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Building a Quality of Life Index

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Abstract

This chapter outlines how an index measuring quality of life should be developed and then applies that work at the county level in the United States. The index we create is a unique and data-driven approach to calculating quality of life. In the chapter, we explain the process that leads us to selecting our five indicators: public safety, health, economic development, infrastructure, and education. Each indicator breaks apart into subindicators. This chapter theoretically and statistically verifies our chosen indicators. First, we develop theoretical arguments explaining the connections between quality of life and our indicators. Then, we perform confirmatory factor analyses on our index to empirically verify our theoretical arguments for why each component should be included in the index. Further, we finally verify our theory and index using survey results. We use only publicly available data to facilitate replication by others. The results of our confirmatory factor analysis provide statistical evidence for our choice of indicators in measuring quality of life. Our findings indicate that those measuring quality of life must account for the roles of: public safety, health, economic development, infrastructure, and education. Most importantly, our results indicate that our index is a valid measure of quality of life.

Keywords: quality of life, index, institutions, government, public policy, political behavior, well-being, happiness

1. Introduction

One of the central debates in the quality of life literature revolves around whether the indicators used to measure quality of life are "subjective" or "objective" in nature. Understanding

the division among the literature is a useful starting point for any attempt to create a quality of life measure, particularly one designed to be used as a metric of success.

If the goal is to measure reflections of individual preferences and aggregate those reflected preferences then measures of satisfaction, happiness, or other individually subjective psychological phenomenon are the appropriate choice. The problems with this approach are substantial particularly if the end goal is a connection between particular policy choices and societal (state, nation, or any relatively large group) level well-being. Chief among these problems are the transitory nature of life quality evaluations which are closely tied to individual time sensitive circumstances and can be influenced by cultural differences, the survey itself, or the simple vagaries of human emotions [1].

In short, the debate surrounding the objective and subjective issue focuses on differences in what is actually being measured. The objective measures represent environmental indicators that most people see as necessary conditions for a high quality of life, but they in themselves are not sufficient. On the other hand, subjective, micro measures only measure a person's psychological perception of satisfaction and life quality, which may be independent of environmental conditions. If the overall goal is to create a common metric of what a high quality of life community and society is then the starting point by necessity must be identifying circumstances under which individuals thrive and whether common circumstances, outcomes, and approaches can be identified that are common across individual transient preferences. Using "objective" measures allows us to build metrics that are strongly rooted in theory and then test those propositions against subjective measures as a validation tool.

2. Quality of life in the scholarly literature

In the literature, objective measures are defined as being based on aggregate population data and have been advocated by such measures as the UNDP [2] in their Human Development Index and the World Bank [3] in their World Development Indicators. Measures such as life expectancy, adult literacy rates, student enrollment ratios, and gross domestic product per capita are used to create the Human Development Index. The reasoning behind using these measures is that the use of quantifiable aggregate measures of economic, social, health or other indicators is sufficient to gauge the quality of life for a given population. Their usage and efficacy also rest on the assumption that the indicators that are being measured are objective in the sense that they are universally seen as desirable attributes.

On the other hand, subjective measures, such as those advocated by Brooks [4] and Gill [5], place the measurement of quality of life in the psychological realm of satisfaction and overall happiness, which is only definable by the individual and thus can only be measured by the use of surveys to individuals. Instead of measuring what they believe to be the most important

indicators of quality of life like the UNDP and World Bank do, Gill, for example, proposes using surveys that ask the respondent to mark their level of overall quality of life on a scale of 0–100 [5]. This allows for the respondents to create their own value weightings for all the inputs into their lives. These results may be statistically combined to draw conclusions about the aggregate population.

The literature however suggests the division might be less clearly delineated than a first blush might suggest. Costanza et al. assert that so-called objective measures (of quality of life) are actually proxies for experience identified through "subjective" associations of decision makers"; and thus "the distinction between objective and subjective indicators is somewhat illusory" [6]. Indeed, a recent review of common characteristics among countries with high subjective well-being measures looks strikingly similar to the list of indicators used to build most objective measures [7].

The purpose in building a quality of life index should be to explore the substantive effects of quality of life. This reality suggests the necessity of including only those indicators with a theoretic basis for affecting individual citizens' life quality. In what follows we review the relevant literature for each of the subindicators, and explore how variation in those indicators should affect life quality.

2.1. What is quality of life?

Scholars throughout the social sciences have attempted to define and quantify their definitions of quality of life in order to make meaningful observations of society and to formulate policy prescriptions. The literature on quality of life touches many areas of interest; unfortunately, most of it has failed to connect the overlapping indicators and methods from the various fields with each other to achieve a consensus on a definition of quality of life and how to measure it. We have examined many of the past indexes that had been created by other researchers. Each researcher found distinct aspects to include in the index, often based on what the research was intended to study. Lambiri et al., compiled most of the significant studies, analyzed their similarities, and grouped them into six different classifications:

> *natural environment (climate, state of natural environment, etc.), built environment (type and state of building, etc.), socio-political environment (community life, political participation, etc.), local economic environment (local income, unemployment, etc.), cultural and leisure environment (museums, restaurants, etc.), public policy environment (safety, health care, education provision, etc.) [8].*

We find these distinctions useful in examining what the different studies used to measure the quality of life. Using this classification system as a model, we examined other indexes and found five specific classifications and a sixth category of other: public safety, health, infrastructure, education, economic environment, and other (anything included in the index that did not fit within the other four categories).

3. Constructing a quality of life index

We believe that indexes should enable comparability and so should be designed to maximize variation and comparisons between observations as well as individual observations across time. We suggest a three-step procedure to scale data into this index; for each variable we converted the actual value to a scale from 0 to 1. To accomplish this scaling, we used the well-tested and verified metric of the United Nations Human Development Index. The basic formula is

$$\frac{Observed\ Value - Minimum\ Value}{Maximum\ Value - Minimum\ Value}$$

Using this scaled value allows for direct comparability within the data set without any further calculations. Because we convert each variable to this scale, we are no longer measuring the actual results of a particular variable but rather the counties score in relation the maximum and minimum observed for that value. This becomes important to the next step, where we aggregate the data into subindicators.

Because the scaled variables now represent a ranking they can be aggregated using simple averages and for each subindicator aggregate those values by taking an average of the county's score on each of the variables included. The formula we suggest employ uses S as the scaled value of the individual variable, and X as the total number of variables included in the subindicator. After taking the average the data is scaled using the above formula to obtain the value of the subindicator.

Using the value of the subindicators, the value of the overall indicator and quality of life score can be calculated using the same mechanism.

3.1. Validating the index

The goal of creating a quality of life index (or really any index) must be validity. A critical intersection for any index's validity is the data collected. Data must be theoretically relevant to the indicators and uniformly available. Once the data are collected, a valid index must be able to analyze that data and draw conclusions from it. The data found in quality of life study indices can be used for a wide variety of purposes. Politicians can use them make better public policy choices, businesses can use them for marketing purposes, and academics can use them for research. If the data does not explain anything, it is of little use. Thus, the data must be presented in a way that it is informative. The methods used to construct the quality of life index must also be easy to understand and replicate.

Any index, including our own, must be viewed skeptically. At the heart of the scientific method and index building is the need for validation. Indexes can be plagued with measurement problems that center on whether they are actually measuring what they purport to be measuring. The prelude to testing whether an index is measuring what it claims to measure is to validate its methodologies.

This methodology for calculating quality of life scores yields a reliable and repeatable index. This index can be calculated using commonly available data, where all parts of the index are

separable. As discussed above, meeting these requirements is of paramount importance if the data is to be used to explain phenomenon in the real world.

While methodological rigor is important, even the most rigorously constructed index can fail if it does not measure what it purports to. We suggest a three-prong approach to validating an index. First, any index that claims to measure a social phenomenon must begin with a strong theoretical explanation to back up why the data included in the index is in fact a component of or a proxy for what is being measured. Second, the data included in the index should scale together using some commonly accepted approach to analysis. Finally, independent tests of the theoretical links such as secondary data analysis or experimental tests should validate the construction of the index.

4. Where the rubber meets the road: deciding what to include

Despite the relative consistency, which emerged from the meta-analysis conducted by Lambiri and from our own review of the mechanics of the various quality of life indexes, deciding what to actually include is substantially more complex. The categories which emerged from the literature are Education, Health, Public Safety, Infrastructure, and Economic Development. In each case, we suggest a two-fold approach to measuring life quality that focuses on service availability (potential in the private and/or public market) and outcome measures.

4.1. Public safety

Community-wide safety and peace are important parts of the quality of life for residents. Crime, lack of fire protection, and deficiencies in other services designed to protect security, well-being, and property impact citizens negatively. Public safety involves the prevention of and protection from potential occurrences that could jeopardize the well-being or security of the general public.

The majority of quality of life indices we examined included public safety measures and most public safety measures included some element regarding crime. Most found some way of representing the amount of violent crime in the area: Graves used the number of violent crimes per 100,000 [9]; Rosen simply uses the total crime rate [10]; Blomquist et al., Ceshire and Hay, Stover and Leven, Ready, Burger, and Blomquist, Nzaku and Bukenya (even though they place this measure in an "amenities" category), and Shapiro all use a measure of violent crime in the area to measure public safety [11–16]. The Economist uses a measure of political stability and security to measure the public safety between countries in their index [17]. Most indexes simply include some measure of the frequency of crime, generally specified to be violent crime, as the standard of measurement for public safety of an area.

To understand public safety, it is important to know the benefits of public safety service availability. We focus on two subindicators: the availability of police and fire protection in each area. The available data, dichotomous availability, had no explanatory power when compiling the index. Thus, we still believe the availability of these resources important but will only include the funding effort data, which captures availability, in the final data analysis.

Fire services throughout the country are significant in identifying, developing, and promoting ways and means of protecting life and property from fire-related perils, such as house, school, car, and job-related fires, etc. In 2015, 3280 Americans died in 1.35 million fires [18]. Shoup and Madema in their book Public Finance discuss the necessity of fire service availability for protection to life and property. The authors also specify fire service's positive role in contributing to economic development: "Risk, in the sense of relative dispersion of possible outcomes of a venture, is reduced for almost any venture by an increment to fire protection service. All in all, fire protection is clearly one of the most important stimuli to economic growth" [19]. Clearly, the availability of local fire services in each county is necessary in maintaining higher public safety, greater economic growth, and better quality of life for county residents.

The availability of police services in rural counties is an important contributor to the prevention of various types of property and violent crimes toward its residents. Police persons are in charge of maintaining order, enforcing the law, and preventing and detecting crime for the well-being and safety of the citizens in their area. Mladenka and Hill discuss the importance of distributing police services evenly among states in order to maintain public safety [20]. In Gyimah's analysis of police production, he uses the crime rate to measure community safety. Although somewhat obvious, his reasoning and empirical data simply show that when "the crime rate is lower in community A than it is in community B, then it is reasonable to postulate that community A is safer than community B" [21]. We can therefore determine that people will have a higher quality of life with a greater amount of police service protection. The use of this crime data in the analysis is necessary to arrive at a more accurate measure of quality of life. It is obvious that the less frequent violent crimes occur in each county, the greater the public safety will be. Cebula and Vedder did a quality of life study on how crime affects peoples' decisions when migrating to new areas. They state that "Higher crime rates should lower net benefits obtainable from migration in a number of ways: loss through theft of property, higher insurance rates, an increase in fear and tension, etc." [22]. Thus one can determine that quality of life is usually lower in counties with higher crime rates.

While it is clear that the presence or absence of police and fire protection is important to public safety in a particular area, it tells only part of the story. The whole story can be understood only by examining the availability of funds to provide those services. We consider the availability of funds for these services by using a measurement of per-capita expenditures for fire and police services. We use this measure for two reasons. First, while spending of this sort may be subject to the law of diminishing returns, we believe that as more is spent per person on fire and police services, the higher public safety will likely be. Second, it is clear that even in areas with higher crime rates, residents perceive additional police spending as contributing positively to public safety. According to Charney, "public [safety] expenditures reflect both the quality and cost of providing public services," even if "public [safety] expenditures are not a perfect measure of the quality of public services." For example, a county with high public safety expenditures could signify an area that demands more safety spending, "rather than measuring a high feeling of safety" [23]. Even though this is a difficult measure of public safety quality, county residents will still have a greater amount of fire and police protection if more money is spent per capita for these public services.

The amount of countywide per-capita expenditures on fire and police services can act as proxies for other county spending on public safety, such as ambulance services and correctional facilities. If the data shows that a county puts a high priority on public safety by spending more per capita on fire and police services than average, it is presumably true that the county will also spend more per capita on these other public safety services. For example, spending on ambulance services in rural counties is important for the health and life expectancy of its residents. The service's role is to help maintain the life of the injured/dying until transported to the nearest hospital for emergency care. According to Stults et al., communities served by a basic ambulance service, as opposed to conventional advanced ambulance care, have a lower survival rate [24]. From this, one can also verify that counties' public safety will be much lower if access to ambulance services is scarce.

Public safety is a crucial indicator in determining quality of life. Public safety, as defined earlier, involves the prevention of and protection from potential occurrences that could jeopardize the well-being or security of the general public. We believe that the measurement of these types of services designed to protect the security, well-being, and property of county residents is necessary in order to have a valuable quality of life index. We conclude that county residents with greater public safety will also have a greater quality of life.

4.2. Health

It is difficult, or untenable at best, for someone to have a good quality of life if they are living in unhealthy conditions or do not have access to quality health care. Maslow underscored the significance of good health when he placed physiological needs at the base of his hierarchy of needs in his explanation of human motivation [25].

The measures of health in quality of life indexes were less uniform than the public safety measurement. Although a common theme was to use mortality rates or life expectancy, this is certainly not the only way that researchers chose to examine this element of quality of life. Calvert and Henderson chose to use a composite that includes the infant mortality rate, the life expectancy rate, and self-reported health [26]. The Economist uses the life expectancy at birth in years for the health indicator [17]. Sufian simply uses the infant mortality rate [27]. Agostini and Richardson combine infant mortality, child mortality, and maternal mortality to measure public health [28]. The majority of the quality of life literature that was reviewed for this study includes a measure of health as an indicator, and inclusion in our own index was important.

Review in the health measurement literature uncovered some interesting intellectual debates surrounding the demand for health care. Newhouse and Hitiris and Posnett make the assertion that since per-capita health expenditures follow GDP fairly closely, health expenditure consumption is elastic, indeed elastic enough that it is a luxury good since its income elasticity of demand coefficient is greater than 1.0 [29, 30]. This implies there is a lot of spending in health care that only marginally improves quality of life and an increase in funding will not necessarily result in an increase in care. The counter to this claim is that since health care represents a basic human need it must be a necessity and an inelastic good. Parkin asserts that the claim of its being a luxury good can only be measured as a luxury by

incorrectly applying microeconomic data to a macroeconomic problem [31]. We agree with portions of both arguments and eventually came to the same conclusion as Getzen who views health care expenditures as both a necessity and a luxury which can vary with the level of analysis [32]. On the micro level, health care is a necessity at first because a certain level of care is essential, and thus inelastic. However, due to diminishing marginal returns there is a point reached where health expenditures become a luxury, even on the micro level. While we are not sure where this point of diminishing returns is, there is some level of health expenditure that is a necessity that must be funded in order to have a good quality of life. The indicators are designed to capture the aggregate health care system to determine if it affords individuals at least the necessary level of care needed, if not also desired luxury health goods.

To capture an aggregate measure of the health system in the test counties, we first use a measure of the availability of professional health workers. Our measure includes physicians per 1000 and health care workers per 1000 to assess this availability. Originally, we had hoped to use measures of hospitals per 1000 and hospital beds per 1000 in addition to the number of professionals, but that data was not available at the county level. However, since health care requires very specific and well-practiced skills, we assume that the more of these health care workers there are in a population, the more likely it is that they will have facilities to work in. This measure is sufficient to furnish a snapshot of the availability of health care facilities that we believe to be most vital to a good quality of life.

We do, however, acknowledge that there may be other factors that may also be indicators of the health of a population other than physical facility access. Socioeconomic status, educational attainment, and cultural factors have all been shown in some cases to be the single greatest determinant of health status [33–35]. The most important of these factors are covered elsewhere in our index and should therefore not confound final results.

While having health facilities readily available is important, the existence of the facilities is of marginal value if people do not have the resources, primarily health insurance, required to be treated in the facilities. We use a measure of health insurance enrollment to help determine accessibility. The number of people with health insurance in a community reflects a measure of access to care and is valuable to the study. The measure that we use to show the insurance rate is taken from the U.S. Census data and includes all forms of insurance including government programs such as Medicaid and Medicare. While it may be true that there are flaws associated with the insurance system in the country, such as overconsumption as outlined by Feldstein [36], the level of insurance in a county helps us to determine what portion of the population is at least having their basic health needs met.

After considering access to health care through availability and insurance, we examine what health-related outcomes are being produced from access to that care. There is a debate in the literature concerning what the most telling measure of health should consist of. Some scholars argue that today's unique circumstances warrant breaking with traditional measures of health that have mainly dealt with morbidity and mortality and also take into account "diseases of civilization" like obesity and depression that have recently appeared as society has become more developed [37]. It is their belief that even though there might be longer life spans and

less infant deaths in developed societies, that does not mean that the health of the people is any better off since they see these new diseases as a drain on quality of life.

However, it is our view that while these may be real threats to the well-being of individuals, their inclusion in this measure would be very difficult to achieve since that data is not consistently available and they affect individual populations differentially. While our measure may not capture a complete picture overall health in a specific area, it does capture a sufficient portion of the whole system as infant mortality is a particularly telling indicator of care. It is also easily accessible for every area we looked at and universal in its application, whereas the inclusion of other subjective indicators would have to be more area specific.

We decided to use a measure of health outcomes that was the most objective possible. Nearly every study we looked at used infant mortality measures in one form or another, including the UNDP's Human Development report [2]. Consequentially, we also decided to use infant mortality as the basis of our health outcomes measures. This indicator is also one of the most obvious and observable results of a good, accessible health care infrastructure that was measured earlier. Our initial measurements of the availability of physicians and hospital beds are directly connected to infant mortality and with life expectancy that we measured in this area. Hospitals and their services are vital to helping mothers give birth to children and combating chronic sickness that often appear in the later years of life. While some scholars would argue that a better measure of health outcomes would be broader than ours, very few would argue that infant mortality is not one of the most telling individual indicators of health. This measure captures the availability of nonluxury health care.

Health services that are readily available could still be inadequate to properly serve the needs of the patients. Health services need adequate funding to be able to function well. We measure the health services funding effort in order to determine if the services are being adequately funded and given every chance to succeed. This measure includes the overall per-capita health expenditures by government agencies and the total amount spent on payroll in health care professions. Funding for health related services is not cheap. Some estimates place the total yearly spending in the U.S. around $3 trillion or nearly 20% of GDP. By capturing this funding information we was able get a better understanding of the health services in the targeted areas. This then allows basic health care, which would impact the health outcome indicators of life expectancy and infant mortality, to be measured. Basic health care is defined in various ways, but for simplicity purposes we define it as access to the services and procedures that sustain life and impact of the health outcome indicators. If a person has access to basic health care, we assume they would have a greater probability of surviving birth and living to an older age. As summarized earlier, we realize that the amount of funding does not guarantee quality since there is a real potential to waste the funds after they reach the point of diminishing returns. By our reasoning, a higher level of funding indicates a higher likelihood that those basic needs will be filled even if there is waste happening elsewhere. There is good literature that indicates that higher expenditures on health care are linked to better health results [38]. Poland et al. also seems to agree that higher expenditures should produce better health outcomes [39]. We feel that the measurement of the funding

effort for health services provides the reader with an overview of the system without making normative judgments.

In sum, we chose to use the measures we did because they are the best way for us to capture the availability of and access to health services in a given area. It encompasses the causes as well as the consequences of a good health system and allows us to see its impact on the overall quality of life in a defined area.

4.3. Infrastructure

Infrastructure that functions efficiently and effectively is another positive component to quality of life. Infrastructure is the physical and organizational structures needed for operation of a societal structure or the services and facilities necessary for an economy to function. Basic infrastructure facilitates economic transactions, allows access to services such as health and education, and provides individuals with the ability to realize their preferences for goods and services across time and space.

There was not a large consensus regarding what data best represent infrastructure. In general, the indexes attempt to quantify this by examining three things: population characteristics, available utilities, and housing characteristics. Both Rosen and Roback examine the population size, and the population density, but uniquely include central city population and population growth rate, respectively [10, 40]. Nzaku and Bukenya use a composite that includes population density with age of the population, nonwhite population, owner-occupied housing, per-capita tax rate, distance to metro area, and road density [15]. Still other indexes include a measure of the available facilities for the treatment of water, sewage, or landfills [11, 13, 14, 26].

Our metric captures the various types of infrastructures that are necessary for individuals to maximize the other indicators of the index and their quality of life. To measure infrastructure, we use both service availability and funding effort that is the existence of the infrastructure and the resources devoted to its expansion, maintenance, and replacement. Measured infrastructure could include a wide variety of public services. We have chosen to use three indicators that we believe capture what is essential to improving quality of life. Our metric represents an expansion of earlier work that has primarily focused on the provision of public or quasi-public goods such as highways as infrastructure. We assert that a more expansive definition of infrastructure is necessary. Our metric both recognizes the importance of the public or quasi-public goods to infrastructure and adds private or toll goods to the measure of infrastructure. These indicators—culinary water, grid fuel, and telephone—are measured as the percentage of households with these services directly available in their homes. This penetration metric, which uses end consumer access as a proxy for general service availability, provides a clear picture of the development of infrastructure and allows for differentiation between areas where most residents have access and other areas where most do not.

The systemic availability of culinary water—also known as domestic water, drinking water, or potable water—is a large contributor to the well-being of those with the service. Culinary water is the water suitable for human consumption or use in the preparation of food. The

study measures the percentage of households per county with culinary water access directly in their homes from a communal source. We conclude that households with culinary water communally available will have a higher quality of life and that counties with higher percentages of culinary water penetration will attract more residents and more development. Howard and Bartram support this assertion, and they indicate that significant benefits are available as culinary water services are more accessible, namely advances in greater public health and sanitation [41]. The percentage of grid culinary water availability per county is also a proxy for government involvement and spending in that specific county. Because grid culinary water is primarily a government service, we assert that a greater percentage availability of grid culinary water in a particular county also translates to a greater amount of other government provided infrastructure in that county. For example, municipal solid waste (MSW) services and sewer services are not recorded in the data but are highly correlated with grid culinary water provision, and because culinary water is highly correlated to the provision of MSW and sewer services, counties with grid culinary water are also likely to provide MSW and sewer services as well. Sewer systems collect sewage waste from local buildings and are later used to either dispose of or treat the sewage for sanitary purposes. Having available sewer systems and MSW services provides greater sanitation and health to the community. Furthermore, a major source of water used to create culinary water is ground water, and according to Miranda et al., MSW services are important in reducing groundwater contamination as well as reducing other solid and hazardous waste material [42].

The second measure of infrastructure availability is access to grid fuel. Having access to grid fuel is a significant measure of a county's development, and unlike the earlier measure of grid water is likely to be provided by private sources over public ones. Grid fuel is primarily natural gas, although there are other types of grid fuel used less commonly. Having household access to these fuels is a positive measure of residents' quality of life. The benefits of household access include the direct influx of fuel for heating or cooking without having to actively seek the fuel; all the residents must do is pay a monthly bill. Rothfarb et al. argue for the importance of a well-organized system in providing natural gas to US households and business, due to their great "depend[ence] on gas for heating and other essential services." The authors discuss the greater availability and reduced cost benefits consumers receive with better developed and systematized grid fuel systems [43].

Our final measure of infrastructure service availability is the household penetration of telecommunication. Although this is not as strong of an indicator as the other two used, we believe it to be a useful measurement nonetheless. Hudson explains very well the quality of life advantages of telecommunication availability:

> *Telecommunications is a tool for the conveyance of information, and thus can be critical to the development process. By providing information links between urban and rural areas and among rural residents, telecommunications can overcome distance barriers, which hamper rural development. Access to information is key to many development activities, including agriculture, industry, shipping, education, health and social services [44].*

Without telecommunications access, it is more difficult for residents to receive and convey necessary information for their day-to-day transactions. In addition, household

telecommunications availability also presents access to minimum low-speed internet. Having at least dial-up internet available in the home can provide important communication and information access. Strover states the significance of "adequate connections to advances telecommunications infrastructure and services [for] rural communities…to be able to fully participate in the emerging information economy" [45].

While it is clear that the presence or absence of our selected proxies and their penetration rates provides an important picture of the level of development of infrastructure in a particular county, it tells only part of the story. The rest of the story can be understood only by examining the availability of funds to provide infrastructure. While our first set of measures speaks to the level of development of a county's infrastructure, our second set of measures speaks to the financial resources available for infrastructure and how those resources are being used. To capture both the presence and absence of infrastructure, we also analyzed the funding that is available to each county that could be used to develop infrastructure, measured both as a function of the total land area in a county and as a per-capita measure. This distinction is important as both differences in size and population create differing infrastructure needs. We use utility bonding numbers and transportation expenditures as proxies for the larger suite of infrastructure goods. Using these proxies allows for both a measurement of spending on immediate needs—transportation—and longer-term needs—utility bonding. This combination provides evidence for the level of investment in infrastructure. Both measures are population controlled to ensure the opportunity of intercounty comparisons.

We measure the public transportation spending per capita for all US counties. Public transportation can include subways, buses, streetcars, light-rail transit, or the most common form of highway funding. Higher spending on all types of public transportation provides a higher quality of life to its residents than do counties with lower per-capita spending on transportation. Transportation spending has a myriad of benefits in facilitating business, recreation, social and family, emergency health, and education travel, etc. A key element of transportation infrastructure spending in dealing with economic development is the amount of highway spending allocated by each county. In an economic growth study by Dye, he states that "highway spending emerges as the strongest correlate of economic growth" because of its ability to facilitate commerce and transportation [46]. A few of the major benefits of having a well-developed highway system include the "expansion of existing business, attraction of new business, and tourism growth, […] increasing business productivity over time associated with reducing shipping costs," and reduced travel times [47]. Residents' opportunity for greater productivity and a higher quality of life are significantly increased by counties that spend more on highways.

Not measured in the data, yet highly correlated with transportation spending, is the availability of transit and airport services. If more funding is allocated for transportation by a county, it is very likely that transit services will be offered as well. The availability of local public transit services is a positive contributor to quality of life. For various reasons, numerous county residents might not have access to private transportation or the ability to travel on their own. Public transportation, whether by bus or rail, is significant to their well-being when traveling to and from home to work, to shop, or to study, etc. Baum-Snow et al. explain a number of benefits to having public transit accessible in their 2000 article: "…better transit

may disproportionately improve the quality of life and the quality of job opportunities…. Public transit potentially increases the access of the poor to better labor market opportunities. This comes in addition to reduce commuting times for people served by better transit." They also add public transit's contribution to reducing air pollution [48].

The benefits of airport services are associated with transportation spending in that counties with transportation spending as a priority will likely have similar reasoning to provide airport services as well. Counties with airport availability provide advantages to the quality of life of its residents more than those counties who do not offer the service. The benefits of having a local airport, mentioned by Newkirk and Casavant, "include economic development, health care and emergency medical services, support of business and commerce, recreation, community activities, enriched community life…. [These] themes support the strong conclusion that rural airports clearly improve the quality of life in rural communities" [49].

The more developed infrastructure accessible to county residents, the more it can achieve the desired economic development that brings the greatest opportunity to the people within the county. These advantages include greater access to transportation, communication, household energy, water, activities, etc. A well-constructed index that purports to measure quality of life must include a coherent measure of the infrastructure.

4.4. Education

The quality of an education system in a county is a telling indicator of the quality of life in that area. And since quality of life is connected to education, its quality is an indicator of what the future will hold for an area. Areas with better education systems have been shown to have higher levels of educational attainment, and as a consequence, higher income [50].

Roughly half of the indexes that we examined included some measure of educational quality. The most common way to represent this was including a measure of the ratio of students to teachers [11, 13, 14, 51]. Other studies include input-based measurements like cost-adjusted per pupil, and library circulation in number of books [52]. Others look at outputs of education: percent of children in secondary school [27], or mean year of schooling, number of 16 year olds enrolled in school, and college and postcollege graduates [28]. Calvert and Henderson created a composite variable made of educational attainment levels, educational expenditures, literacy rates, access to education, distribution, segregation, discrimination, lifelong learning, and alternative education [26].

In our measure of education as an indicator of overall quality of life, we capture a measure of the availability of educational services. We look at the services that are offered in public schools in order to determine if the schools are fulfilling the educational needs of the largest number of students possible. One of the programs that we measure is the availability of college preparation courses like Advanced Placement, International Baccalaureate, or concurrent enrollment for college credit while still in high school. This allows us to capture a measure of the needs fulfillment for advanced students that could be held back from reaching their potential if these courses are not offered and they are kept with the bulk of the students in classes that don't challenge them. We also capture a measure of the needs fulfillment of

the students in a school system that may need extra assistance to succeed. The availability of a Limited English Proficient (LEP) program is measured to account for the ever-growing number of students who need extra help with English due to the diversity of home-spoken languages. In addition, we measure the availability of special education services to help those students with special needs.

Also in our measure of service availability for education, we measure the access that people in a particular county have to higher education. There is a myriad of literature on the benefits of higher education to individuals and society [50] and the citation here of the full literature would be superfluous. We assume and the literature concurs that the proximity and availability of higher education make taking advantage of its benefits easier for the local population and it is a positive attribute to have access to higher education. As education system becomes increasingly competitive in attempts to capture previously untapped markets, new technologies and efforts are being made to make higher education available to increasingly isolated places [53]. We expect to see access to higher education to continue to expand to the benefit of the local citizens in most counties.

The final measures of availability that we used are of the presence of charter schools in a county, as well as other education services offered such as private schools. The presence of charter schools is measured by the annual survey done by the National Center for Education Statistics and the measure of other education services is obtained from the U.S. Census data. The presence of either or both of these indicators represents efforts by the local government and population to offer services that can be invaluable to those that take advantage of them. While charter and private schools are not designed to be to the benefit of everyone, those who wish to take advantage of their service often feel it is very important and can strongly influence their academic performance. It is also claimed by some that the presence of choices within the education system is healthy as it usually fosters competition [54] and increased efficiency with funding [55].

If an area has a good education system, many studies assert they should have positive outcomes from that system to show for it [50]. In the attempt to determine if an area has these positive outcomes, we use a number of different indicators to measure the education system's impact. We first looked at the dropout rate in the local secondary schools. A student is defined as a dropout if he or she is between the ages of 16 and 19, has not graduated from high school, and is not enrolled. Those who fit this category have either failed the system or been failed by the system, neither of which tells of a promising quality of life in an area. We expect to see a lower dropout rate in areas with better education systems. Another outcome of a good education system is the number of persons enrolled in higher education. We use U.S. Census data to get this indicator that measures all the previous year's high school seniors who are enrolled in higher education and also the number of any others who are enrolled in higher education in the county. This allows us to see both the level of high schools students going on to attend college and also the total number of people enrolled in higher education in a given area.

The final outcome that we captured by this method is the education level of the population in the given county. Using U.S. Census data, we are able to capture the percent of the population that has graduated from high school, the percent that has graduated college, and the percent

that has obtained an advanced degree. This allows us to determine the level of education of the whole community, which is important to understand how much an area values education and its impacts. We suspect that a higher level of education in the community at large will correlate with the other indicators of quality of life.

Our measure of educational availability, funding, and outcomes gives an effective and significant measure of the education system. This measure allows us to adequately account for the education system of an area since, as Lyson notes, education "serves as an important marker of social and economic viability and vitality" [56].

4.5. Economic environment

Economic development is a necessary indicator when determining quality of life. Economic development can be defined as efforts that seek to improve the economic well-being and quality of life for a community by creating and/or retaining jobs and increasing incomes. It is the institutional changes made to promote economic betterment and the social organizational changes made to promote growth in an economy.

Every index we reviewed included some measure of economic conditions but different indexes use different indicators to capture this information. The Economist [17] used GDP per person and percent unemployment; Roback uses the unemployment rate, as does Rosen although Rosen includes population growth as part of the index [10, 40]. In contrast, Agostini and Richardson capture the economic environment using the real per-capita income [28].

We have chosen to use and gather data for three categories that we believe to best determine the county residents' quality of life level, namely the availability of services, economic outcomes—such as per-capita income and the unemployment rate—and availability of private capital for the rural counties. The following paragraphs will support our argument that the more economically developed a county is, the higher quality of life its residents have.

How accessible services are in each county affects the quality of life of its residents. To measure service availability, we focus on the total number of employers and the number of new businesses per year in each county.

Employment is one of the most fundamental measurements of economic development. When unemployment is high, it creates a downward spiral in a community's economy: the unemployed residents cannot receive an income, which reduces consumer spending, which in turn reduces industry earnings, creating fewer jobs, and so on. Thus, a healthy economy arrives close to full employment, generating more consumer spending and industry growth in the community. We chose to measure the total number of employers in each county as an economic quality of life indicator because when more opportunities are available for resident employment, residents have the ability to receive their desired income with greater facility. Hence, they will be able to better satisfy their needs and wants.

By measuring the total number of employers, the number of individual businesses within the community can be determined. Wennekers and Thurik assert that the positive economic effects from the number of small firms within a community include: "routes of innovation,

industry dynamics and job generation" as well as "a lower propensity to export employment, a qualitative change in the demand for capital, and more variety in the supply of products and services" [57].

The greater number of new businesses established each year is also linked to a higher quality of life for residents in the counties we researched. Buchanan and Ellis list entrepreneurship, the creation and development of new businesses, as one of the basic factors that pushes economic development [58]. When more businesses are created, more opportunity for employment is available for the residents. Business expansion can also be evidence of more capital availability and greater response to higher consumer demand. We measured and recorded data on how many new establishments were created in each county per year to capture the entrepreneurship that is occurring in each of the counties. To calculate this activity, we take the number of businesses that existed the previous year and subtract the current year's business count.

Reduced employment opportunities, due to poor business creation and diversification within a county, create the necessity to travel for employment. We measured data on the number of county residents who travel for employment by determining the commute time and destination. These measures indicate the investment of time people are making for desired employment. To measure destination, we measured the percent of residents employed outside of a county. From this measurement, we can conclude that a greater percentile of residents employed outside the county of residence is indicative of a lower level of economic development in that county. Khan et al. explain the effects of commuting on individual economic growth: "if economic growth elsewhere raises an individual's earning prospects, the individual will move, but if the individual can exploit economic growth elsewhere by commuting, he will not need to move to gain from the expansion" [59]. In other literature, Shields and Swenson conducted research on 65 Pennsylvania counties to determine how commuters balance employment and wage opportunities with relation to housing prices and travel costs. The results suggest that the "proportion of jobs filled by in-commuters varies by industry" [60]. This is an important factor because it illustrates why counties should focus on industry diversity when attracting businesses in order to best capture all types of employment.

In determining the level of economic development of counties, we have chosen three indicators: economic diversity, per-capita income, and unemployment rate. Quantifying these variables will help us better measure resident standard of living as well as economic growth by county.

The more diversified business in a county, the higher the opportunity for the residents to have a higher quality of life. For example, consider a county with mining as its sole industry. If resources were exhausted or a natural accident occurred that made it impossible to ours, the county and its residents' quality of life would decrease substantially. A book by Phillips supports this example in stating that economic diversity is vital to sustaining development in rural areas because of the negative effects of the boom and bust cycles [61]. In this data, we used Hachman's method to determine the economic diversity score. We therefore conclude that a county that has employment and business across diverse industries is more economically developed and can provide a higher quality of life for its residents [62].

Per-capita income is one of the most obvious and routinely used indicators of quality of life. Those who have a higher per-capita income have more funds to purchase the necessities as well as more disposable income to purchase luxuries. Lucas, in his study "On the Mechanics of Economic Development," argues that per-capita income is the best indicator of economic development [63]. However, Alpert reminds us that that per-capita income is not an all-encompassing indicator when determining the degree of economic development [64]. We agree, and our index reflects that conclusion, per-capita income is important, but not sufficient in determining economic quality of life.

The unemployment rate is another indicator of how economically developed a county is. This measurement has been used in many quality of life studies: a lower unemployment rate provides more opportunities for residents to find jobs, which leads to higher quality of life. Phillips argues the unemployment rate is an important indicator in determining economic development. He states both the need for both "basic and nonbasic employment: basic jobs are those that bring new money into the economy" whereas "nonbasic jobs are those that recycle money through the local economy" [61].

The final indicator seeks to measure the availability of capital in counties. Capital availability is a vital part of any county's economic development as it represents the potential funds that can be used to hire workers, develop infrastructure, and power the engine of economic growth. We used total deposits in commercial banks, manufacturing capital expenditures, and total annual payroll of all industries as the indicators.

The greater the total deposits in local commercial banks, the greater the funds readily available for use in entrepreneurial activities, for larger scale business investment, and for private investment on homes/home improvement and automobiles, and so on. Low et al. explain the positive correlation between bank deposits and entrepreneurial growth, emphasizing the effects of bank deposits on "creat[ing] loanable funds that could help regional entrepreneurs invest and grow further" [65].

Although funding availability through deposits in commercial banks is useful in community economic development, simple capital availability does not necessarily indicate productive potential use of the capital. Capital has a multiplicative effect when it is invested and put to use that cannot occur when it is simply held in reserve. The measurement of manufacturing capital expenditures is a valuable measurement of capital use and availability in economic development because it illustrates how businesses apply their capital. Measuring manufacturing capital expenditures is valuable in providing evidence of business growth and productivity within distinct communities due to local capital investment.

Our final subindicator measures the total annual payroll of all industries for each county. This measure, which indicates the amount of money businesses allocate to paying employees each year, is evidence of industry growth or decline. Greater payroll indicates an expansion in the local community because industries have additional funds to pay employees after covering their costs and other financial obligations. Payroll can also indicate the quality of human capital available in the county: employees with higher degrees and work experience receive higher wages. With greater payroll provided to employees, greater opportunity for private

capital investment is available as well. The reverse is also true, as noted by Eberts and Fogarty: "as private investment increases, demand for labor and thus payrolls also increase, expanding the income of the local economy" [66]. Thus, with more private capital availability, opportunity for growth and development increases, creating a greater quality of life for residents.

As described above, economic development can be defined as efforts that seek to improve the economic well-being and quality of life for a community by creating and/or retaining jobs and increasing incomes. From the three areas discussed above—service availability, economic outcomes, and private capital availability—I was able to establish the advantages to having an economically developed county. We can therefore see that residents living in a county with a more advanced level of economic development will have a better quality of life than of those whose county is less economically developed.

4.6. Other indicators

Although many of the indexes examined had variables that fit well within these categories, there were usually a few that did not. Some used a variety of different indicators, but there were a few similar indicators that repeatedly showed throughout the literature. One of the most prevalent indicators was weather and environment in general. Many indexes examined the amount of pollution, the type of weather, the location, or other positive aspects of the natural environment. Many tried to capture a social environment, like Shapiro who measured the number of restaurants in an area [16]. Florida attempts to measure the many unconventional aspects of an area, including the homosexual population, the number of bars and nightclubs, the amount nonprofit art museums and galleries, the number public golf courses among a host of other factors [67].

The factors that seek to extend the explanation of quality of life beyond our five included indexes and the natural environment are not particularly useful and in our opinion should not be included in quality of life metric as they are not consistently included across studies of quality of life, and represent idiosyncratic conceptions of what life quality is.

5. Empirical validation

Properly constructing an index requires a bit of a balancing act. While the index must include enough variables to capture a reasonably complete picture of what is purportedly being measured, adding unnecessary variables introduces noise to the index and dilutes the explanatory value of other variables. To achieve that balance, strong theoretical justifications must exist for the inclusion of each variable. This was done in the previous section. After constructing a theoretical basis and collecting data, the resulting index can be statistically and empirically vetted to further establish its validity. First, the collected data should behave as the theory predicts. Second, the index should mirror how individuals actually comprehend their own life quality.

To confirm that our index behaves as expected, we performed both a confirmatory factor analysis. To verify that the index reflects real people's life quality, we used a survey.

5.1. Confirmatory factor analysis

In building the index, we have attempted to compile a set of indicators that all contribute to quality of life in predictable directions. Confirmatory factor analysis is a statistical tool used to ascertain whether a set of observed variables (the indicators, in our case) are commonly correlated with another unobserved factor (quality of life). To confirm that this index is indeed measuring quality of life, each of the indicators should return a positive value and, because we elected not to weight any of the indicators, each should return a similar value. **Table 1** reports the results of our confirmatory factor analysis.

In our factor analysis, two factors are retained, factor one offering evidence in support of our hypothesis. Positive numbers ranging from .42 to .62 suggest that the indicators truly are related to some common underlying trend, while the high uniqueness values indicate that each provides unique information about that trend, rather than merely reiterating information already captured by another variable.

5.2. Survey

To offer empirical evidence that the construction of the index is appropriate, we conducted a survey of undergraduate students in five classes, most of which were general credit classes and all of which covered social science topics. The students in these classes included all student years (freshman-senior) and all sorts of majors.

The survey collected demographic, university, and political information about each participant, asked to rank their own situation along each of the index's indicators, and finally to scale their own quality of life. The middle of the survey also included a distraction, which asked students about their knowledge of the school, its governance, and whether they would support a fee proposal. For the index to be valid, the ratings offered by survey participants for the indicators ought to align with the overall quality of life score. After collecting data from the surveys, we conducted two OLogit regressions, one with the indicator and the other without it. The results of these regressions are included in **Table 2**.

The coefficients displayed in **Table 2** demonstrate that the indicators are indeed associated with a significant improvement in quality of life. The Psuedo R Square for the model including the indicators, as reported above, is .2254, compared to only .0440 in the controls-only

Variable	Factor 1	Factor 2	Uniqueness
Education	.5122	−.1826	.7043
Public safety	.5326	−.0702	.7114
Infrastructure	.6135	.0588	.6202
Health	.4294	.2141	.7697
Economic development	.6094	.0047	.6286

Table 1. Confirmatory factor analysis.

3	Coef	Standard error	P score
Personal safety	.3429	.1785	.05*
Infrastructure	.2753	.1080	.01**
Economic	.1503	.0739	.04*
Health	.3505	.1208	.00**
Education	.7941	.1246	.00**

N = 258 Pseudo R Square: .2254.

*.10, **.05

Control variables excluded from the table.

Table 2. Survey results-ordered logit.

model. We conclude that the indicators lend significant explanatory power to the model, and that the index therefore captures with ample veracity what it claims to capture.

Using both the confirmatory factor analysis and the ordered logit regressions to back up the theoretical relationships discussed earlier, we have demonstrated that the index is a reliable and meaningful measure of the quality of life.

6. Conclusion

The initial impetus behind this project was a desire to better understand the relationship between public policy outcome and the life quality of individual citizens. Claims about the impact particular policy decisions have on livability, well-being, and quality of life are commonly invoked by policy maker and politicians as justifications for particular policy choices. There has however been little substantive quantitative work on measuring these somewhat amorphous concepts.

Our interest in these questions grew in large part form from claims about the impact of publically owned lands on the quality of life of residents who live and work among them. Numerous claims that public lands positively impacted the well-being of citizens both economically and in nonquantifiable ways are replete in these policy discussions. We found these claims intriguing and warranting a more in-depth examination.

This exploration led us to the central research question of this chapter, how do you measure life quality? We found that the concept of life quality and its measurement has been discussed and debated among scholars of various fields for many years, and, while there are a variety of positions advocated by various disciplines, there appears to be an emerging consensus regarding its importance, but not its measurement. While the limits of quantitative measurement of life quality are clear, namely that they are by their very nature an abstraction, they provide a metric where by claims of policy makers and politicians that particular policy approaches are better for life quality can be evaluated. Our approach provides one such tool for policy evaluation.

Acknowledgements

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