Measuring the stock of wealth and its association with food systems efforts

B.B.R. Jablonski, T.M. Schmit, A. Bonanno, L.O. Christensen, and T. Johnson

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Abstract

A more comprehensive evaluation of impacts resulting from rural programming and initiatives is necessary to better inform the efficacy of rural development efforts and guide policy decisions. This is because healthy, sustainable communities depend on cumulative net investment in a broad range of capital assets. This research contributes to the literature by providing a comprehensive measure of wealth and empirically estimating the relationship between the stocks of wealth and a food system intervention outcome (using the share of farmers accessing direct to consumer markets as a proxy). Finally, we estimate optimal levels of capital associated with this food system outcome, demonstrating empirically that policymakers need to know preexisting levels of the capitals before determining appropriate interventions. Through this analysis, we hope to contribute to the understanding of where differential investments are required in a capital for an intervention to be more likely to be successful in rural areas.

Introduction

Though rural areas cover 97 percent of United States (U.S.) land by area, they contain less than 20 percent of the population (US Census Bureau 2016). Headlines following the 2016 presidential election such as "The election highlighted a growing rural-urban split" (NYTimes, November 11, 2016) and "Urban and rural America are becoming increasingly polarized" (Washington Post, November 17, 2016) spurred renewed interest in rural America (Google Trends 2018), highlighting to the general population that rural[1] people and places in the U.S. face many challenges relative to their urban counterparts. As a few examples, rural employment has not returned to its pre-recession level, median incomes remain below those of urban areas, and rural poverty rates are higher (Cromartie 2017).

A growing body of interdisciplinary research (e.g., Arrow et al. 2012; Pender et al., 2012a) calls for a more comprehensive evaluation of the impacts resulting from rural investments to inform and guide policy decisions; the continued dominance of purely economic/market approaches (e.g., regional output, Gross Regional Product, wages, and employment) to determine and evaluate rural development policies is outdated. This is because healthy, sustainable communities depend on cumulative net investment in a broad range of capital assets to generate rural wealth (e.g., Arrow et al. 2012; World Bank 2006, 2011; UNU-IHDP and UNEP 2012). These capital assets are commonly characterized as social, cultural, human (intellectual),

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

political, physical (built), natural and financial (Pender et al. 2014b) and wealth is defined as the stock of all capital assets, net of liabilities that can contribute to people's well-being (Pender et al. 2012a).

Measurement of the stocks of capital and their relationship to economic development have generally focused on a single capital, e.g. Rupasingha, et al. (2006), and Putnam (2007) with social capital, Arrow et al. (2012), Costanza and Daly (1992), Marre and Pender (2013), UNU-IHDP and UNEP (2012), World Bank (2006), and Wu et al. (2017) with natural capital, Flora and Flora (2004) with cultural capital, Romer (1986) and Schmit et al. (2017) with intellectual capital. However, little empirical evidence exists that describes how the investment in one capital relates to and/or affects the others (Pigg, et al. 2013). Further, research that sets forth comprehensive measures of stocks is new and limited (e.g., Chen and Weber 2012), and what does exist often confuses stocks and flows (e.g., Pender et al. 2012b). In their 2012 article published in *The American Journal of Agricultural Economics* Pender et al. (2012a) explicitly call for "more applied research on 'what works where and why' in promoting rural wealth creation and in measuring wealth in rural areas" (540).

This research contributes to the rural wealth creation (e.g., Pender et al. 2012a, 2012b, 2014; Chen and Weber 2011) and community capital (e.g., Flora and Flora, 2008) literatures by asking how we comprehensively measure the stock of wealth. To answer this question, we propose a database of stocks of rural wealth based on a comprehensive, inter-disciplinary literature review, where data utilized were available at the county level in the U.S. The development of the database enables comparison of the level of stocks across rural and urban to support enhanced understanding of how different levels of stocks and their interactions are heterogeneously associated with different policy outcomes in different places.

Subsequently, to test the association between the stock of capital and a rural development policy outcome we utilize selected food system policies (share of farms selling through direct markets, by county) as our empirical focus. There are several reasons for our focus on food systems policies. First, the induced innovation model of agricultural development argues that technologies for particular industrial sectors are developed endogenously in different places, reflecting local factor endowments (capitals) (Hayami and Ruttan 1971).[2] Second, rural economies have historically relied on goods-producing sectors such as farming, mining and manufacturing. Agriculture and mining are still major rural industries in terms of production and revenue (Cromartie 2017). Third, there has been substantial and increasing support at the Federal level for direct market interventions. The 2002 farm bill established the Farmers Market Promotion Program (FMPP), and funding for the program was made mandatory in 2008. The 2014 farm bill increased the amount of funding for the program from $33 million (2008) to $150 million (50% of which goes to direct marketing, the other 50% supports intermediated marketing opportunities) (NSAC 2014). An expressed intent of the FMPP is to support rural communities and economies; priority points, as well as a minimum of 10% of all funds are given to projects

[2] This sentiment is also in line with more recent emphasis on endogenous development as a more viable approach to rural economic development (e.g., McGranahan et al. 2011).

implemented in rural areas, or to projects that support agri-businesses located in rural areas (USDA AMS 2018).[3]

Finally, we estimate optimal levels of capital associated with share of farms participating in direct markets, demonstrating empirically that different levels of the stock of capital are associated with different food systems outcomes. Thus, understanding preexisting levels of the capitals before determining appropriate interventions may result in policies that are more likely to be successful in rural areas.

The rest of this article first discusses and reviews the literature on challenges with using financial measures to select and evaluate rural development policies. Next, we discuss our methodological approach to create our indices of stocks of each of the capitals. Subsequently, we provide our methodological approach to our regression analysis, testing the association between various food system intervention outputs and the stocks of wealth. Finally, we provide our results and a discussion, as well as opportunities for future research.

Challenges with Financial Measures of Selecting and Evaluating Rural Development Policies

A Social Accounting Matrix (SAM) characterizes the flows[4] of all formal monetary transactions that take place within an economy; it is a matrix representation of the full set of current accounts. SAMs are consistent with the National Income and Product Accounts (Hanson and Robinson 1991) and therefore produce a number of macroeconomic indicators including Gross Domestic Product, and are accordingly used as primary indicators of the performance of an economy, and to compare relative performance across regions. As evidence, GDP is the U.S. Bureau of the Economic Analysis' "featured and most comprehensive" measure of U.S. and sub U.S. economic activity (U.S. Department of Commerce 2017). By design, these indicators monitor annual flows of goods and services.

Though many of these flows are related to stocks of various types of tangible, market-valued capitals (Johnson et al. 2014), there is recognition of the limitations of traditional SAMs (e.g., Abraham and Mackie 2003). Limiting regional accounts to market activities distorts measures of economic activity and welfare (e.g., Kubiszewski et al. 2013). Abraham and Mackie (2003) provide as examples that nannies' services are included in GDP, while parents'' services are not. Similarly, swimming in a commercial swimming pool is included in GDP, while the value of swimming in an ocean is not. Pender et al. (2014) note that after natural disasters there may be increases in economic activity due to reconstruction-related expenditures. However, though GDP of a particular region may increase, nobody would argue that the region is better off due to the natural disaster.

[3] As another example, the Value Added Producer Grant (accessing local markets is included in the definition of value added) was started in 2001 and between 2001 and 2015 the program provided a total of 2,345 grant to farmers and ranchers—a total value of $318 million (Rupasingha and Pender 2018).

[4] Wealth, when activated or deployed, creates a flow of benefits. Without stocks there can be no flows. Often economic data on flows, particularly trade flows, are more readily available than data measuring stocks (Weber and Rahe 2010). As an example, a stock of human capital is embodied in the education, skills and the health of people while the flow would be benefits of human capital such as income, personal fulfillment, better governance and lower crimes.

A brief on 'The Comprehensive Rural Wealth Framework' by the Rural Policy Research Institute (2017) identifies two primary challenges with using only economic-centric measures like GDP, per capita income, and median household income. First, they point out that there are key non-economic factors that contribute to societal well-being. Second, the economic-centric measures may ignore key tradeoffs. They provide the example that a region may benefit economically in the short-run from clear-cutting its forests, but this may imperil its long-term future.

Abraham and Mackie (2003; 2005) led a National Academies panel specifically to examine and make recommendations as to key data that are needed to develop augmented accounts – national accounts that incorporate nonmonetized capitals. Most recently, Johnson et al. (2014) proposed an accounting framework for measuring wealth, incorporating a disaggregated set of capital accounts into a comprehensive SAM. To do this they borrowed ideas from welfare economics, and made contributions to the literature in distinguishing between the wealth of a region's residents and the collective wealth of the region itself, stocks and flows of capital, and the various types of capital. Though their framework is conceptually satisfying, the challenge of empiricizing the approach remains.

Methodology

Defining the stocks of capital

To overcome the shortcoming of the previous literature in either comprehensively measuring wealth creation, and/or confusing stocks and flows, we first, carefully delineate between stocks and flows, and second, build on an approach developed by Rupashingha et al. (2006) to create an index for each of the capitals by conducting a principal component analysis on various stocks associated with each of six capitals.

In order to determine relevant measures of the stocks of capital, we reviewed existing international and domestic literature including: the UN's (2014) Inclusive Wealth Report, Mumford's (2013) report on comprehensive wealth in the lower forty-eight states of the U.S., the International Integrated Reporting Council (2013) report on integrated wealth reporting, the Pender et al. (2012) report for the USDA Economic Research Service on rural wealth creation, the Yellow Wood Associates (2010) report on rural wealth creation, and the European Union's 2008 TOP-MARD Project (Bryden et al. 2012). While these sources describe how to investigate one or multiple forms of capital, they are often inconsistent in the scale of measurement, as well as in distinguishing between stocks and flows.

From these sources, we compiled a comprehensive list of measures of stocks, organized by capital, and included the dataset when listed.[5] Some of the sources suggested possible metrics, but did not include a potential dataset. If the same metric was listed more than once, we listed it once and attributed it to the first author that identified it. As necessary, we sought secondary data sources that provided comparable metrics at the county level in the U.S.

Herein we discuss six types of capital: 1) built; 2) cultural; 3) financial; 4) human; 5) natural; and 6) social and political. Following Rupasingha et al. (2006) we measure each of the capitals at the

[5] This list is available from the corresponding author upon request.

county level.[6] Previous research has found that anything larger than the county-scale fails to adequately capture wealth and wealth creation in rural places (Marré and Pender 2014). Additionally, there is widespread believe that development activity is fundamentally a local phenomenon (Rupasingha et al. 2006).

For each of the capitals we identified secondary datasets with metrics associated with each of the capitals. Our study includes examination of 3,068 counties in the lower 48 states excluding the District of Columbia, San Juan County CO, Baltimore City MD, Saint Louis County MO, Hudson County NJ, Bedford County VA, Cities of Alexandria, Bristol, Buena Vista, Charlottesville, Colonial Heights, Covington, Danville, Emporia, Fairfax, Falls Church, Franklin, Fredericksburg, Galax, Hampton, Harrisonburg, Hopewell, Lexington, Lynchburg, Manassas, Manassas Park, Newport News, Norfolk, Norton, Petersburg, Poquoson, Portsmouth, Radford, Richmond, Roanoke, Salem, Staunton, Waynesboro, Williamsburg, and Winchester in Virginia as the USDA did not collect 2012 Census of Agriculture data for these locations.[7] In the following section, we provide our definition of the capital and describe the specific variables we used to create the index for each of the specific capitals.

Built

Built capital, sometimes referred to as physical capital, is the physical infrastructure used to support community activities. This capital can be classified as public or private. Examples of public built capital include water and sewer capacity, transportation infrastructure, electric and natural gas infrastructure, waste-disposal facilities, telephone and fiber optic networks, schools, hospitals, fire-protection, police and other public buildings. Examples of private build capital include housing, commercial building, manufacturing facilities, port facilities and churches. Research has shown that communities with well-managed, high-quality built capital are more likely to successfully sustain and attract economic development opportunities (Crowe 2008).

As in line with other studies, our measurement of built capital focuses on the physical infrastructure within a county. Built capital includes the number of food and beverage establishments (NAICS 311 and 3121) from the 2015 County Business Patterns, per 10,000 population. The number of other manufacturing establishments (NAICS 31-33 minus 311 and 3121) per 10,000 population (U.S. Census Bureau 2015). County population with access to fixed

[6] In addition to the lack of a precise definition for each of the capitals, there is not a commonly accepted theoretical or methodological framework within economics for measuring the different forms of capital (Sobel 2002). Glaser et al. (2002) suggest that this is at least in part due to the lack of consensus around the unit of analysis with regards to capital. While Putnam (1995) and others including Coleman (1990) and Bowles and Gintis (2002) argue for the consideration of capital aggregated at the community level, economists often find it difficult to think of communities as decision-makers, so that an aggregate definition serves as a barrier to the development of an economic theoretical and methodological framework for modelling capital. In their meta-analysis of social capital studies, Westlund and Adam (2010) found from the 65 reviewed studies, 21 studies used the firm as the level of analysis, 7 the region/state in multiple countries, 14 the region/state/community within one country, and 23 the nation. Those that use the aggregate beyond the firm often rely on a diverse and selective research strategy mainly employing secondary data. Previous studies have relied on a variety of different indicators to measure the different forms of capital making comparability across studies difficult. Some authors operate with few indicators while other apply hundreds of variables for each of the capitals (Sabatini 2008). Many studies rely on a single data set instead of using complementary and alternative data from other sources (Westlund and Adam 2010).

[7] Shannon County, SD changed their name to Oglala Lakota County in May of 2015. The change was made in the Census.

advanced telecommunications (25 MBps/3 MBps service), divided by the population (FCC 2015). And, an ERS computed county level highway access measured in kilometers to the nearest interstate highway on-ramp or to other highway intersections (Dicken et al. 2011).

Cultural

Pender and Ratner (2014) define cultural capital as "the stock of practices that reflect values and identity rooted in place, class, and/or ethnicity" (20). Cultural capital can take either a tangible or intangible form. Tangible examples of assets include number of museums, libraries, art galleries, monuments, heritage buildings, sports venues, and unique tourism attractions. To capture tangible cultural capital assets we use data from the American for the Arts Local Arts Index (Kushner and Cohen 2018) including the number of public libraries per 10,000 residents and number of museums per 10,000 residents. We also include the USDA's ERS (2014) creative class county data, including the share employed in the arts from the 2007-2011 American Community Survey.

One important aspect of intangible cultural capital is the level to which residents feel represented in their communities. Emery and Flora (2006) explain that cultural capital "influence(s) what voices are heard and listened to, which voices have influence in what areas, and how creativity, innovation and influence emerge and are nurtured" (21). We endeavored to capture one type of diversity within a community by including the total non-white population (U.S. Census Bureau 2015).

Financial

Financial capital includes the stock of money and other liquid 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 to investment in other of the other capitals (Johnson et al. 2014).

In our measurement of financial capital, we sought to include both private and public wealth (Fannin and Honadle 2014). To value private wealth, we included a metric of the number of owner occupied units without a mortgage (net assets are higher if no mortgage, ceterus paribus), divided by population (U.S. Census Bureau 2015). We also included deposits to an FDIC-insured institution within a county, including foreign banks, divided by population (FDIC 2016). For public financial wealth, we used the U.S. Census Bureau's (2012) Census of Government's findings on the cash and security holdings minus the government debt, divided by population.

Human

Human capital has been a central concept in economic theory since the 1950s. Becker (1962) defined human capital as the resources embedded in people. Romer (1986) famously emphasized its role in modern economic growth theory. There are typically three key components of human capital – education, skills and health. The educational component together with innate skills or skills acquired through experience is often measured by discounted future income streams of an individual. Arrow et al. (2012) define the health component of human capital as the value of life expectancy, and changes in health capital as the value that people attach to the additional years of life that result from health improvements. They found that human capital amounted to more than 95 percent of comprehensive wealth in the United States in 2000 and thus raised concerns about the validity of their estimates and need for further study.

For our measurement of the educational component of human capital, we used the county population with a Bachelor's, Graduate or Professional Degree, divided by the adult population (U.S. Census Bureau 2015). For the health component, we used data from the Robert Wood Johnson Foundation's (2013) County Health Rankings and Roadmaps including their adjusted z-scores for Health Outcomes (today's health) and Health Factors (tomorrow's health).[8] We also include percent of the population that is food secure, percent of the population that has health insurance (Robert Wood Johnson Foundation 2017), the number of primary care physicians per 10,000 residents (NPPES 2016), and the number of primary health care providers divided by population (Health Resources and Service Administration 2014).

Natural

Natural capital is defined by Costanza and Daly (1992) as "a stock [of natural resources] that yields a flow of valuable goods and services into the future" (38). Natural capital includes both renewable and non-renewable resources. Renewable natural capital stocks are active and self-maintaining under sustainable practices. Ecosystems are an example of renewable natural capital. Two examples of non-renewable natural capital are fossil fuels and mineral deposits. Many advances have been made in the field with growing interest in ecosystem services. The European Union has made tremendous strides with the construction of their natural accounts, but these are limited to annual flows not stocks.

For our measure of natural capital, we used the National Amenities Scale (McGranahan 1999), prime farmland acres as a percentage of total acres (USDA NRCS 2012), and county acreage covered by easement divided by the total acres in a county (National Conservation Easement database 2016). Additionally we include the sum of all acres in conservation stewardship program, Community Reserve Program, emergency watershed/floodplain, EQUIP, grassland reserve program, trees timber, wetland bank reserve, wetland reserve program, wildlife food plot, wildlife habitat incentive program, and woodland/native understory from the USDA FSA (2017), divided by total county acres. And, finally we include U.S. Forest Service (2016) acreage divided by the total acres in a county.[9]

Social and Political

Social capital is one of the most studied forms of capital. Authors have posed various definitions but they all generally share a common theme around the formation of groups and other forms of civic activity (Rupasingha et al. 2006). Pender and Ratner (2014) define social capital as the "stock of trust, relationships, and network that support civil society" (19). Using this definition, political capital can be viewed as a special type of social capital. While some choose to disaggregate the two, we follow Rupasingha et al. (2006) and look at the two together.

[8] We used 2013 over more recent data because it was the last year they reported individual z-scores for each county rather than a simple ranking of counties within a state.

[9] Note that we also tried to incorporate certified organic acreage (USDA 2008) and a measure of crop species diversity using Shannon diversity indices expressed as effective number of crop species in 2012 (Aguilar et al. 2015). Unfortunately, we lost too many variables (organic acreage included 2,593 observations, and the diversity index included 2,687 observations).

The measure of social and political capital is taken from Rupashinga et al. (2006, 2014 update) including their aggregate social capital variables divided by 10,000 population, voter turnout, the Census response rate, and the number of non-profit organizations excluding those with an international focus, divided by the population. As of May 2018, Rupasingha et al.'s (2006) article had 384 citations. Thus, given the pervasive usage of this index in the literature, we determined to be consistent.

We standardized all of the variables by dividing them by their mean in order to avoid the variance being too dissimilar across variables. We also ran summary stats and obtained a correlation matrix in order to look for variables that present missing observations, or those that have very large correlation. Summary statistics for each of the variables are presented in Table 1.

[Table 1 here]

Principal component analysis

Principal component analysis (PCA) is a data reduction method used to re-express multivariate data with fewer dimensions. The goal is to re-orient the data so that the original variables can be summarized with relatively few components that capture the maximum possible information (variation) from the original variables. PCA is also useful in identifying patterns of association across variables.

PCA supports identifying components $z = [z_1, z_2, \ldots, z_p]$ that are a linear combination of $u = [u_1, u_2, \ldots, u_p]$ of the original variables $x = [x_1, x_2, \ldots, x_p]$ that achieve maximum variance. The first component z_1 is given by the linear combination of the original variables x and accounts for maximum possible variance. The second component captures most information not captured by the first component and is also uncorrelated with the first component

PCA seeks to maximize variance so it is sensitive to scale differences in the variables. Accordingly, we standardized the data. PCA maximizes the variance of the elements $z = xu$ such that $u'u = 1$. The solution is obtained by performing an eigenvalue decomposition of the correlation matrix, by finding the principal axes of the shape formed by the scatter plot of the data. The eigenvectors represent the direction of one of these principal axes.

We follow Kaiser's rule and retain only factors with eigenvalues exceeding unity; any factor retained should account for at least as much variation as any of the original variables (see Table 2). Additionally, we rotate the factor loadings matrix in order to make most factor loadings on any specific factor small while only a few factor loadings large in absolute value. In other words, we use the factor loadings to obtain the highest possible correlations on the fewest possible factors. The goal is to find clusters of variables that to a large extent define only one factor. We use oblique rotation as it allows for correlation between the rotated factors, which facilitates interpretation of the results. The resulting components are scaled from zero to 100 to obtain indexes. Where we retained multiple components, we created aggregate indices by taking the average of each component. Hereafter we refer to the aggregate indices as the capital indices.

[Table 2 here]

Once the stock of capital indices are generated, they are used as regressors to explain the variation in food system variable outcomes (*FSO*), that is, the share of farms with direct to consumer sales in a county.

We first regress these metrics on all the capital indices (*K*), state-level fixed effects (*S*) and Rural-Urban Continuum code indicators (*RUCC*) to capture unobservable differences in state-level factors that may affect food system outcomes, as well as other factors which may be related to the level of "rurality" of a given county. The model is estimated for the full sample first and then splitting the sample to isolate "metro" counties (RUCCs 1, 2 and 3) and nonmetro ones (RUCCs 4 and higher). The USDA ERS (2016) created the RUCCs are a classification scheme to distinguishes metropolitan counties by the population size of the metro area, and nonmetropolitan counties by degree of urbanization and adjacency to a metro area.

We estimate three different model specifications. The first model specification (1) includes all the capital indices linearly; the second specification (2) includes each capital as both linear and quadratic; and, a third specification (3) includes pair-wise interactions of the different capitals.

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

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

$$FSO_i = \alpha + \sum_{j=1}^{6} \beta_j K_{ij} + \sum_{\forall j;-j} \delta_{j,-j} K_{ij} K_{i-j} + + \sum_{n=1}^{N} \gamma_n S_{ni} + \sum_{r=1}^{R} \theta_r RUCC_{ri} + e_i \qquad (3)$$

The rationale behind specifications 2 and 3 are to capture non-linearities in the associations between food system outcomes and capital stocks indices. All models are estimated used Ordinary least Squares (OLS).

Results and Discussion

Table 3 presents the promax component loadings and unexplained variation in each variable. Here we describe the variables that make up each of the components, by capital, focusing on those most strongly correlated with each component that exceeds unity.

[Table 3]

Capital Indexes

Built Capital – following Kasier's rule we retain the first two components for built capital. Here the first principal component is strongly correlated with <u>business establishments</u>, both food and beverage (foodbev_est_CBP) and manufacturing (est_CBP). The second component is strongly correlated with <u>highway density</u> (highway_km).

Cultural Capital – here we retain the first two components of cultural capital. The first component is correlated with three variables: public libraries (pub_lib), museums (museums), and creative industry businesses (create_indus). Each of these are positively associated with the others. Broadly, this component can be construed as capturing arts and cultural institutions. The second principal component is correlated with two variables: percent of creative class share of employment from the arts (create_jobs), and percent of the population that is nonwhite. Together, the second component can be thought of as capturing the stock of people-focused cultural capital.

Financial Capital - we retain only the first principal component, where two variables explain most of the variation: percent of owner occupied units without a mortgage (owner_occupied) and FDIC deposits (deposits). This component reflects the stock of financial solvency within a county.

Human Capital - The first principal component is most strongly correlated with the health aspects of human capital, both today's health as captured in the health outcome z-score (health_outcome) and tomorrow's health as captured in the health factor z-score (health_factor). The second principal component is correlated with the percentage of the population that is food secure (food_secure) and the percentage of the population that is insured (insured). We believe this second component is broadly reflective of risk management and security.

Natural Capital – we retain the first two principal components. The first principal component is correlated with the natural amenity scale (natamen_scale), and acres in Federal conservation stewardship programs (acre_FSA). Interestingly, acre_FSA and natamen_scale vary inversely. The second component is most strongly correlated with the percentage of total acres that is prime farmland (prime_farmland) and the acres in conservation programs (conserve_acre).

Social and Political Capitals – our PCA results look a little different than those from Rupashinga et al. (2006) given two primary differences in how we handled the data. First, we standardized the variable number of non-profit organizations without including those with an international approach (nccs14) by 100,000 people in a county in 2014. Second, we retained the first two components, as they both exceed unity. We believe this approach allows us to tell a more nuanced story, which represents different components of social and political capital.

The first principal component here is strongly correlated with the aggregate of other social variables (assn14) and the number of nonprofits (nccs14). Together, this component reflect social participation The second principal component is almost entirely captured by the variables census response rate (respn10) and less so by voter turnout (pvote12). Accordingly, this second component captures the stock of political participation.

Association between Food Systems Outcomes and Capital Indexes

In table 4 we present the selected estimated coefficients for the capital indexes by metro and nonmetro areas. We present results associated with the share of farms with direct sales by county.

[Table 4 here]

The index of built capital is positive and significant across the full samples, as well as within nonmetro regions. But, it is not significant within metro regions. Given that our built capital index is strongly associated with business establishments and highway density, it is not surprising that these stocks would be positively and significantly associated with nonmetro food systems outcomes. Traditional, more commodity oriented agricultural operations are less dependent on proximity to a particular market than are farms that sell through direct markets. Previous research shows that transportation costs are one of the largest variable expenses for farms selling through direct markets (LeRoux et al. 2010; Bauman et al. 2017). Highways may be important for producers to reach their intended market. Consistent with findings from Schmit and Gomez (2011), farmers markets in more centralized, larger locations are positively associated with vendor performance. Further, the majority of fruit, vegetable, and greenhouse and nursey crop sales originated on metropolitan farms (Lichter and Brown 2011). Operations focused on these commodities are much more likely to be in metro regions, and they are generally more aware of both density of business establishments and distance to transportation (given the highly perishable nature of the commodity). Though Goetz (1997) found in his county-level regressions that the availability of transportation infrastructure (including highway) had a negative effect on most food manufacturing, it had a positive effect on fruit and vegetable manufacturing.

The cultural capital index is negative and significant across the full sample, as well as within metro and nonmetro. Though Richard Florida's original definition of the creative class included farmers and farm managers, the USDA ERS' (2017) update dropped farmers or farm managers in their definition of creative class "due to low creativity requirements of farmers as report in O*NET". Thus, inherent in the variable may be a bias against some of the producers that sell through direct markets.

Consistent with previous literature (e.g., Schmit et al. 2017), we find that human capital has a positive and significant association with our food system intervention outcome, both for the entire sample, as well as within both metro and nonmetro regions. Our human capital index is largely associated with health outcomes and factors, as well as risk management and security. Though farmers markets are purported by many to promote health, a review of the literature from 1980-2009 on the nutritional implications of farmers markets revealed "few well-designed research studies" (McCormack, et al. 2010, 399). Our results provide at least a starting point for empirical evidence showing positive association between farms with direct sales and our human capital index.

The index of social capital is positively and significantly associated with the share of farm with direct sales across the whole sample as well as in metro areas. We did not see a significant relationship between the share of farms with direct sales and the social capital index in nonmetro regions. This may be due to the fact that all farms have high levels of social capital in nonmetro areas.

Finally, there are two capital indexes without any significant relationship to the dependent variable: financial and natural. This implies that the index of financial and natural capitals are likely associated with farming in general, and not farms with direct sales. Recall that prime farmland, acres in FSA programs, the natural amenity scale, and acres in conservation programs are strongly correlated with our natural capital index. There is little literature to support that farmers interested in selling through direct markets would be more likely to be attracted to these stocks of natural capital than all farmers more generally. Similarly there is little reason to believe that the stock of financial capital would be associated with farms selling through direct markets as opposed to all farmers. As Johnson et al. (2014) write, is very different from the other capitals in that it is either allocated to consumption or to investment in other of the other capitals. Accordingly, in and of itself it is not associated with significant food systems outcomes.

Optimal levels of capitals in nonmetro areas

Perhaps most useful in supporting effective rural development policies, in table 5 we present linear and quadratic coefficients by capital for nonmetro regions, as well as their inflection point. Using these data we can see that before a policymaker wants to intervene in an effort to support a particular outcome, they should take into account the level of the current capital. At low levels of certain capitals improving them may result in a positive effect. If a level is already high, improving the capital may actually have a counterproductive effect.

The index of the stock of built capital, for example, starts negative and moves to positive at an inflection point of 5.936. Given the low starting level of the index of build capital in nonmetro areas, investment in built capital results in a positive effect. Cultural capital responds in a similar manner. The natural capital index, on the other hand, starts at a relatively high level and moves to negative at an inflection point of 31.499. Thus, investment in the stock of natural capital when a county is already at a high level may actually have a negative effect. Financial, human and social-political capitals perform similarly.

[Table 5 here]

Figure 1 presents the marginal effects of the relative capital stocks on the share of farms selling through direct markets graphically. Here, one can see that when the index of a particular stock starts low or negative, investment has a generally positive effect. However, when the index of a stock is already high, investment beyond a particularly point actually has a negative effect. In other words, investment in the stock has a negative association with the share of farms selling through direct markets.

[Figure 1 here]

Future Research

This paper builds off the community capitals and rural wealth creation literatures and is the first research to provide a database of the stocks associated with each of the capitals using available secondary data for the entire United States. There are many potential applications of these county-level indicators for the stock of rural wealth. First, as noted earlier, a more comprehensive evaluation of impacts resulting from rural programming and initiatives is necessary to better inform the efficacy of rural development efforts and guide policy decisions. Local, state, Federal governments, as well as philanthropic organizations are making substantial investments to support rural development efforts, including food system programming specifically. Using the database of stocks we can now test what, if any, relationship exists between these policies, and the level of capital stocks. This research provides clear evidence that outcomes resulting from rural development policies and interventions will be impacted by existing levels of stocks. Thus appropriate interventions need to be determined, at least in part, based on what level of stocks exist.

Second, this research contributes to the literature empirically demonstrating that communities depend on net investment in a broad range of capital assets, and that financial measurement alone is insufficient. Accordingly, this measurement of the stock of rural wealth 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 Abraham and Mackie (2003). The ability to measure the stocks of capital assets is critical to understanding the potential magnitude of change that could result from additional flows of capitals. This is very difficult when using non-financial measures. For example, the work of Schmit et al. (2017) shows that farmers get new ideas for products through selling at farmers markets. If the farmer does something with this idea and changes the stock of human capital in an area, one still needs to understand the magnitude of this impact; in other words, what is the marginal impact. Thus, having a standardized measure of the stocks provides an important step in incorporating nonmarket items into more traditional accounting frameworks.

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Table 1. Descriptive statistics.

Variable name	Variable description	Data Source	Mean	Std. Dev
d2c_total	2012 farms with direct to consumer sales divided by the total number of farms	USDA County Level Data: Table 2. Market value of agricultural products sold including direct sales: 2012 and 2007.	0.0710	0.0675
directfarms	2012 total farms with direct to consumer sales	USDA 2012 Agriculture Census Table 2. Market Value of Agricultural Products Sold Including Direct Sales: 2012 and 2007	46.5068	61.3847
Built Capital Indicators				
foodbev_est_CBP	2015 number of establishments NAICS 311 and 3121 from the 2015 County Business Patterns per 10,000 population 2015	U.S. Census Bureau. County Business Patterns. 2015.	1.4435	1.8500
est_CBP	2015 number of other manufacturing establishments (31_33)-(311+3121) per 10,000 population 2015	U.S. Census Bureau. County Business Patterns. 2015.	8.4279	5.0272
broad	2016 County population with access to fixed advanced telecommunications (25 Mbps/3 Mbps service), divided by 2015 population	Federal Communications Commission. 2016 Broadband Progress Report. 2016.	0.9797	5.0481
highway_km	ERS computed county-level highway access measured in kilometers to nearest interstate highway on-ramp or to other highway intersections using ESRI 2007 highway data down-casted to the 1-kilometer level (per 10 km).	Dicken C, Williams R, Breneman V. County-level highway access measures. Economic Research Service U.S. Department of Agriculture. 2011.	1.7203	2.3847
Cultural Capital Indicators				
create_jobs	Creative class county data including share employed in the arts from the 2007-2011 American Community Survey	USDA Economic Research Service. Creative class county codes using data from the pooled 2007-2011 American Community Survey, U.S. Census Bureau. 2014.	0.1614	0.1122
pub_lib	Public libraries per 10,000 population 2012	Kushner, Roland J and Randy Cohen, principal investigators. 2018. Local Arts Index data set.	46.4278	348.5144
create_indus	Creative industires businesses per 10,000 population 2014	Kushner, Roland J and Randy Cohen, principal investigators. 2018. Local Arts Index data set.	111.9716	396.1935

nonwhite_pop	Total population that identifies as non-single-race white divided by total population 2015.	U.S. Census Bureau. American Community Survey. 2015.	0.2585	1.6823
museums	Museums per 10,000 population 2015	Kushner, Roland J and Randy Cohen, principal investigators. 2018. Local Arts Index data set.	45.8940	235.4739
Financial Capital Indicators				
localgovfin	2012 Cash and security holdings minus 2012 government debt divided by total population 2012	U.S. Census Bureau. Census of Governments: Finance-Surveys of State and Local Government Finances. 2012.	0.2705	5.4101
deposits	2016 survey of branch office depositis within a county as of June 30, 2016 for all FDIC-insured institutions, including insured U.S. branches of foreign banks divided by population 2015	Federal Deposit Insurance Corporation. Deposit Market Share Reports. 2016.	44.0969	641.6706
owner_occupied	Number of owner occupied units without a mortgage (net assets are higher if no mortgage, ceterus paribus) divided by population 2012	U.S. Census Bureau. American Community Survey. 2015.	0.1599	0.3945
Human Capital Indicators				
ed_attain	Educational attainment measured as the adult population with a Bachelor's, Graduate or Professional degree divided by the adult population 2015	U.S. Census Bureau. American Community Survey. 2015.	0.2110	0.0928
health_factor	Health Factors Z-Score	Robert Wood Johnson Foundation. 2013 county health rankings national data. 2013.	0.0051	0.4709
food_secure_rev	100 minus % food insecure, divided by 100	Robert Wood Johnson Foundation. 2017 county health rankings national data. 2017.	0.8535	0.0412
insured_rev	100 minus % uninsured, divided by 100	Robert Wood Johnson Foundation. 2017 county health rankings national data. 2017.	0.8287	0.0619
primary_care	Total number of primary care physicans divided by the population 2015	Health Resources and Service Administration. Area health resources file/National provider identification file. 2014.	8.6691	51.9145
health_outcome	Health Outcome Z-Score	Robert Wood Johnson Foundation. 2013 county health rankings national data. 2013.	0.0075	0.7099
Natural Capital Indicators				

natamen_scale	1999 Natural Amenities Scale	McGranahan, David. (1999). Natural amenities drive rural population change. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 781).	0.0538	2.2900
prime_farmland	2012 Prime Farmland - non-federal prime farmland in 2012 in thousands of acres divided by total acres in county	USDA Natural Resource Conservation Service. National Resources Inventory. 2012.	0.0006	0.0014
conserve_acre	County acreage covered by easement divided by total acres in county	National Conservation Easement Database. National Conservation Easement Database. 2016.	0.1163	1.2721
acre_FSA	Sum of all acres in conservation stewardship program, CRP, emergency watershed/floodplain, EQUIP, grassland reserve program, trees timber, wetland bank reserve, wetland reserve program, wildlife food plot, wildlife habitat incentive program, woodland/native understory from the FSA Crop Acreage Data 2017, divided by total acres in county	USDA Farm Service Agency. FSA Crop Acreage Data. 2017.	0.0232	0.0351
acre_NFS	National Forest Service acreage divided by total acres in county	U.S. Forest Service. Table 6. NFS acreage by state, congressional district and county. 2016.	454.1022	24,988.1400
Social Capital Indicators				
assn14	The aggregate of other social variables (divided by population per 10,000) divided by 10	Rupasingha A, Goetz SJ, Freshwater D. The production of social capital in US counties. The journal of socio-economics. 2006 (with updates) Feb 1;35(1):83-101.	1.3793	0.7032
pvote12	Voter turnout	Rupasingha A, Goetz SJ, Freshwater D. The production of social capital in US counties. The journal of socio-economics. 2006 (with updates) Feb 1;35(1):83-101.	0.6685	0.0913
respn10	Census response rate	Rupasingha A, Goetz SJ, Freshwater D. The production of social capital in US counties. The journal of socio-economics. 2006 (with updates) Feb 1;35(1):83-101.	0.7051	0.1116

nccs14	Number of non-profit organizations excluding those with an international approach divided by population 2014	Rupasingha A, Goetz SJ, Freshwater D. The production of social capital in US counties. The journal of socio-economics. 2006 (with updates) Feb 1;35(1):83-101.	0.0069	0.0195

Table 2. PCA results and PCA results with Promax Rotation (only components with eigenvalues >1 retained)

		Unrotated Components			Promax Rotated Components	
Capital	Component	Eigenvalue	Proportion	Cumulative	Eigenvalue	Proportion
Built	Comp1	1.18597	0.2965	0.2965	1.17749	0.2944
	Comp2	1.01074	0.2527	0.5492	1.02001	0.255
	Comp3	0.997959	0.2495	0.7987		
	Comp4	0.805335	0.2013	1		
Cultural	Comp1	2.61097	0.5222	0.5222	2.60253	0.5205
	Comp2	1.02355	0.2047	0.7269	1.03031	0.2061
	Comp3	0.964055	0.1928	0.9197		
	Comp4	0.244176	0.0488	0.9685		
	Comp5	0.157254	0.0315	1		
Financial	Comp1	1.60661	0.5355	0.5355	1.60661	0.5355
	Comp2	0.999995	0.3333	0.8689		
	Comp3	0.393399	0.1311	1		
Human	Comp1	2.61115	0.4352	0.4352	2.25375	0.3756
	Comp2	1.7237	0.2873	0.7225	2.05661	0.3428
	Comp3	0.980614	0.1634	0.8859		
	Comp4	0.449723	0.075	0.9609		
	Comp5	0.21646	0.0361	0.9969		
	Comp6	0.01835	0.0031	1		
Natural	Comp1	1.26741	0.2535	0.2535	1.25946	0.2519
	Comp2	1.02763	0.2055	0.459	1.03542	0.2071
	Comp3	0.996081	0.1992	0.6582		
	Comp4	0.96183	0.1924	0.8506		
	Comp5	0.747049	0.1494	1		
Social/ Political	Comp1	1.1952	0.2988	0.2988	1.12643	0.2816
	Comp2	1.01518	0.2538	0.5526	1.08058	0.2701
	Comp3	0.946143	0.2365	0.7891		
	Comp4	0.843478	0.2109	1		

N = 2682

Table 3. Promax component loadings and unexplained variation in each variable.

Capital	Variable	Comp1	Comp2	Comp3	Unexpl
Built	foodbev_est_CBP	**0.6817**	-0.2256		0.3922
	est_CBP	**0.7112**	0.1844		0.3779
	broad	0.1719	0.1094		0.9541
	highway_km	-0.0047	**0.9504**		0.0791
Cultural	create_jobs	-0.0386	**0.6398**		0.5673
	pub_lib	**0.5723**	-0.003		0.1467
	create_indus	**0.5702**	0.0009		0.1535
	nonwhite_pop	0.0325	**0.7684**		0.3942
	museums	**0.5873**	0.0168		0.1038
Financial	localgovfin	0.0067			0.9999
	deposits	**0.7071**			0.1968
	owner_occupied	**0.7071**			0.1967
Human	ed_attain	0.4913	0.1735		0.3003
	health_factor	**0.6263**	-0.0629		0.1372
	food_secure_rev	-0.0247	**0.6907**		0.02173
	insured_rev	-0.0304	**0.6919**		0.02158
	primary_care	0.106	0.0668		0.9579
	health_outcome	**0.5956**	-0.0822		0.2264
Natural	natamen_scale	**0.6657**	-0.2019		0.3874
	prime_farmland	-0.2246	**0.6841**		0.438
	conserve_acre	0.2798	**0.6416**		0.4913
	acre_FSA	**-0.6465**	-0.2018		0.4432
	acre_NFS	0.1009	-0.1971		0.9452
Social	assn14	**0.6652**	-0.0201		0.5023
	pvote12	0.3937	0.5281		0.4648
	respn10	-0.1445	**0.8278**		0.2647
	nccs14	**0.6194**	-0.1937		0.5578

N = 2682

Table 4. Selected estimated coefficients for capital indexes by metro and nonmetro areas.

Share of farms with direct sales by county	Full and Split Samples		
	ALL	Metro	NonMetro
Built	0.400***	0.465	0.300***
	(0.117)	(0.282)	(0.087)
Cultural	-0.908***	-2.460***	-0.417**
	(0.265)	(0.927)	(0.180)
Financial	-0.171	1.223	-0.15
	(0.418)	(0.988)	(0.677)
Human	0.660***	0.911***	0.279***
	(0.111)	(0.199)	(0.105)
Natural	0.127	0.486	-0.091
	(0.341)	(1.243)	(0.227)
Social	0.239**	0.730**	0.071
	(0.114)	(0.294)	(0.083)
Constant	99.393***	-45.84	54.215***
	(19.735)	(53.998)	(17.897)
N	2682	1032	1650
Adj Rsquared	0.448	0.468	0.514

Note: State and RUCCs Fixed Effects Parameters omitted for brevity Standard Errors in Parenthesis; ***, ** and * represent parameters statistically different from 0 at the 1%, 5% and 10% probability level, respectively

Table 5. Estimated linear and quadratic coefficients including inflection point by capital index, nonmetro.

	Dependent variable: Share of farms selling direct					
	Linear Coefficient		Quadratic Coefficient		Inflection Point	
Built	-0.076		0.006	*	5.936	
	(0.202)		(0.004)		(12.897)	
Cultural	-1.912	***	0.020	***	47.984	***
	(0.446)		(0.006)		(5.746)	
Financial	1.168		-0.030		19.530	
	(2.360)		(0.071)		(14.223)	
Human	1.374	***	-0.019	***	36.076	***
	(0.396)		(0.007)		(4.253)	
Natural	1.279	***	-0.020	***	31.499	***
	(0.406)		(0.005)		(5.554)	
Social	0.498		-0.004		63.775	***
	(0.314)		(0.003)		(14.271)	

Note: Selected Regression Coefficients only - State and RUCCs Fixed Effects Parameters omitted for brevity
Standard Errors in Parenthesis; ***, ** and * represent parameters statistically different from 0 at the 1%, 5% and 10% probability level, respectively

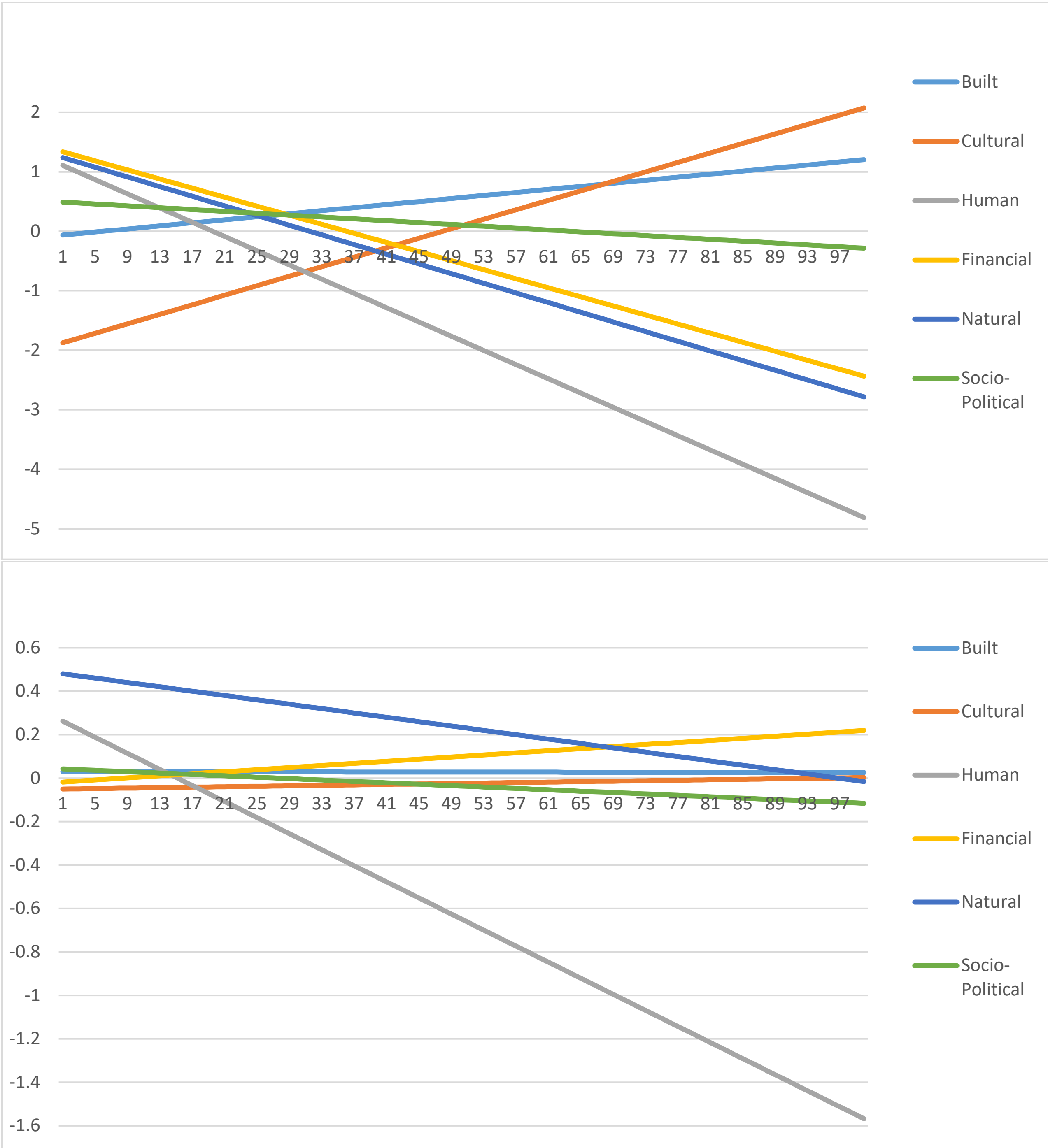

Figure 1. Marginal Effects of Relative Capital Stocks on Share of Farms Selling through Direct Markets