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A Gravity Model Integrating Land-Use and Transportation Policies for Sustainable Development: Case Study of Fresno, California

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Introduction

The idea of urban compaction has long been proposed and promoted to address the problem of urban sprawl in many American cities. Nevertheless, successful cases of implementing urban compaction in the United States are rare. This study uses a classic gravity model, TELUM (Transportation, Economic, and Land-Use Model), to examine the extent to which a land-use or transportation policy must be regulated to make the urban compaction occur in a typical auto dependent city—Fresno, California. Five scenarios are considered: BL, L1, L2, T1, and T2. The BL is a natural growth scenario. The results will be used as benchmark for further comparisons. The L1 and L2 are land-use related policies, such as high-density zoning and growth boundary policies, which have been widely used to arrest urban sprawl in many cities. The T1 and T2 are designed as transportation interventions to the allocation of future developments to investigate whether transportation would play a role in the transformation of urban compaction.

Study Methods

Urban models have been widely used to forecast future city developments and, therefore, planners would be able to prepare for providing adequate land, transportation, and public infrastructure and facilities. Most previous studies have focused on the function of forecasting within these urban models but have largely neglected the possibility that they can be operated in reverse. For instance, one can easily use an urban model to simulate what will happen if a high-density zoning policy is implemented in a city. Along these lines, this study uses an urban model, TELUM, to investigate the extent to which the high density zoning policy (L1) should be implemented to initiate urban compaction. This study also applies this approach to other polices—including a growth boundary policy (L2), locational transportation impedance (T1), and carbon tax (T2)—to promote a compact sustainable city.

Findings

The BL (baseline) results show that Fresno will inevitably expand outward due to the lack of available vacant developable land within the city's boundary. The L1 (high-density zoning) scenario increases the availability of vacant developable land in the urban core area. The results show that urban compaction would occur and complete the process in the next 30 years when two layers of usable land are added to the urban core areas. Building on the L1 scenario, the L2 (growth boundary) scenario applies a growth boundary by employing a zero development policy in the rural areas. The results suggest that this policy speeds up the process of urban compaction and makes the city more compact as compared to the L1 results.

The T1 (locational impedance) scenario builds on L2 and decreases travel cost in the urban core areas by 50% and doubles that in the rural areas. The results reveal that this policy essentially creases transportation barriers among the urban core, suburban, and rural regions. Future activities (e.g., residential, commercial, industrial) are found to have a tendency to interact with those in their own regions. The urban core areas will see more future developments because of lower travel costs and stronger local economies. On the other hand, the suburban areas will lose development due to poorer travel and economic conditions. The rural areas will see more developments when the local economy matures. The effect of this scenario is remarkably similar to that of barriers to trade. The T2 (carbon tax) scenario squares travel cost and therefore results in spatially correlated developments. The idea of TOD could help with this uneven distribution by connecting the small-area clusters with a complete transit network toward a compact multicentric city.

Fresno will expand outward. Land-use planning can help arrest urban sprawl, and transportation policies could also help if designed properly.

Policy/Practice Recommendations

The proposed research framework can be used for any city to evaluate how a transportation or land-use policy would affect the urban form, how much effort is required to make a difference, and how long it will take to complete the compaction process. This study's findings provide new insights into the problems of urban sprawl for decision-makers in the context of promoting sustainability of a compact city.

About the Authors

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To Learn More

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