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Literature Review: Energy and Urban Economics

Due to rising energy prices and recent attention surround energy consumption, an increasingly relevant area of academic interest is how urban systems are adapting. Historically, urban areas developed without constraints due to energy availability. The low price of energy led to highly dispersed urban landscapes. The value of clean air, larger properties, and the suburban lifestyle outweighed transportation and other energy costs. Today, in the face of energy constraints and rising energy prices, established cities have to adapt. This creates an opportunity to study the dynamics of urban development with respect to resource constraints. Research into this field can have many benefits, like shedding light on possible socioeconomic inequalities, as well as providing an efficient framework for developing cities to emulate.

Urban Form and Energy Consumption

There are two main points of view on how urban landscapes will respond to rising energy prices. Some authors argue that urban planning models indicate that the changing energy landscape will lead to a monocentric city. Other authors hold that semi-independent suburban centers of economic activity will result. The difference of opinion arises largely due to variation in the assumed cost of moving people versus goods. If goods are more expensive to move, a monocentric model will arise, and visa versa. Others argue that the reality seems to be something in the middle (Sharpe 1982).

Monocentric City Theory

A pertinent issue in the discussion of how energy and urban economics are related is whether different socioeconomic groups are impacted differently. Sharpe (1982) found that inefficiencies in urban planning do increase to socioeconomic inequalities. Specifically, he found that outer urban residents are affected most by rising energy costs. This is due to rising transportation costs and loss of value in property. Therefore, this model supports the shift to a monocentric city model due to rising energy prices.

Sharpe (1982) found that initially, rapid suburbanization, efficient public transport, rising wealth, and low energy prices led to sprawling development. Subsequently, as oil prices started increasing in the

1980s, evidence of socioeconomic discrepancies arose. In particular, low-income groups in outer areas who have low accessibility to public transportation carry most of the burden. This is because higher energy prices make it more attractive to live in urban areas, due largely to transportation costs. Low-income people are especially impacted by rising transportation costs because transportation takes up a larger percentage of their expenditures. Furthermore, low-income people are more likely to be burdened by changing land values across urban areas. Therefore, supporting the monocentric city theory, these socioeconomic groups are forced to move towards the city center for low-priced housing and short commute time (Sharpe 1982).

Semi-Independent Suburban Center Theory

Theoretical Approach

In support of the semi-independent suburban center theory, one model holds that because energy reduction is easy, there is little incentive to relocate. A household's energy costs can vary greatly based on commute distance, size of home, number of cars, age of household members, and number of people in a family (Small 1980). However, depending on the elasticity of demand for energy-using goods and services, consumers can adjust their consumption behaviors. Several studies demonstrate that "in those sectors most strongly affected by potential scarcity", there are a variety of easy avenues to reduce energy consumption (Small 1980, 101). For example, a Resources for the Future study showed that simple home alterations can reduce heating costs by 20% (Schurr et al. 1979). Therefore, if energy prices rise, households can take simple steps to reduce their costs, rather than relocating to reduce costs. This supports the semi-independent suburban center theory because there is little incentive to move to a city center.

Rather than relying on theoretical frameworks, some economists assert that no conclusions can be made about location response to energy prices without quantitative evidence. They favor an empirical approach using data on energy consumption patterns together with cost data for city-suburban migration. This type of analysis more concretely sheds light on how energy scarcity might impact city form (Small 1980).

Empirical Approach

The 1980 Small paper empirically analyzes how energy use for urban versus suburban dwellers vary in terms of work travel, nonwork travel, and home heating/cooling. In order to quantify incentives for relocation based on cost differentials for work travel, Small (1980) used data from the 1975 Travel-to-Work Supplement of the Annual Housing Survey. The data allows for comparison of whether city or suburb residences are employed in the city or suburbs. The increased cost of the commute was calculated as 5 cents extra per mile for 240 round-trips per year. The data revealed that absolute increases are quite small for all four categories of commuters. Specifically, "city locations are less attractive by $33 per year per worker compared to the average suburb" (Small 1980, 108). Therefore, the data does provide weak evidence that *more* centralized suburban locations are more popular due to rising energy prices.

Small acquired nonwork travel data from anther author who used household survey data to estimate car ownership and use. The cost differential was estimated using variables like single family versus multifamily home, owner-occupied versus rented, and suburban versus central city location. The cost difference for an urban versus city resident was estimated as $113 per car.

Finally, heating and cooling cost differences in suburban versus city centers were found using engineering studies on housing unit types in the four regions of the U.S. The calculation used weighted averages for energy consumption based on region and home type. Small (1980) found that, with a 75 cent per gallon increase, the cost differential ranges from $63 to $136 per year amongst the different groups.

One shortcoming that is acknowledged in Small's 1980 paper is that this study does not completely quantify the net incentives for relocations. In addition to household modifications and buying more fuel-efficient cars, consumers can opt to carpool, etc. Quantifying all of these options would be arduous. Instead, Small chooses to assume that these alterations would impact different locations proportionally. Therefore, excluding these factors from the analysis gives the upper bound on relocation incentive.

Qualitatively these cost differentials total about $256 annually for households. It is important to remember that this study excludes any considerations of energy-saving behavior, like carpooling, that might result from increased energy prices. Small (1980) extrapolates on these findings by adapting a model that predicts household migration response to taxation disparities in cities versus suburbs. The multiple regression equation is not given in this paper. However, Small says that the model shows that if households reacted to energy price differentials in the same way as taxes, a $256 increase would cause a net outmigration of .56% from cities. Small (1980) concludes that location shifts within suburbs and cities may occur but that overall density and form will not change as a result of energy prices.

Urban Energy Footprint Model

Continued research in the field of urban and energy economics has lead to more robust models. For example, one of the most recent and comprehensive methods, developed by Larson et al. (2012), is the Urban Energy Footprint Model (UEFM). It shows how land use and transportation policy affect housing markets and transportation. Unlike most models in the field, Larson et al. (2012) includes income groups and traffic congestion as factors.

Congestion is found by $v(k) = 1/(a-bV(k)^c$, where v(k) is the commuting speed, V(k) is the traffic volume through location k, and a, b, and c are parameters that reflect the severity of the congestion function. In order to determine the spatial structure of the housing market, the authors drew variables from the American Housing Survey, 2000 Census of Population database, and the Internal Revenue Service. In order to add the energy consumption variables to the spatial housing market data, this model drew from the Housing Assistance Supply Experiment (HASE) and estimates from household energy consumption equations, which are based on the 2005 Residential Energy Consumption Surveys (RECS) (Larson et al. 2012).

The paper concludes that the relationship between energy prices and urban form are significant. Specifically, Larson et al. (2012) hold that with rising fuel prices, the city becomes more compact in terms of reduced area and increased density. Also, low-income households are more impacted than higher income households due to a difference in income elasticity of demand. Interestingly, the increased fuel prices save more energy due to the shifts in the housing market than the reduction in driving. This bold conclusion differs from other research, but is perhaps more valid because of the inclusion of more variables (Larson et al 2012).

Conclusions and Further Research

Inspired by the findings in the vast literature surrounding energy and urban economics, there is room for further research into the socioeconomic differences in urban form response to energy. A combination of models that exists in the field today seems like the most viable way to answer the question of whether low income groups are more effected by rising energy prices and how that influences their movement in an urban sprawl.

Some limitations of the existing literature include that some studies focus mostly on oil prices rather than coal and natural gas because historically oil has been more scarce than the other two (Sharpe 1982). Another major shortcoming of in this field is that most of the research doesn't factor in the differences in energy use across cities. Energy use can vary substantially based on the quality of public transportation, state gas taxes, environmental sympathy of the population, technology, and land use policies. However, the current models rely heavily on national averages for energy consumption. This leads to broad conclusions, rather than city-specific results.

Furthermore, the fact that the global energy landscape is so fast-paced must be taken into account. Many studies were conducted in the 1980s, which was a time of great pessimism towards energy resources. Today, we have improved extraction technologies for conventional resources, like oil and gas, as well as development of alternative and renewable energy sources (Small 1980).

It is important to understand the dynamics between urban and energy economics because, for example, energy policies may have unintended impacts on urban form and visa versa. The UEFM model lacks inclusion of technological improvements. Technological improvements can expect to impact the energy industry by reducing the need to travel, creating more energy efficient products, and by producing alternative forms of energy. Therefore, I think the model should include a variable that captures the increasing likelihood that these advancements will happen in the future. A proxy could be made for the state of technological advancement by comparing two similar cities in a developed versus developing nation.

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