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Linking Entrepreneurial Activities and Community Prosperity/Poverty in United States Counties: Use of the Enterprise Dependency Index

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Abstract: More than 3000 U.S. counties are used to examine a hypothesis that the enterprise dependency index (population numbers/enterprise numbers, EDI) can serve as a measure of community prosperity/poverty. The theoretical derivation of EDI is presented. Then, a slightly nonlinear relationship between the total and poor populations of the counties is recorded. Poverty is slightly more systematically concentrated in smaller counties. The foregoing indicates that poverty forms part of the demographic–socioeconomic–entrepreneurial nexus of human settlements. The EDIs and poverty rates of counties are statistically significantly and positively correlated. The nonlinear power law, however, explains only about 45% of the variation, suggesting that the two measures are not identical. Further analyses confirm the independence of the two measures. Poverty is only one part of the two-part prosperity/poverty continuum. Measurement of poverty rates seemingly ignores the economic impacts of prosperity in communities. The analyses suggest that EDI, based on the ability of communities to ‘carry’ enterprises, is a more sensitive measure of community prosperity/poverty than the poverty rate. The hypothesis that EDI is a useful measure of community prosperity/poverty is accepted. Further research is, however, needed to optimize the use of this measure.

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1. Introduction

Considerations of sustainability should not only include ecosystem health and economic development but also social justice [1]. Poor communities and sustainable development might, however, be incompatible, because these communities usually have few resources under their control and in situ resource exploitation is often an issue of survival [2]. The so-called Brundtland Commission considered sustainable development goals and introduced the normative imperative that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs [3]. Poverty, racism, political marginalization, and the opportunity to make a livelihood should, therefore, feature in consideration of sustainable societies [1]. Community poverty, and its measurement, is, therefore, an important issue.

The purpose of this contribution is to promote a different way to measure community poverty. It is based on the enterprise dynamics of human urban settlements. To develop the reasoning behind the suggestion, background information is provided. First of all, community poverty and ways to measure it are reviewed. Thereafter, new approaches to the study of urban socioeconomics are reviewed, leading to considerations of the enterprise dynamics of human settlements. The development of a population and enterprise-based method to measure community prosperity/poverty is then explained.

1.1. Community Poverty

For a long time, poverty research focused on the culture of poverty and not community poverty. Myrdal [4] was the first to ignore this dominant trend. He emphasizes the rise of an underclass of unemployed and unemployable people and families, which was a seemingly inevitable result of the structural and technological problems inherent in modern society [4]. Community poverty became an important national and international issue. For instance, President Lyndon B. Johnson declared a “War on Poverty” in January 1964 [5]. The ending of poverty then became a major issue in the policy discussions of richer countries [6]. In 2015, the international community formulated a number of Sustainable Development Goals, which include the aim of ending extreme poverty by 2030 [7]. Yet, poverty remains a problem. In 2018, poverty in the United States, one of the world’s most prosperous nations, was still persistently high [8]. In 2017, an estimated 9.2 percent of the global population lived below the international poverty line of 1.90 USD a day [9]. There were still 689 million extremely poor people in the world in 2017.

The measurement of poverty faces two distinct problems: the identification of the poor among a total population, and the construction of an index of poverty using the available information on the poor [10]. The former requires the choice of a criterion of poverty (e.g., the selection of a poverty line) and then determining those who satisfy that criterion (e.g., fall below the poverty line, sometimes referred to as the ‘head count’) and those who do not. Over a long period, the appropriateness of the choice of the poverty criterion elicited many opinions [11–14]. Yet, decades ago, Sen [10] had pointed out that the most common procedure is simply to count the number of poor and then to calculate the poverty rate, i.e., the percentage of the total population falling in the poverty group.

Although the poverty rate is only a crude index [10], it is still widely used in research e.g., [15–19]. McGranahan and Beale [20] also used poverty rates to explain rural population loss in the U.S. They [20] remarked that, generally, economic models of regional growth and decline suggest that areas of high poverty should also be areas of population loss because, as opportunities decline in an area, poverty rates rise and people move to other areas in search of better opportunities. Outmigration subsequently reduces the poverty rate, such that poverty rates should ultimately equalize across areas. However, based on poverty rates, McGranahan and Beale [20] argued that two facts about rural distress in the U.S. refute this general model. Firstly, areas with high poverty rates and areas with large population losses usually have had these conditions for a long time. The conditions did not originate in the short term. Secondly, rural counties with high poverty rates in 1990 were no more likely to have population losses in the 1990 to 2000 period than other rural counties. QuickFacts of the U.S. Census Bureau also presents the poverty rate (percent of people in poverty) for states, counties, cities, towns, and zip codes in the U.S [21].

A major weakness of the poverty rate is that it deals with only one side of the two-sided prosperity/poverty continuum of communities and societies. The continuum reflects the ratio between the number of not-poor (i.e., prosperous) and the number of poor people in a society. The poverty rate is not an ideal measure because the same number of poor people could be resident in communities with widely differing numbers of prosperous residents and, thus, widely differing states of prosperity/poverty. It is, therefore, worthwhile considering a poverty measure that is not based on a criterion of poverty (e.g., a poverty line), but which measures the prosperity/poverty state of a community. To explore this possibility, it is necessary to consider the enterprise dynamics of human settlements.

1.2. Human Settlements and Enterprise Dynamics

In the new millennium, urban scaling research [22] demonstrates that the spatial and temporal levels of social, economic, and political interactions of urban settlements are subject to constraints imposed by environmental conditions, technology, and institutions [23,24]). Scaling simply refers, in its most elemental form, to how a system responds when its size changes [25]. In other words, it can potentially reveal the underlying principles that determine the dominant behaviour of highly complex systems. The development

of a Settlement Scaling Theory (SST) for cities [22,24] is based on the nonlinear scaling that has been observed in human settlements whose populations vary in size by many orders of magnitude [26]. SST provides a set of hypotheses and mathematical relationships that together generate predictions of how measurable quantitative attributes of settlements, including their business establishments, are related to their population sizes [24–26].

Business establishments (here called enterprises) are used in urban studies as fundamental units of economic analysis [26]. The reason is that innovation, wealth generation, entrepreneurship, and job creation all manifest themselves through the formation and growth of workplaces. Youn et al. [26] reported a surprisingly simple result: the total number of enterprises in U.S. metropolitan statistical areas (MSAs) is linearly proportional to their population sizes. This relationship is true for MSA populations that differ over many orders of magnitude. Thus, in a constant fashion, larger MSAs have proportionally more enterprises, and vice versa. Linear proportionalities (between population numbers and enterprise numbers) have also been observed for South African towns [27,28] and U.S. counties [29].

However, in all of these cases, be it MSAs, counties, or towns, there was also some variation around the lines of best fit between population and enterprise numbers. In other words, a specific population number could be associated with a range of enterprise numbers in different human settlements, or a specific enterprise number could be associated with a range of population numbers in different settlements. Toerien [28,29] argued that if more people are needed to support a given level of enterprises in one community compared to another, the buying power to support enterprises of the former group is lower and that of the latter group is higher. The former is a poorer community and the latter a more prosperous community.

1.3. Enterprise Dynamics and Prosperity/Poverty of Communities

The observed linear relationships between enterprise numbers and population numbers of human settlements [26,28,29] can be stated as:

$$\text{Enterprise numbers} = b (\text{Population numbers}) + C \quad (1)$$

The regression coefficient, b , is:

$$b = \text{Enterprise numbers} / \text{Population numbers} \quad (2)$$

The regression coefficient (b) indicates how many enterprises can be ‘carried’ by a specific population. It is a measure of the ‘enterprise carrying capacity’ (ECC) of a human settlement. Although the concept of carrying capacity is used widely in ecological disciplines [30], it is not used much in mainstream economics [25]. In ecological systems, carrying capacity is shaped by processes and interdependent relationships between finite resources and the consumers of those resources [30]. In human settlements, the enterprise carrying capacity is determined by the needs and wants of people and the money they have available for spending. This determines the number and types of enterprises from which they can buy.

Toerien [28,29] called the inverse of the regression coefficient of Equation (2) above, (i.e., $1/b$), the enterprise dependency index (EDI), and suggested that it is a measure of community prosperity/poverty. The ECC (enterprises/population) and EDI (population/enterprises) are obviously two sides of the same coin. They are both assessments of the prosperity/poverty statuses of communities. Because of the similarity, this contribution focuses mainly on the application of EDI in community prosperity/poverty analyses. It must be kept in mind that ECC could have been used in its stead.

It should be possible to link demographic information (population numbers) and entrepreneurial information (enterprise numbers) and the prosperity/poverty information (EDI) of human communities. However, would such a linkage be useful? Because community poverty is an important consideration in many countries, including the United

States, it could be very important. For instance, the Great Recession (2008 to 2010) increased neighbourhood poverty in the U.S. in the midst of affluence [15]. The result was the re-emergence of a racial and ethnic underclass living in inner-city neighbourhoods. Consequently, there is a need for a geographic redirection of poverty research because poverty should be understood in terms of where it is located [31]. Benzow and Fikri [31] reflected on the 1980 to 2018 poverty trends of American neighbourhoods. During this period, approximately 4300 neighbourhoods that housed 16 million Americans crossed the high-poverty threshold (a 30 percent poverty rate or higher).

The quest to reduce poverty has historically relied on two levers: economic growth and the intentional redistribution of resources to the poor, either by the domestic state or foreign aid [7]. Unemployment and underemployment are some of the strongest predictors of poverty [8,32,33]. For instance, households whose usual breadwinners are out of work are three times more likely to be poor than working households [33]. Rifkin [34] reflected on the future impacts of technological development on enterprises, and, hence, on employment. He argued that a new age of global markets, automated production, and a near-workerless economy is in sight. What happens in the workplace in the future would have important implications for humanity, and future unemployment could be a serious problem. Whereas Rifkin [34] is concerned about the impact of enterprise dynamics on employment (as impacted by technology), it has become necessary to examine the possible application of the EDI in urban research in much greater detail. This is done here.

1.4. Purpose of This Contribution

The prime purpose of this contribution is to examine a hypothesis that EDI, an enterprise dynamics characteristic, is a useful measure of community prosperity/poverty. Until recently, the prosperity/poverty status of communities has not been measured using enterprise and demographic dynamics. Such an approach was shown to be potentially useful [28,29] and it is now subjected to more extensive analysis.

2. Methods

A specific challenge confronted the planning of this contribution. The hypothesis to be tested involved the evaluation of a new method that is not based on the number of poor people but on the ability of communities (the people in U.S. counties) to financially support enterprises. This meant that the analytical strategy had to be based on scaling laws (i.e., cross-sectional scaling [35]) regularly encountered in modern urban research. The analysis used data from more than 3000 U.S. counties. The 2017 dataset of the counties' demographic, socioeconomic, and enterprise characteristics was examined to test the utility of EDI as a measure of community prosperity/poverty. This dataset was selected because 2017 is long after the Great Recession (2008 to 2010) and before the onset of the COVID pandemic. It was expected to reflect normal conditions.

The scaling analyses were used to: (i) determine if the number of poor people in counties is related to their total population, and (ii) examine whether the county enterprise and demographic dynamics are similar to those of cities [22–25]. These analyses would establish whether the SST philosophy [22,24] could be applied. Once this was established, the relationships between demography and enterprise numbers (relating to ECC), as well as between the enterprise numbers and demography (relating to EDI), of the counties were examined.

Having established that population and enterprise numbers are linearly correlated, the variation of data around the regression line was examined. Pearl and Mackenzie [36] suggested that, in cases where confounding might be an issue, it is helpful to hold the value of one characteristic constant and to monitor the behaviour of another. The stated hypothesis implies that the prosperity/poverty state (measured as EDI) is a confounder of the relationship between population numbers and enterprise numbers and causes the variation observed. The suggestion of Pearl and Mackenzie [36] was applied for both

population numbers and enterprise numbers. The results were then interpreted in terms of EDI dynamics.

Thereafter, it was necessary to quantify the relationship, if any, between EDI and the level of personal income in counties. Hereafter, it was necessary to determine if the total income of counties is related to their enterprise numbers and population numbers, and hence their prosperity/poverty states. Finally, the relationship between EDI and the poverty rate was examined to assess the utility of each in estimating community poverty/prosperity. This allowed a final assessment of the stated hypothesis.

2.1. Datasets Used

The 2017 Poverty and Median Household Income Estimates dataset [37] was used to extract the 2017 numbers of officially poor people in U.S. counties. The poverty rates in this dataset were then used to provide estimates of the total population of each county. A dataset of the Bureau of Economic Affairs [38] provides estimates of the 2017 personal income levels of U.S. counties. The personal income levels of each county were multiplied by its estimated population numbers to provide estimates of total personal income in the counties. The County Business Patterns: 2017 dataset [39] provides estimates of the 2017 number of establishments (here called enterprises) in the counties.

2.2. Power Law Analyses

Scaling is a general analytical framework used by many disciplines to characterize how population-averaged properties of a collective vary with its size [22–25]. Power law analyses (log–log regressions) were used to examine if scaling is present in the relationships between the various micropolitan characteristics. Microsoft Excel software was used for all of these analyses.

2.3. Scaling Terminology

The scaling terms sub-linear, super-linear, and linear are used by West [25] in the application of power law analyses. These terms indicate the following: sub-linear scaling indicates disproportionate agglomeration of one socioeconomic characteristic at smaller or lower values of another characteristic of a county. It indicates economies of scale. Super-linear scaling is associated with disproportionate agglomeration of one socioeconomic characteristic at the larger or higher values of another characteristic of a county. It indicates increasing returns to scale. Linear scaling indicates that one characteristic is linearly associated with another characteristic irrespective of the size of the human settlement.

3. Results

3.1. Link between Demography and Poverty

There is a strong and almost linear power law association (exponent = 0.95) between the total population and the number of poor people in more than 3000 U.S. counties (Figure 1). Overall, poverty numbers form a reasonably constant fraction of county populations over many orders of magnitude. This suggests that there might be a limit as to how many poor people can be ‘carried’ by the prosperous (‘non-poor’) fraction of a population. However, there is a small scaling effect indicating a slight decrease in the poverty rate (%) associated with increasing population sizes (Table 1). Poverty is somewhat more prevalent in smaller than larger counties. The dynamics of poor populations clearly form part of the orderliness of the demographic–socioeconomic–entrepreneurial nexus of U.S. counties and, thereby, justifies the SST approach used in this analysis.

Figure 1. The power law (log–log) relationship between the number of officially poor people and the total population in U.S. counties in 2017.

Table 1. Proportionality between the total population and the number of officially poor people in U.S. counties in 2017. The poverty rates were calculated with the aid of the power law equation in Figure 1. Poor % = poor people as % of population.

Population	Poor People (No.)	Poor %
320	57	17.69
1280	212	16.53
5120	791	15.44
20,480	2955	14.43
81,920	11,045	13.48
327,680	41,277	12.60

3.2. Population–Enterprise Relationships

The 2017 power law association between the population numbers and enterprise numbers of the selected U.S. counties is depicted in Figure 2. The power law relationship (diagonal red line) has an exponent that indicates an almost linear relationship. The power law explains more than 95 percent of the variation (see R^2 in Figure 2). The power law is very similar to that reported for U.S. metropolitan statistical areas (MSAs) [26]. Youn et al. [26] reported an exponent of 0.98 ± 0.2 for MSAs (see Figure 1 in [26]). The exponent for the U.S. counties is 0.9855 (Figure 2). The power law covers a population range of more than four orders of magnitude, i.e., from less than one thousand to about 10 million people per county. The enterprise range also covers four orders of magnitude, i.e., from about 10 to more than 100 thousand enterprises per county. This power law provides information about the enterprise carrying capacity (ECC, the enterprises/population relationship) of the counties.

As expected, a statistically significant power law also describes the relationship between enterprise numbers and population numbers (Figure 3). The power law relationship (diagonal red line) has an exponent that indicates a slightly sub-linear relationship. It also explains more than 95 percent of the variation (see R^2 in Figure 3) and covers enterprise and population ranges of more than four orders of magnitude. The power law provides information about the EDIs (the population/enterprises relationships) of the counties.

Figure 2. The enterprise numbers–population numbers relationship of more than 3000 U.S. counties in 2017 as they relate to the enterprise carrying capacity (ECC).

Figure 3. The population numbers–enterprise numbers relationship of more than 3000 U.S. counties in 2017 as they relate to the enterprise dependency index (EDI).

The strong and extended proportionalities depicted in Figures 2 and 3 indicate a need for more detailed analyses. Despite the fact that strong population–enterprise or enterprise–population relationships are reflected in Figures 2 and 3, it is evident that some variation is still not fully explained by the power laws (see the distribution of data points around the power law lines in Figures 2 and 3). For instance, constant populations levels (such as those depicted in line AB in Figure 4) are associated with a range of different enterprise number levels. Similarly, constant numbers of enterprises (such as those depicted in line CD in Figure 4) are associated with a range of different population numbers.

Figure 4. Illustration of changes in the ratios between population and enterprise numbers of more than 3000 counties when population numbers are kept constant (line AB) or when enterprise numbers are kept constant (line CD). More prosperous counties are above the regression line and poorer counties are below the regression line (in blue).

It follows from Equation (2) in the text that if either the population or enterprise numbers of a group of counties are kept constant, variation in the magnitude of the other variable would indicate that the EDI, and hence the prosperity/poverty status of the counties, is changing. This was verified in two ways. Firstly, two examples of constant enterprise numbers per county (400 to 410 enterprises in Figure 5A and 1000 to 1025 enterprises in Figure 5B) are presented. Large populations with constant enterprises had high EDIs, indicating higher community poverty, and small populations with constant enterprises had low EDIs, indicating more prosperous communities. This conclusion was corroborated by higher poverty rates when EDIs were high and lower poverty rates when EDIs were low (Figure 5A,B).

Figure 5. Examples of population numbers in counties with a constant number of enterprises: (A) represents those with 400 to 410 enterprises and (B) represents those with 1000 to 1025 enterprises. The counties in each group were ranked based on their population numbers. EDI = enterprise dependency index and Pov % = poverty rate.

Secondly, two examples of enterprise number variations with constant population numbers per county are presented: 5000 to 5300 people (Figure 6A) and 100,000 to 105,000 people (Figure 6B). Constant populations with higher enterprise numbers indicated lower EDIs, i.e., more prosperous communities. Constant populations with fewer enterprises indicated higher EDIs, i.e., poorer communities. This was true irrespective of the levels of the constant populations.

Figure 6. Examples of the enterprise numbers of counties with constant population numbers: (A) represents those with 5000 to 5300 people and (B) represents those with 100,000 to 105,000 people. The counties in each group were ranked based on their enterprise numbers. EDI = enterprise dependency index and Pov % = poverty rate.

The former analyses suggest that the prosperity/poverty statuses of counties influence the population number–enterprise number relationships of U.S. counties. In other words, the number of enterprises in a county is not only a function of its population number but also of its prosperity/poverty state, i.e., the buying power of its population.

3.3. Relationships between County Incomes, Populations, and Enterprises

The foregoing conclusion prompted an analysis of the relationships between total county incomes and county populations (Figure 7A) and county incomes and county enterprise numbers (Figure 7B). Population numbers and enterprise numbers are slightly disproportionately and sub-linearly correlated with total county incomes (see equations in Figure 7A,B). In other words, county populations and enterprises are disproportionately higher in counties with lower incomes. Having money to spend is obviously an important county property.

Figure 7. The power law associations between total county incomes and (A) county population numbers, and (B) county enterprise numbers.

The spread of points around the regression lines in Figure 7A,B raised the question as to whether the prosperity/poverty statuses of counties might play a role in the above relationships. This possibility was tested by examining the EDIs of counties with constant incomes (Figure 8A,B). There was a gradient from low EDIs to high EDIs in each comparison, irrespective of the magnitude of constant county incomes. County prosperity/poverty statuses, therefore, play important roles as confounders. They moderate the relationships between total county incomes and population or enterprise numbers.

Figure 8. The Enterprise Dependency Indices (EDIs) of counties with constant incomes: (A) represents lower incomes and (B) represents higher incomes. Counties in each group were ranked according to the magnitude of their EDIs.

3.4. Relationship between Personal Incomes and Prosperity/Poverty States

What is the link between EDI (as a measure of prosperity/poverty) and the levels of personal income? Figure 9 shows that there is a negative relationship. Higher personal incomes indicating higher community prosperity are generally associated with lower community EDIs. Conversely, lower personal incomes are associated with higher EDIs, which is indicative of more poverty (Figure 9). However, this only explains about 34% of the variation, indicating a need to delve deeper.

Figure 9. The power law association between county personal incomes and their Enterprise Dependency Indices (EDIs).

3.5. Relationship between the Enterprise Dependency Index and the Poverty Rate

There is a weak but nevertheless highly statistically significant ($p < 0.01$) power law correlation ($r = 0.45$, $n = 3134$) between the EDIs and the poverty rates of the counties (Figure 10). Higher EDIs are generally associated with higher poverty rates and vice versa. However, only some 19% of the variation is explained in this way (Figure 10). A wide spread of data points supports indications that poverty rates and EDIs are not identical.

Figure 10. The power law association between the enterprise dependency index (EDI) and poverty rates (%) of U.S. counties.

The lack of a strong relationship between EDI and the poverty rate in counties was confirmed. Counties grouped on the basis of constant poverty rates (10% and about 20%) have widely differing EDIs (Figure 11). The EDIs of counties with a 10 percent poverty rate vary from as low as 20 people per enterprise to more than 80 people per enterprise. Counties with poverty rates of approximately 20 are associated with EDIs of less than 40 to more than 100. Similar results (not shown) were obtained for poverty rate groupings of approximately 5 and 15%. EDI measures the number of people needed to ‘carry’ the average enterprise in a county. The large non-poor fraction of county populations most probably masked the expression of community prosperity/poverty when measured by the poverty rate. Compared to EDI, poverty rate appears to be an inferior measure to reflect the relationship between entrepreneurship and community prosperity/wealth.

Figure 11. Constant poverty rates (in percent) and enterprise dependency indices (EDIs) of U.S. counties: (A) poverty rate 10%; (B) poverty rate approximately 20%.

4. Discussion

Poverty research has many dimensions, ranging from efforts to: define poverty [40], measure poverty [14,41], model poverty [42], identify the determinants of relative poverty in advanced capitalist democracies [16], develop poverty policies [43], etc. Because U.S.

neighbourhood poverty increased in the midst of affluence during the Great Recession, Lichter et al. [15] suggested that poverty should be understood in terms of where it is located. In other words, poverty research should also focus on communities. Community poverty is a constant concern all over the world [4–7].

Poverty is also important in considerations of sustainability [1]. Together with ecosystem health and economic development, community poverty should also be taken into account [1]. Sustainability is concerned with the well-being of future generations [1,44]. The Brundtland Report of 1987 provided the inspiration for questions about the meaning of sustainability as a concept [3,44]. Brundtland and her colleagues proposed that sustainable development should meet the needs of the present without compromising the ability of future generations to meet their own needs. Poverty clearly reduces the ability of future generations to meet their own needs. Sustainability is now almost always considered in terms of three dimensions: social, economic, and environmental [44]. Community poverty and its measurement and dynamics should form part of sustainability considerations.

The measurement of community poverty is considered to be important [11,13,14]. The measurement of poverty rates became the established, and virtually only, way of determining the poverty states of communities [11–19]. This happened despite the knowledge that the poverty rate is a crude index [10]. To determine community poverty rates, some measure of poverty is usually chosen, and the number of the poor in communities is simply counted, and poverty rates calculated [10]. In this process, only one side (the number of poor people in communities) of the two-sided prosperity/poverty continuum is taken into account. The contribution of non-poor (prosperous) people to community prosperity/poverty is ignored. To overcome this weakness, a way was needed to estimate the state of community prosperity/poverty that is not dependent on the number of poor people. This study evaluated an alternative method based on demographic and enterprise dynamics to measure community prosperity/poverty.

The proposed method [28,29] draws upon research in the new millennium that demonstrated strong orderliness in the demographic–socioeconomic domains of urban settlements [22,25]. Human settlements are extremely complex systems with many interdependent facets, e.g., social, economic, infrastructural, and spatial characteristics [22,25,45–48]. These characteristics are highly correlated and interconnected and are driven by the same underlying dynamics [25]. Scaling phenomena are prevalent [22]. Such systemic regularities are embodied in SST (a scaling theory) [24] and provide windows to the underlying mechanisms, dynamics, and structures common to all such settlements. This study reports on a number of poverty-related community dynamics.

Firstly, the dynamics of the number of poor people in U.S. counties are shown to be part of SST [22]. Scaling laws constrain the development of new theories [49]. Any theory that attempts to explain a phenomenon should be compatible with the empirical scaling relationships that the data exhibit [49]. A highly statistically significant ($p < 0.01$) power law relationship was detected between the number of poor people and the total populations of U.S. counties (Figure 1). The nature of such a relationship is not considered in most, if any, community poverty research efforts [11–20]. Yet, it has a direct influence on the calculation of poverty rates (Table 1). The number of poor people in counties scales slightly sub-linearly with population size (see power law equation in Figure 1). In general, poverty rates tend to be systematically higher in smaller than in larger counties (Table 1). These dynamics support the suggestion that the poverty rate is a crude measure [10].

Secondly, the main focus of this contribution is to examine whether the relationships between population numbers and enterprise numbers in human settlements could be applied in the evaluation of the proposed method. In particular, it examines whether the EDI (enterprise dependency index) could serve as a measure of community prosperity/poverty. The EDI relates to how many people are associated with the average enterprise in a community. Strong linear relationships have been formerly observed between the number of people and the number of enterprises in groups of human settlements [26–29]. These highly significant and linear relationships meet the requirement for the development of

new theories [49]. Linear relationships are also found in the evaluation of U.S. counties (Figures 2 and 3). They stretch over many orders of magnitude of population and enterprise numbers. The relationship for U.S. counties (Figure 2) is almost identical to the relationship for U.S. cities [26]. The number of county enterprises are, consequently, closely and positively associated with the sizes of county populations.

Thirdly, county population sizes and enterprise numbers are closely correlated with county incomes (Figure 7). Higher personal incomes are generally associated with greater community prosperity and vice versa (Figure 9).

Fourthly, a theoretical derivation of EDI as a measure of community prosperity/poverty from the linear relationship between population and enterprise numbers in human settlements is presented (Equations (1) and (2) in the text, Figure 4). Variation around lines of best fit of the relationships depicted in Figures 2, 3 and 7, is explained in terms of differences in their EDIs, i.e., their prosperity/poverty states (Figures 5, 6 and 8). The prosperity/poverty states of counties moderate the magnitudes of their incomes, populations, and enterprises. The size of a county population and the population's ability to pay enterprises for services and goods apparently determine the number of county enterprises. The prosperity/poverty states of counties and their measurement (as EDIs) are important socioeconomic derivatives that should be used in socioeconomic analyses and in considerations of sustainability.

Fifthly, the question arose as to whether poverty rates and EDI reflect in similar ways on the prosperity/poverty statuses of U.S. counties. For the first time, it is demonstrated that EDIs and poverty rates of U.S. counties are weakly, but statistically significantly related (Figure 10). However, only about 20% of the variation is explained. These two community poverty measures are clearly not identical (Figure 11). However, higher EDIs are generally associated with higher poverty rates and vice versa, yet counties with constant poverty rates are associated with widely varying EDIs (Figure 11). The large non-poor (prosperous) fraction of county populations appears to be a confounder that partly masks the expression of community prosperity/poverty when measured by the poverty rate. EDI appears to be a more sensitive measure of community prosperity/poverty than the poverty rate.

Given the results presented, the hypothesis that EDI is a useful measure of community prosperity/poverty is accepted. However, further research is needed to optimise the use of this measure. This includes actions such as examining the role of poverty in the sustainability of communities, determining the limits of the ability of human settlements to 'carry' poor people, and understanding poverty as a component of SST (settlement scaling theory) and how events such as the Great Recession or the COVID-19 pandemic affect the prosperity/poverty statuses of human settlements. There is scope for much more research.

5. Conclusions

Community poverty is an important socioeconomic and sustainability issue. The measurement of community poverty by way of poverty rates is known to be a crude measure. It deals with only one part of the two-part prosperity/poverty continuum in communities. There is a need for an alternative method to measure community poverty.

The number of poor people and the total populations of U.S. counties are nonlinearly correlated. The population dynamics of poor people in U.S. counties fit into the settlement scaling theory (SST) and into the demographic–socioeconomic–entrepreneurial nexus of the counties. In general, poverty tends to be systematically higher in smaller than in larger counties. This fact is ignored in most poverty research.

Earlier research indicates that new urban research that led to a settlement scaling theory (SST) could form the basis of a new way to estimate community prosperity/poverty. The method is not derived from the numbers or fractions of poor people in populations but is based on the ratio between population numbers and enterprise numbers. It determines an enterprise dependency index (EDI) in the form of how many people are associated with the average enterprise in a community. This contribution examines this method in greater detail.

Linear relationships between population and enterprise numbers in U.S. counties extend over many orders of magnitude. The number of county enterprises is closely and positively associated with the size of county populations. Community poverty, measured as EDI, is a confounder. It moderates the former relationship.

County population numbers and enterprise numbers are closely correlated with total county incomes. Higher personal incomes in U.S. counties are generally associated with more community prosperity and vice versa. Income appears to be an important driver in county socioeconomic dynamics.

The size of a county's population and its population's ability to pay enterprises for services and goods apparently determine the number of county enterprises. The prosperity/poverty states of counties and their measurement (as EDIs) are important socioeconomic derivatives that should be used in socioeconomic analyses and considerations of sustainability.

EDIs and poverty rates of U.S. counties are weakly, but statistically significantly, positively related. Higher EDIs are generally associated with higher poverty rates and vice versa, but there is much variation. These measures are not identical. EDI appears to be a better measure of community prosperity/poverty than poverty rates based on the number of poor people.

The hypothesis that EDI is a useful measure of community prosperity/poverty is accepted.

There is much scope for further research about the utility of EDI.

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