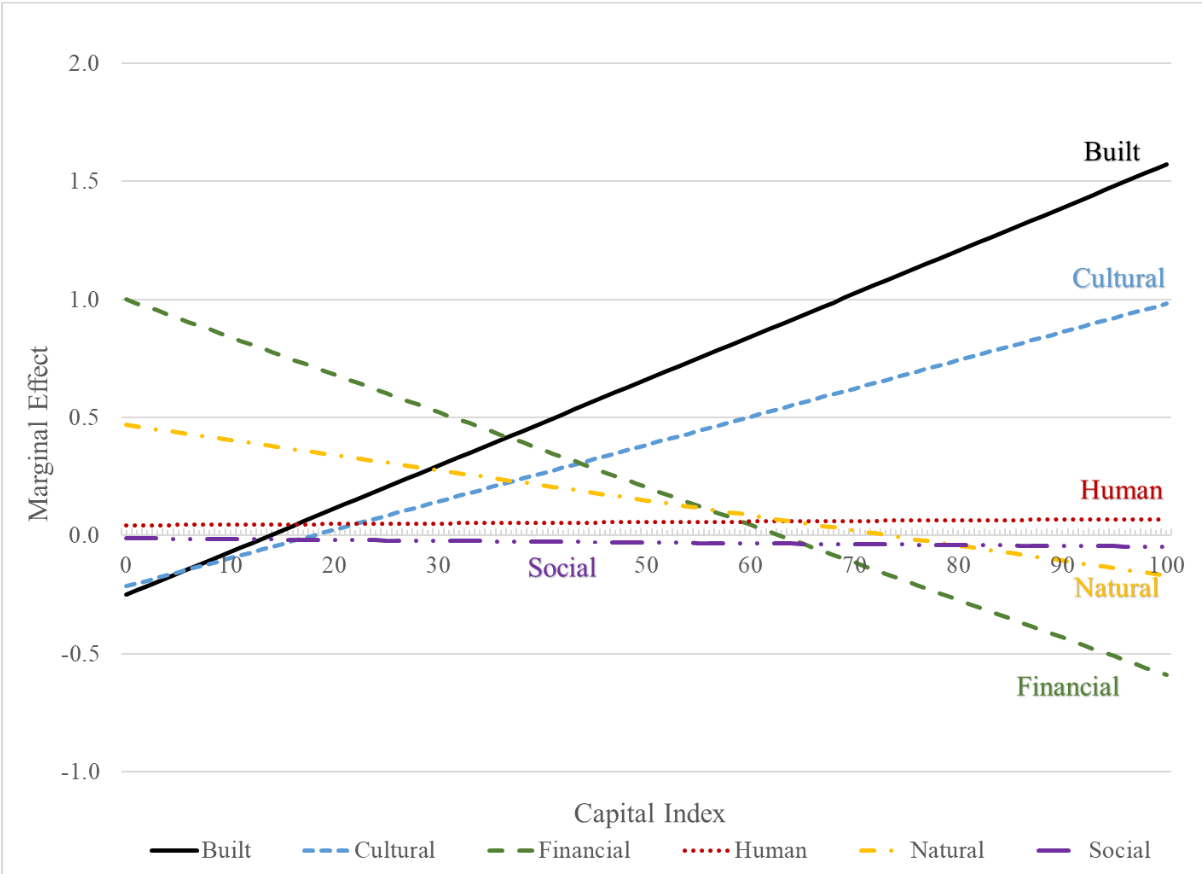

Figure 1. Marginal effects by type of capital on percentage of farmers participating in direct-to-consumer local food markets, metro counties (Model 2), other capitals set at sample means.

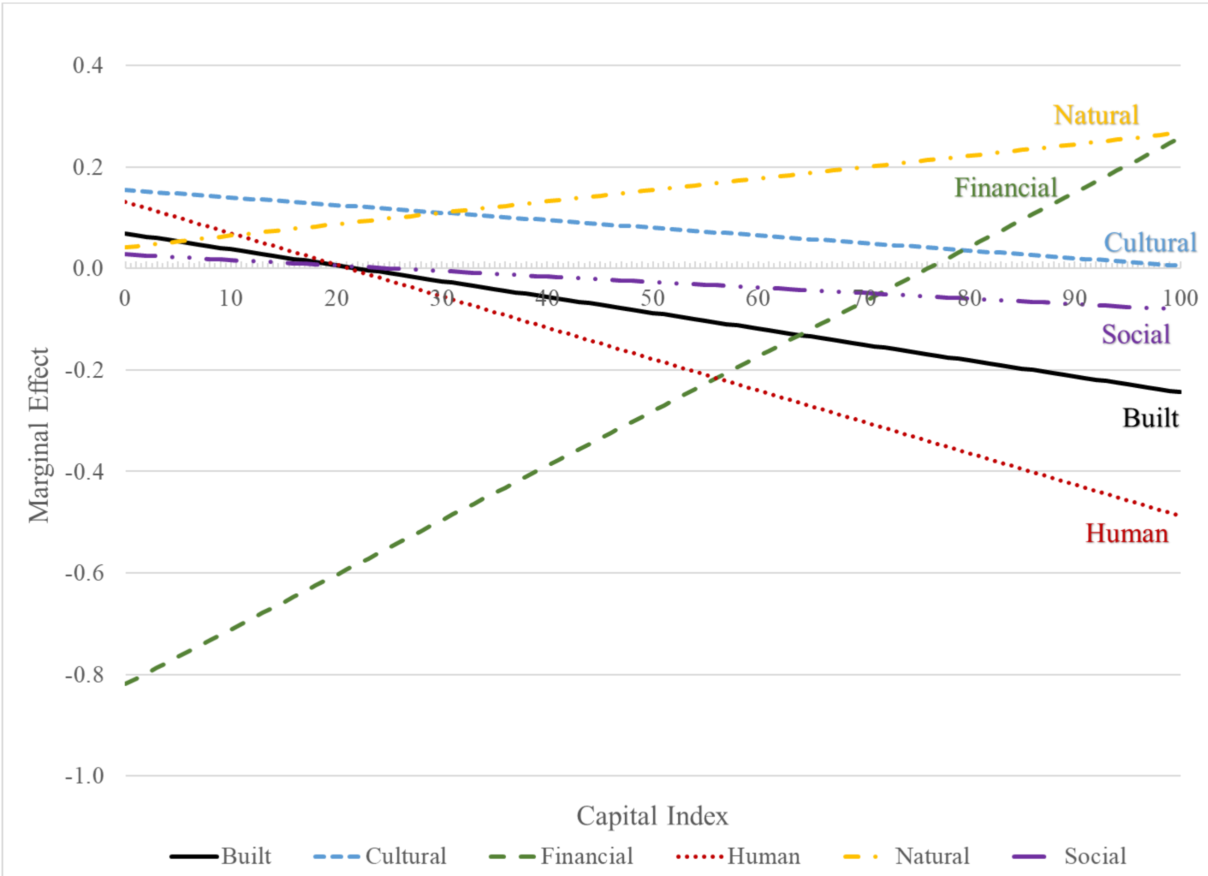

Figure 2. Marginal effects by type of capital on percentage of farmers participating in direct-to-consumer local food markets, nonmetro counties (Model 2), other capitals set at sample means.

APPENDIX A. Capital stock indices by quintile and type of capital

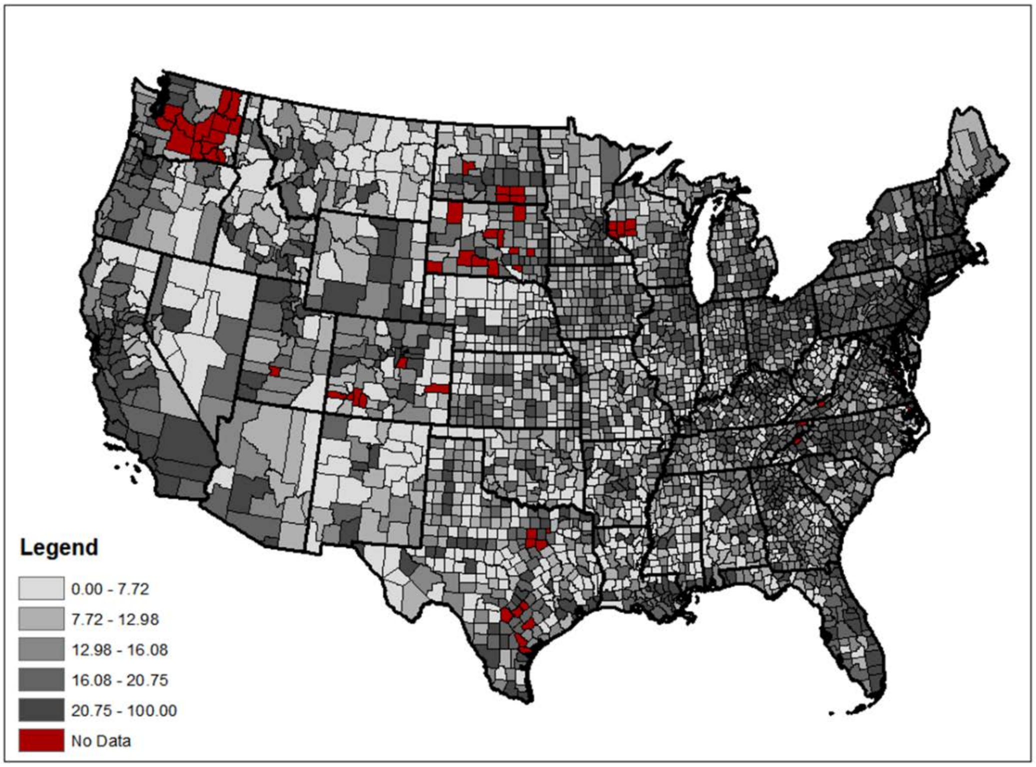

Figure A1. County capital indices: built capital.

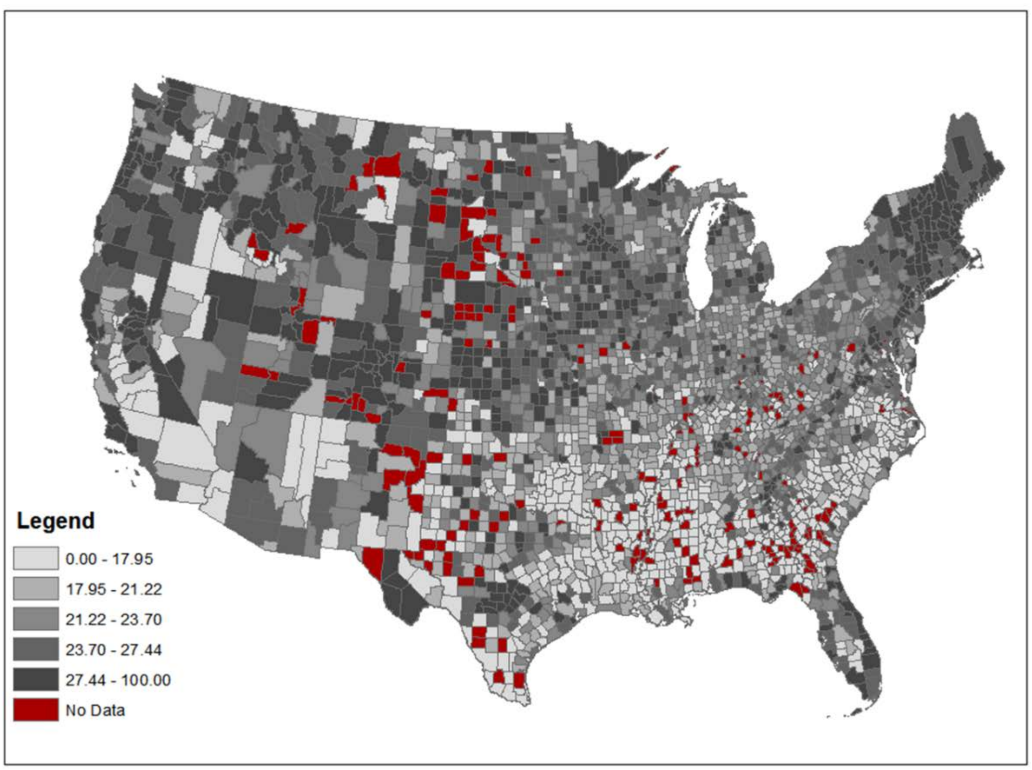

Figure A2. County capital indices: cultural capital.

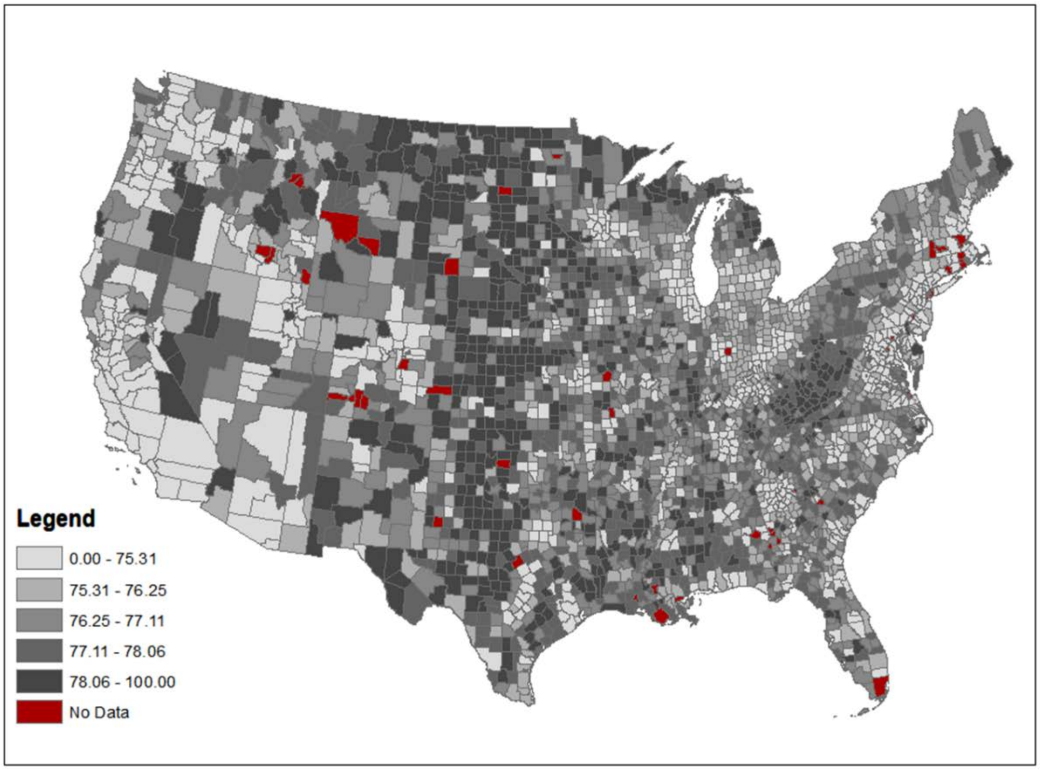

Figure A3. County capital indices: financial capital.

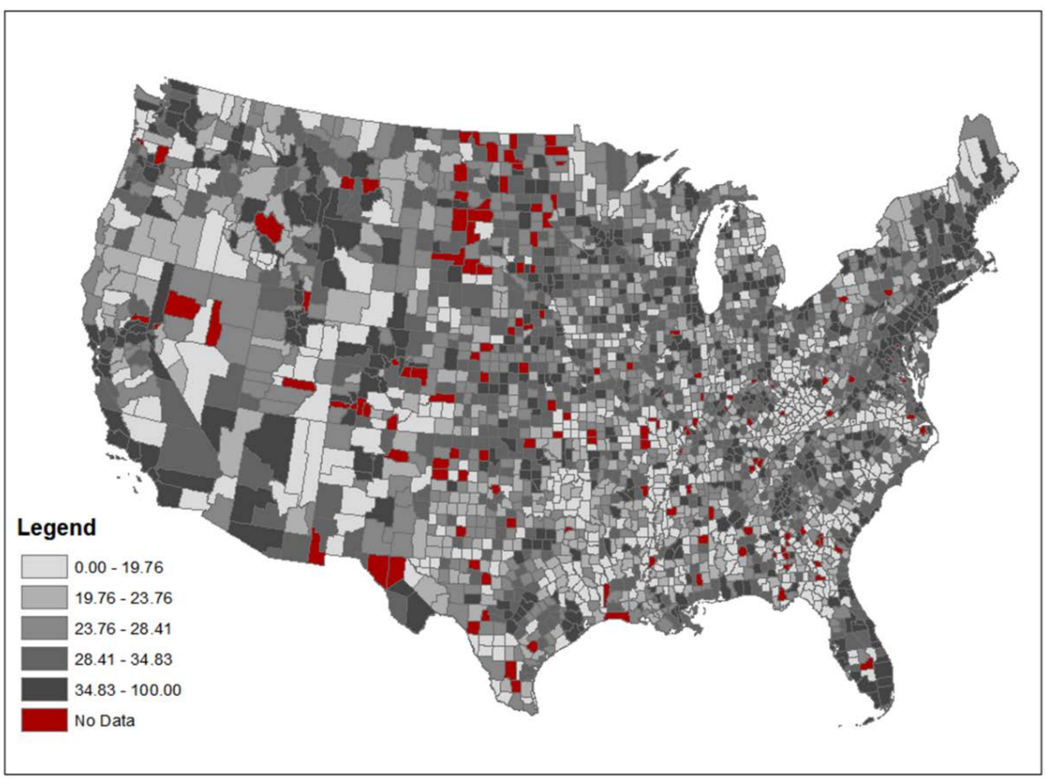

Figure A4. County capital indices: human capital.

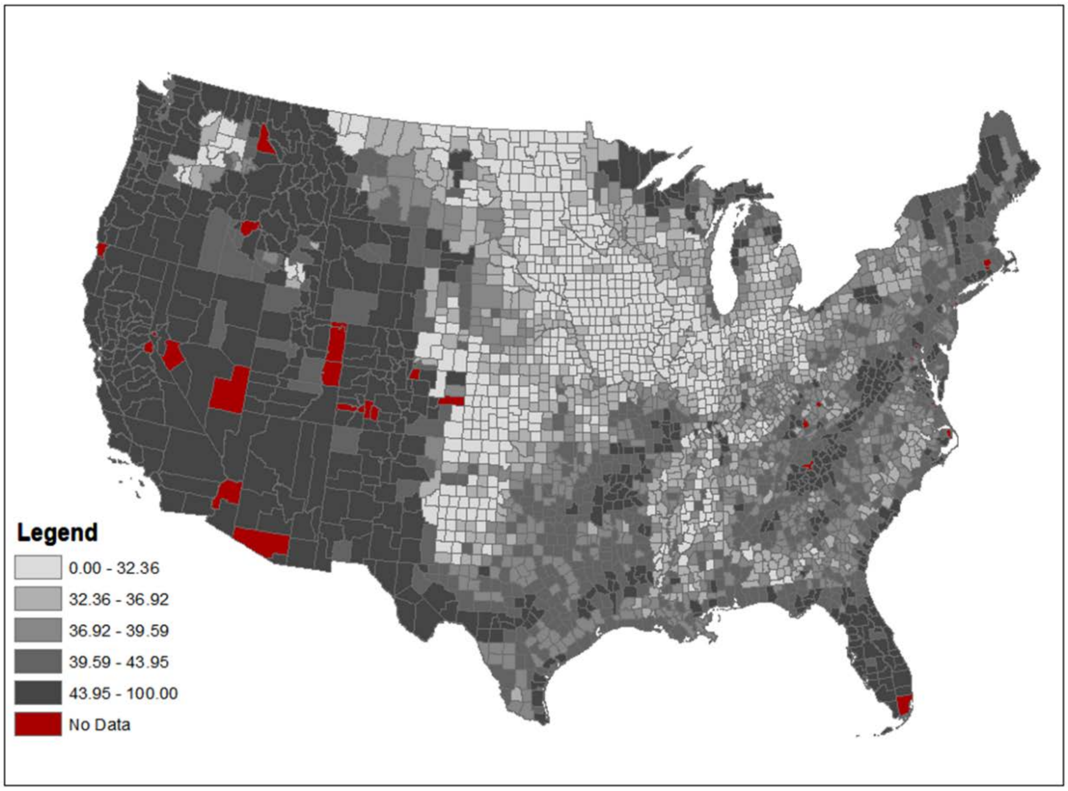

Figure A5. County capital indices: natural capital.

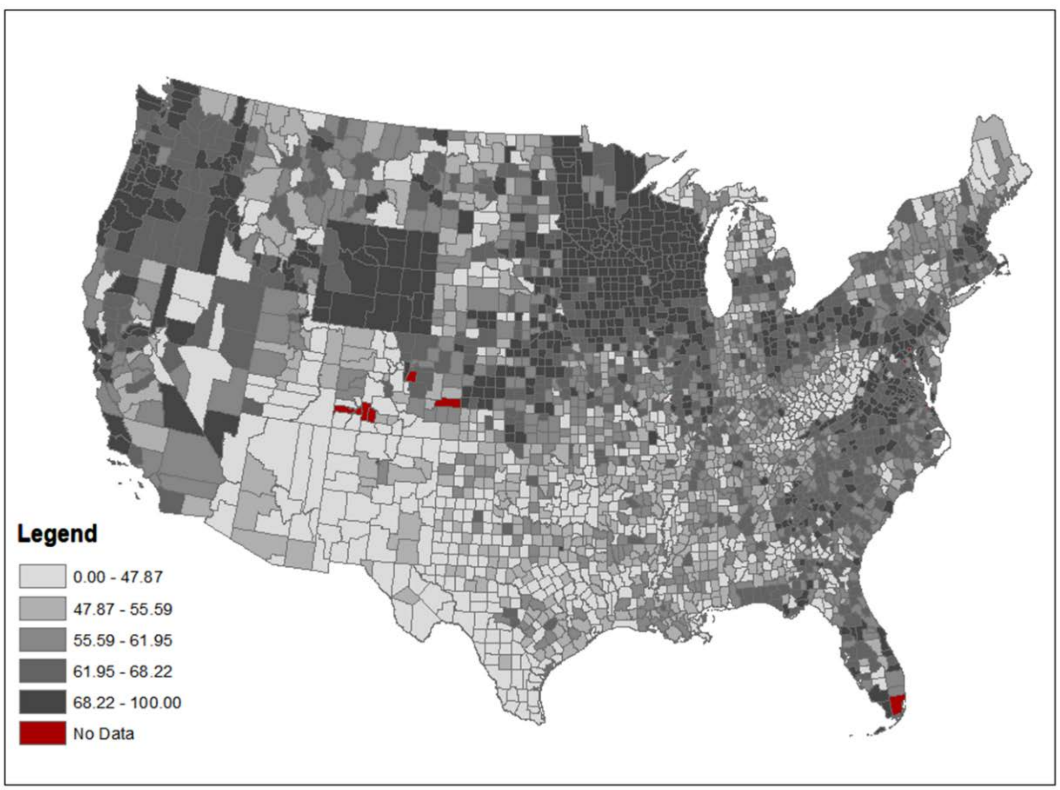

Figure A6. County capital indices: social capital.

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