A Cost-Effect Analysis: An Empirical Case Study of Transportation Sustainability Efforts in Two College Towns

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Abstract
College towns are known for their large student populations, strong human capital, and collaborative economic activity. Ideally, they are arenas to expand research and development, given the presence of vibrant academic institutions. One of the themes of this expansion is sustainability—-an urban growth objective that emphasizes ecological awareness and strategies to mitigate the effects of climate change. This does not necessarily denote environmental protection alone; it can include a number of goals, including social diversity. The literature shows that sustainability is a complex objective in an urban setting. Consequently, we focus on economic activity aimed at improving soft and hard infrastructure that is strategically aimed at smart growth. To that end, this paper evaluates the economic cost and effect of sustainability strategies in Denton and Austin, Texas. In particular, we look at walkability and public transportation strategies and how they have been instituted in these two college towns. Methodologically, we look at urban transportation design differences between these two cities. Using route maps and user data, we show why Denton's sustainability strategies are widely considered more successful than Austin's, despite the size differential in Austin's favor. These results can help governments, urban planners, and economists develop strategies to deal with the challenges of urban growth.

Keywords
Transportation Sustainability — Walkability — Public Transportation — Denton, Texas

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Contents

Introduction

Historical and urban development trends stem from the need to meet economic and population growth.[1] The attractiveness of working in urban areas is due to the agglomerative forces that benefit consumers and producers economically.[2] In this review, I will draw attention to two of these forces which are significant in accelerating urbanization and shifting the nature of rural to urban areas. Subsequently, this examination will explain the regressive shift from urban to rural/suburban areas during the Twentieth Century and how it motivates modern urban development models. Overall, the progression of urban development will then explain the pressing limitations ranging from the environmental to the socioeconomic impact that have been examined through various perspectives in academic literature. The conclusions of the examined impacts transform the current trend of urban development to achieve a striking objective: *sustainability*.

The Brundtland Report in 1987 coined the word sustainability as meeting the needs of the present and the future through three objectives: economic growth, environmental protection and social responsibility.[3] Since its original conception, the definition and goals of sustainability in the literature diversifies the trend of urban development through various urban development models. It resulted in an addition of numerous urban categories such as sustainable city, smart city, low-carbon city and green city. Many of these categories contain similar economic characteristics yet differ based on individual economic challenges.

The purpose of examining a few of these new categories and their development models are to highlight the ambitions of urbanization in present day urban-rural areas. Moreover,

urban-rural sites have their own sets of behavioral and geographical economic characteristics where these engineered sustainable models are applied. First, this paper reviews the literature on popular movements of urban development and the reasons for present-day classifications of urban areas around college towns. Then, I draw a clearer understanding by conducting a case study evaluating Denton's sustainable urban development in comparison to Austin. I focus on the effectiveness of a popular design urban movement, walkability and the new urbanism.

1. The Economic Benefits of Urban Areas

For many decades, urbanization is known to cut transportation costs of firms, especially during the Nineteenth Century. The reduced logistical cost resulted in firms clustering into agglomerations which came to be urbanized areas. On the other hand, rural areas have simpler models for growth and slower economic activity in comparison. Prior to the boom of the manufacturing industry, the rural setting builds the costs of input due to the large distance between the producer and the consumer. In terms of reducing costs, urban areas meet the needs of firms and consumers coming together where it incites beneficial forces such as stronger market competition and increasing returns in productivity, innovation and technology. In terms of efficiency, concentrated economic activity in the long-run sees a positive trend in economies of scale and reached a common threshold of participation in the global market. Evidence shows that economic geography developed the metropolitan areas today. For instance, New York City is a popular port-city during the 19th Century and Chicago was a center-point for the American railroad system. Early urbanization improved the hard infrastructure such as transportation and water filtering systems so that the reach of efficiency and prosperity within the area spans accordingly with urban growth.

Subsequently, as firms began to relocate closer together, workers were displaced from rural areas to reposition for better employment opportunities. The people living in these areas receive higher wage premiums implying stronger productivity. Higher wages also reflect higher costs of living and inflation. However, these are indicators that there is an elevated purchasing power. Furthermore, the marginal increase in population density was great enough to establish an active social environment that allows knowledge transfers to occur. This powerful connection proliferates ideas for innovation and economic empowerment contributing to better human capital and overall economic growth. It supports increasing returns in productivity.

Additionally, knowledge transfers also allowed labor market pooling to occur where workers from one industry switch to another efficiently than before. Owing to this improvement, the costs of structural unemployment due to development is eased. There is a rise in labor mobility and over time the economic wellbeing of an individual is transformed. This possibility highlights the value of soft infrastructure within the operation of society. Soft infrastructure are elements focused on improving human capital and overall labor productivity.

As the trend develops, urban life becomes denser and compact. The population spatial structure shows efficient energy consumption and overall lower carbon emissions. In conclusion, over the decades, the incentivization rate from urban development was pivotal to rapid economic growth. In 2012, 80% of the U.S. population live in urban areas. Over 10% of global GDP comes from large US cities alone. Historically, the goals of urban development have buffered the economic benefits and overcome the constraints it originally had.

2. The Economic Impact of Suburbanization and Urban Sprawl

As a result of reduced costs, improved standards of living, and capacity of production, accelerated growth became prominent. The previous section highlights population growth and the framework of an urban skeleton, emphasizing the relationship between population and technological progress. Together, these elements bring the economy closer to the constraints of employed resources. Cities continue to grow, living costs rise and eventually, a declining marginal benefit occurs. This can happen faster depending on how urban growth is achieved. From a traditional walkable and industrial model during the Industrial Era in the 20th century, development tends to spread away from the urban centers. As a result of this spread, suburbanization was the next step in economic activity.

Suburbanization is simply the growth of rural into urban-rural areas where specialized industries or a population of commuters reside. It is a population shift where an urban area becomes car-centric to tie the pocketed suburbs to the city center.[4] Urban development trends to focus on land expansion instead of urban concentration. Presently, a prominent example is the urban structure of the Dallas-Fort Worth metroplex in north Texas. The metroplex consists of 13 counties, two central cities, and numerous suburbs across the region.

To accommodate urban land expansion, highways and roads are built and invested in to connect the urban–rural areas. This accommodation relies on an inconvenient, complex transportation infrastructure and larger portion of resources spent to support the model.[5] Additionally, the complexity leads to inefficient use of people's time and energy because of congested roads. It makes driving a requirement to participate in the economic activity of the city and the market. In contrast to traditional urbanization, suburbanization increases the economic cost of transportation as communities are spread out in a region.

The goal of urban development is no longer economically efficient because on average people spend more time on the road and less time in economic activity. It also puts them further at risk considering the implications of auto-oriented transportation. This makes the demand for vehicular transportation inelastic. The average price to drive from suburb to suburb is greater than traditional urban regions. Moreover,

it creates a barrier to a large group of consumers who cannot afford to drive to access the market. Urban sprawl is the common trend of urban development[1] prior to the introduction of environmental consciousness and sustainability. The benefit of a sprawl provides access of outlying rural areas to dense agglomerations. However, the impact of suburbanization revolves around the car-centric behavior of the consuming population.[6] The evolved consumer lifestyle depletes the available resources has in the area economically.

Suburbanization consistently takes place in areas like the metroplex due to the abundance of land around the central cities like Dallas and Fort Worth, and towns with dominant industries like Denton, Richardson and Irving. Economic growth is achieved by meeting the market demand in the short-run. It is wrong to think that suburbanization comes with numerous externalities. Suburban development provides cheaper options than urban living and cuts down costs as opposed to living in the city center. It also makes an area affordable for human capital to live closer to their job sites, and this is part of the appeal of an urban-rural region. Denton houses higher-education professionals and consumers as well as the surrounding suburbs. Likewise, the city of Plano is a manufacturing hub where many of its residents participate closely or indirectly to the area's economic strength. Organized urban-rural areas increase activity to improve efficiency.

3. Smart Growth: Modern Sustainable Models

Modern sustainable models tend to shy away from suburbanizing areas. Despite the economic implications of traditional urbanization as demonstrated from times of industrialization to that of suburbanization, the key negative externality of urban growth is the irreversible impact on Earth's biosphere. In the lens of rational choice, measuring the benefits with utility presents an axiom of preference where more of available resources is better. Presenting the axiom as an incentive in early urban growth, resource depletion and exploitation is among many of the facets of economic constraints. It leads to the loss of arable land, climate change, and threatens biodiversity.[1] It was not until the United Nations Human Conference on Human Environment in 1970 that the need for sustainable strategies to innovate urban growth was recognized. Innovation is the motivation behind new models in urban development to be environmentally and socially conscious.

Thus, modern urban development models seek sustainability in their working definitions. Sustainability in the micro-economic sense differs greatly to the assumption of environmental protection. Conceptually, the urban challenges involved in sustainability depend on the individual challenges of the city and other factors such as geography, culture and history. The approaches to implementing these models consist of similar economic characteristics involved in reducing environmental cost and raising human capital in different levels depending on the city's economic challenges. The combination of the two effects defines smart growth. The differentiation of these approaches derived numerous city categories promoting sustainable urbanization.[7] The strategic use of the available human, technology and institutional factors a city has defines the methodology of smart and sustainable urban development.[8] Urban planners evaluate the effectiveness of local and national policies, making decisions on new and existing infrastructure and improving on hard and soft infrastructure to improve on these factors.[9] Cities emphasize each factor differently depending on the city's socioeconomic dilemmas.

The most frequently mentioned approach is the smart city approach.[8] The methodology used in these developmental models lead to the following smart city categories mentioned in literature: the knowledge city, the informational city, the creative city and the ubiquitous city.[7] Essentially, smart models focus on the efficiency of connectivity among human, technology and institutional factors. The connection intends to strengthen a dense population to achieve productivity, innovation and sustainability (Batagan, 2011).[10]

3.1 The Smart City and New Urbanism

The value of walkability is an element of a popular urban design movement called New Urbanism. The movement argues against urban sprawl and defines the revolutionary concept of enhanced transportation infrastructure to increase consumer's walkability and create a pedestrian-friendly urban core.[6] It instructs urban planners to design the urban architecture consisting of denser residential housing and an efficient suburban to central public transportation system. These characteristics intend to discourage auto-oriented transportation and invest in preferred light rail and bike system instead. Overall, it hopes to influence consumers to use automobiles as an alternative rather than a preferred form of transportation.

However, economists like O'Toole argue against smart growth and population density. He believes that the attractiveness of suburban living is its affordability. He argues that market forces that will drive transportation fares up. This makes consumers dependent on public transportation at an unnecessary disadvantage.[11] O'Toole points out that Portland, Oregon, a smart city, applies development strategies to stimulate smart growth comes with artificial economic constraints. The architectural control needed to preserve population density and walkability disincentivizes firms in the area to expand and produce.

3.2 College Towns' Microeconomic Structures

College towns follow the framework of smart cities with an emphasis on education and research, innovation and development.[12] College towns, in the literature, are alternatively labeled as knowledgeable cities/learning cities. They are cities that attract consumers due to their infrastructures and firms revolving around education and innovation. The unique urban structure of a college town owes, in part, to its large young population, production of human capital and significant presence of academic institutions.[13] It encourages interaction within the

student population and collaboration within the urban development. A college town is a specialized urban-rural area that invests in soft infrastructure such as improving education and training for the population.[14] Higher education is noticeably influential in meeting regional economic development.[15] The collaborative effort between the city and academic institutions is a strategic strength utilized to implement sustainable development.

On the other hand, available literature on the influence of higher education encompasses an analysis of improving soft-infrastructure. There were studies on higher education-city partnerships[13], evaluative report on human capital[14] and the significance of knowledge transfer and learning in sustainable development.[12] Together their contributions summarize the economic participation and impact of the town's student population on urban development. The educational economic activity stimulates urban and economic growth as academic institutions continue to attract more incoming students and workers. Subsequently, the presence of academic institutions foster innovative mindset.

A notable limitation of the literature lies in not perceiving college towns as an urban economic units. Moreover, there is minimal focus on young urban growth compared to its mature relative college towns. Most of available literature on smart cities is conceptual where there is a lack of consistent measurement in determining a city's specific sustainable goals. Given the presence of higher education, to what extent is sustainable development effective? Questions like these motivates this study to emphasize the sustainable economic cost and benefits of knowledgeable urban rural areas. It is especially significant since present-day higher education is globally connected to exchange ideas and to collaborate and create new solutions to advance current state of technology. Furthermore, college towns synthesize human capital potentially contributing to the global economy given the strength of the century's informational age. The first step to approach sustainability is to tackle the microeconomic challenges of college towns and its urban-rural area since academic institutions produce potential labor and entrepreneurship for the future.

4. Analysis

Denton is a "walkable" urban redesign. College towns are uniquely suited for this type of design, with densely-clustered young populations located around the university and urban center. Universities are also centers of human capital with research productivity and innovation. The walkable design initiative shared between City of Denton, UNT, and TWU promotes skinnier streets with bike lanes, wider sidewalks and back-in parking on street sides and large parking lots on the periphery. The images in the poster illustrate the West Oak project between the Denton rail system and downtown. This redesign is meant to bring in tourists from surrounding areas on the rail system and provide comfortable pedestrian-friendly areas for people to walk, shop, and eat.

Denton recently received a grant of $1.5 million to increase the number of bike lanes from the North Central Texas Council of Governments (NCTCOG). The purpose of the grant was to provide barriers for cyclists to improve safety. This project also comports with the stated purpose of Denton's urban planning to increase regional connectivity and access. The rail system from Denton connects to Dallas and Fort Worth transit systems in order to bring in commuters and students from the urban centers, even though Denton is located 35-40 miles north of these urban areas.

Figure 1. Denton, Texas Rail System, Connections to Dallas/Fort Worth

The universities have also worked hard to promote public transportation for commuters. Denton County Transportation Authority's (DCTA) A-Train system connects to the Dallas light rail system north of Dallas. Once in Denton, commuters can board buses, whose routes are synchronized with train arrivals, to connect with university campuses. Our results are displayed in the poster and show that commuter activity is increasing at a steady rate per year, 3% annual growth over the last three years. DCTA is expected to carry over four million passengers in 2018 alone. However, our results show that more needs to be done to promote ridership. In neighboring Lewisville, only 14% of residents indicate a preference for public transportation and only 44% say that their community is served by public transportation services.

5. Discussion/Conclusion

The Denton rail system capitalized on the strengths of a college town in a suburban sprawl. By comparison, Austin's rail system has not been a success; ridership was actually down last year. Denton's rail system and public transportation have thrived, increasing ridership in each year of operation and

running a budget that is operating in the black with $27.6 million in revenue in fiscal year 2016.

Denton was able to do this by leveraging regional partnerships. The rail system was built under a regional partnership that connected it to rail systems in Dallas and Fort Worth and connections to other Dallas-Fort Worth suburbs like Lewisville and Carrolton/Farmers Branch. The Denton County Transportation Authority constructed new rails that conveniently connect to the bus system serving Denton's two large public universities. The train station, as shown in Figure 1, is also closely located to downtown Denton, providing easy walkable access to attractions and festivals hosted by the city, including the Arts and Jazz Festival.

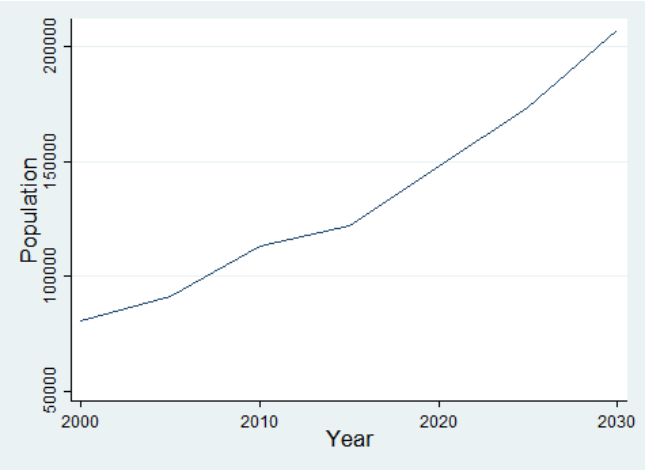

Figure 2. Projected Population Growth: Denton, Texas

By utilizing the unique features of a college, Denton was able to build and revitalize the downtown area. Enrollment at both universities has increased with eased access of Dallas-Fort Worth commuters to the institutions. What was once a "commuter town," Denton's population is expected to grow rapidly in the coming years,

Author Biography

Abir Arabi is an Undergraduate Research Fellow at the University of North Texas where she is majoring in Economics with a minor concentration in Mathematics. As an undergraduate scholar, she has spent most of her scholarship in policy analysis and urban economics. She presented her work at the American Association of Behavioral and Social Sciences Conference 2018, the Federal Reserve Bank of Dallas, and at the University of North Texas Scholar's Day. She also serves as a peer-reviewer at the Economics Scholars Program Undergraduate Research Conference 2018 along with participated as a discussant in the same conference for the last two years. Other than pursuing research, she serves as the Marketing Director at the Economics Student Organization, where her involvement led to encouraging her peers in Economics to discuss scholarly work and consider economic research at the undergraduate level. Currently, Abir will acquire her undergraduate degree at UNT and will enter UNT Toulouse Graduates School to complete her Masters of Science degree in Economics. She hopes to pursue a PhD. degree in Economics where with it, she can pursue a professional career in economic research and policy analysis.

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