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THE ECONOMICS OF COMMUTING UNDER THE NEW NORM OF 'WORK-FROM-HOME'

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Abstract: The current study investigates the validity of the traditional urban economic theory of spatial distribution structure in relation to the labour market's value of commute and leisure time considering the recent pandemic-induced Work-from-Home (WfH) situation.

A structured literature review is performed to study the (1) early models of spatial distribution of households and firms like the monocentric city model, and (2) investigate the extensions of the basic models to study the impact of commute time on location decisions. Based on gaps revealed in the review, two theoretical model extensions are built to suggest (3) the impact of WfH on the life satisfaction of the urban labourers in the form of reduced Work-Family-Conflict (WFC) and (4) the impact of WfH on urban density and/or urban sprawl.

Empirical testing of the model extensions suggested in this paper could be used to encourage employers to rethink innovative strategies to engage workers by providing them with more work location and hours flexibility yet maintaining productivity. For urban planners, these findings can be an opportunity to pause and rethink how the urban spaces can be put to alternative uses like parks and gardens to generate revenue for the city while maintaining social distancing.

Keywords: Work-from-home; work-family-conflict; new-norm, social distancing, life-satisfaction, Covid-19.

1. INTRODUCTION

In the study of urban economics, urban spatial structure is the fundamental element. The spatial distribution of households and firms determines

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commuting patterns, which in turn influence urban transportation planning. Traditionally, while discussing urban structure and commuting, considerable attention has been given to the housing markets or land markets in urban areas but not so much to the labour market (Mills, 1987; Mayock, 2016). However, careful thought will reveal that the labour market might have a great influence on where households and firms decide to locate, and thereby their commuting patterns.

There has been considerable focus on the impact of commute on *individual* labour supply decisions (Gutiérrez-i Puigarnau & Van Ommeren, 2015; Stancanelli & Van Soest, 2012; Goux *et al.*, 2014). Curiosity on gender roles in the labour supply has sparked research suggesting that most of the time it's the women- especially married women and not men who withdraw from the labour market when commuting time increases (Bertrand *et al.*, 2015; Black *et al.*, 2014). Research in the area of urban spatial structure and commuting overlooked the urban labour supply and demand in a spatial context and merits attention.

This paper examines the development of economic analysis of commuting under the traditional theory and the subsequent extensions to spatial location models in the context of the urban labour market. Specifically, it investigates the validity of the traditional urban economic theory of spatial distribution structure in relation to the labour market's value of commute time and leisure time in light of the recent pandemic-induced Work-from-Home (WfH) situation. This investigation is a novel attempt to justify Hamilton's (1982) finding that 'wasteful' commuting according to conventional theory is *not so* 'wasteful' after all.

The rest of the article is structured as follows. The next section begins with the base model of residential location and commuting. Section 3 reviews some of its extensions involving labour supply decisions determining the value of commuting time. In section 4 a theoretical model extension is built to suggest the impact of WfH on the life satisfaction of the urban labourers in the form of reduced Work-Family-Conflict (WFC). The urban model is further modified in section 5 to suggest the impact of WfH on urban sprawl. Section 6 concludes with some policy implications and suggestions for further research.

2. THE BASIC MODEL OF RESIDENTIAL LOCATION AND COMMUTING

The basic model of residential location and commuting in urban economics builds upon the standard problem of consumer choice involving two goods

as discussed by Simpson and van der Veen (1992). Supposing a household's utility is a function of q and x where q is the amount of housing or land, (where expenditures on land and housing are assumed to be proportional) and x is the Hicksian composite commodity, representing all other goods. Following the monocentric city assumption let's assume all economic activity occurring in the central business district (CBD), and let h represent the distance to the city center. For an individual consumer, the price gradient for housing is given as $p(h)$, and the cost of commuting is defined as $c(h)$. The commuting costs will differ according to location and distance from the city centre, h (assuming housing features are constant), where $\partial_C/\partial_h > 0$. The standard consumer choice problem is simply to:

$$\max U(q, x)$$

$$\text{subject to } p(h)q + x + c(h) = y \tag{1}$$

where y is consumer income, and the price of goods bundle x is normalised.

The standard first-order conditions for a maximum are:

$$p(h) = \frac{\partial U/\partial q}{\partial U/\partial x} \tag{2}$$

and

$$\frac{\partial p}{\partial h} = -\frac{\partial c/\partial h}{q} < 0 \tag{3}$$

The second-order conditions for a maximum are ensured by appropriate restrictions on the utility function i.e. it is well-behaved and convex with a negative slope. The equilibrium bid-rent schedule for the consumer is represented by equation (3). Higher commuting costs per unit of land, $\partial p/\partial h/q$, must be compensated by a reduction in unit land costs, $\partial p/\partial h$. This trade-off between land and commuting costs became the fundamental premise of the basic model in early residential location literature.

The location variable- commuting distance, h, creates disutility for the consumer (or utility in the form of access to the city centre). Therefore, the consumer's locational equilibrium solution should look like

$$h = h\,[U(), p(.), c(.), y] \tag{4}$$

where decisions in location will depend mainly upon income, y if we assume the utility function, housing prices and commuting costs are the same for everyone. Earlier studies have shown (Siegel, 1975; Simpson, 1987) that households with

higher income prefer to commute more by purchasing cheaper land in the suburbs if the elasticity of the marginal utility of land is sufficiently small. Such a prediction somewhat supports the pattern of settlement in American suburbs where houses usually have a bigger land area.

This link between income and commuting suggests consumers are valuing commuting time. Therefore, commuting time should be included in the consumer's utility function. Considering time as an unspecified function of distance, one model extension suggested (Alonso, 1964; Wheaton, 1977) adding commuting distance h directly in the utility function:

$$\max U(q, x, h)$$

$$\text{subject to } p(h)\, q + x + c(h, y) = y \tag{5}$$

The first order conditions for a maximum are:

$$p(h) = \frac{\partial U/\partial q}{\partial U/\partial x} \tag{6}$$

and

$$\frac{\partial p}{\partial h} = \frac{1}{q}\left[\frac{\partial U/\partial h}{\partial U/\partial x} - \frac{\partial c}{\partial h}\right] \tag{7}$$

Here, the disutility of commuting, given by $\partial U/\partial h/\partial x$ makes the bid-rent schedule steeper, reflecting the value of commuting time. Further calculations in these studies revealed that "the impact of income on the bid-rent schedule depends on the difference between the income elasticities of total marginal travel costs and land". However, missing in this extension is an explicit relationship between commuting distance and commuting time and how people value commuting time in comparison to *work* time or *leisure* time. This warrants a discussion on how households allocate time among alternative uses.

3. LABOUR SUPPLY AND COMMUTING TIME

Household labour supply decisions depend on how an individual values a given amount of time allocated among different activities. This time allocation affects the household utility function. Therefore, labour supply is important as a variable and should not be lumped in the composite good *x,* like in the basic model. Differences in income across households suggest differences in the value of time allocation between work and leisure. If the relative price of leisure to other goods does not remain constant, leisure must be considered as a separate

factor allowing for substitution between leisure and other goods. Similarly, commuting time must be treated separately from the composite good x if its value varies with income across households.

Supposing the total time T for a single-worker household can be divided into work time W, leisure time L, and commuting time t. Usually, the commuting time and cost depend upon location and time spent working, which is assumed to be proportional to the number of work trips, so that $t=t(W, h)$ with $\partial t/\partial W > 0$ and $c=c(W, h)$ with $\partial c/\partial W > 0$. The earnings received by the household per work period is w and unearned income is y. The household utility function will now include leisure.

$$\max U(q, x, L)$$

$$\text{subject to } p(h)\, q + x + c(W, h) = wW + y$$

$$\text{and } W(h) + L + t(W, h) = T \tag{8}$$

The following conditions must satisfy the solution:

$$p(h) = \frac{\partial U/\partial q}{\partial U/\partial x} \tag{9}$$

$$w = \frac{\partial U/\partial L}{\partial U/\partial x} \tag{10}$$

and

$$\frac{\partial p}{\partial h} = -\frac{\partial c/\partial h + w\partial t/\partial h + \partial c/\partial W.\partial W/\partial h + w\partial t/\partial W.\partial W/\partial h}{q} \tag{11}$$

Unlike in equation (3), equation (11) suggests that the equilibrium bid-rent schedule now depends on commuting time and the wage rate.

If labour supply is introduced into the analysis of commuting distance as a second shift parameter, its direct effect can be seen as:

$$c\,(W,h) = K(W)\, Ch$$

and

$$t(W, h) = K(W)\, Dh \tag{12}$$

where $K(W)$ represents the number of commuting trips, which depends on labour supplied ($\partial K/\partial W > 0$), C is the money cost per mile of a trip, and D

is the time spent per mile of a trip. Following condition (12), the bid-rent schedule (11) can be rewritten as

$$\frac{\partial p}{\partial h} = -\frac{K(W)C + wK(W)D + Ch(\partial K/\partial W)\partial W/\partial h + wDh(\partial K/\partial W)\partial W/\partial h}{q} \quad (13)$$

If we assume that the number of commuting trips is proportional to labour supply, such that $\partial^2 K/\partial L^2 = 0$. It can be deduced that as labour supply increases, commuting and commuting costs increase, making the negatively sloped bid-rent schedule of households steeper, while other factors such as income, are held constant. Thus, households with more labour supply, especially where both spouses work, will move closer to the city centre to reduce commuting costs.

If we include commuting time directly into the utility function of the household, as suggested by earlier economists like Wales (1978) we get,

$$\max U(q, x, L, t)$$

$$\text{subject to } p(t)\,q + x = wW + y$$

$$\text{and} \quad W + L + t = T \quad (14)$$

This specification considers commuting time, t, equivalent to the distance from the centre, h, in our monocentric city model. The first order conditions to be satisfied for a solution to the problem given by (14) are:

$$p(t) = \frac{\partial U/\partial q}{\partial U/\partial x} \quad (15)$$

$$w = \frac{\partial U/\partial L}{\partial U/\partial x} \quad (16)$$

and

$$w + q\frac{\partial p}{\partial t} = \frac{\partial U/\partial t}{\partial U/\partial x} \quad (17)$$

The value of commuting time in equation (17) includes both the wage rate, which is the marginal value of leisure from equation (10), and the reduction in housing expenditures arising from the additional time spent commuting. As suggested by equation (3), $q\partial p/\partial t < 0$ in general. So, we can expect the value of commuting time to be less than the wage rate. By specifying a particular functional form for $p(t)$, Wales (1978) calculated the value of commuting time for households and concluded that 'on the average commuting time is

valued at about two-thirds of the wage rate' (p. 222). However, Wales suggests commuting time as a utility with a positive price. When does it make more sense to specify commuting time as a disutility?

4. DISUTILITY OF COMMUTE TIME, WORK-FROM-HOME, AND WORK-FAMILY-CONFLICT

If we continue with the assumption of the monocentric city model, labour locations in the periphery require regular commuting to the CBD for work, which increases traffic congestion. Traffic congestion is a serious problem in modern cities as longer commuting times or distances raise the fixed cost of working and can have an adverse consequence on labour supply and productivity in the form of "late arrival to work, negative mood, and low task performance" (Hennessy, 2008; Van Rooy. 2006). However, if the assumption of a monocentric city is dropped to allow decentralised employment (Simpson & van der Veen, 1992; Zheng *et al.*, 2017) this adverse effect is less pronounced.

Disutility associated with commute time has also manifested in people reporting less energy after commuting (de Geus *et al.*, 2008); women feeling a longer commute affecting their sense of family responsibilities (Roberts *et al.*, 2011); men feeling more leisure activities lost if they must commute longer (Hilbrecht *et al.*, 2013). Negative moods from sitting in traffic congestion, and the need to leave home early to get to work on time, can further impact commuters' quality of family life leading to work-family conflict (Cantwell *et al.*, 2009; Christian, 2012)

The two major domains of an individual's life are work and home. Several studies have highlighted the importance of work and family roles impacting job, family, and overall life satisfaction (Beutell & Schneer, 2014; Gopalan *et al.*, 2018; Michel & Michel 2015). Previous studies (Turcotte, 2011; Wheatley, 2012) have shown that commuting displaces time for activities associated with one's family and social life as time has a zero-sum property- more time spent on commuting means less time available for other activities. Previous studies have also consistently shown a negative relationship between commuting and life satisfaction (Choi *et al.*, 2013; Nie & Sousa-Poza, 2018; Olsson *et al.*, 2013; Stutzer & Frey, 2008). Life satisfaction (LS) refers to one's perception of the quality of life as a whole (Diener *et al.*, 1985).

Acknowledging the disutility associated with commute time, flexible work practices and working from home have started gaining popularity (Leslie *et al.*, 2012; Blinder & Krueger, 2013; Bloom *et al.*, 2015). Work flexibility (WF)

such as a flexible work schedule, working from home, telecommuting, etc. has been viewed as a favourable factor in facilitating the reconciliation of work and family life. Bai *et al.* (2021), argue that work flexibility would reduce commute time (e.g., avoiding 'rush hour' commutes) and ease the commuters' tension between time and space.

The recent (COVID-19-induced) pandemic started in 2020 and made social distancing mandatory to avoid infections and fatality. Consequently, for many employees work-from-home (WfH) represents the only option to both continue earning a wage and minimise the risk of virus exposure. Moreover, uncertainty regarding the duration of the pandemic or future contagion waves led many companies to consider WfH as a 'new normal' way of working (Alon *et al.*, 2020). Complete WfH suggests zero commuting time. This could lead to less work-family-conflict (WFC) and thereby higher life satisfaction or just the opposite as seen in the work of Evans *et al.* (2020) and Sharma and Borah (2022). To investigate the link between disutility of commuting time, work flexibility (WF), and work-family conflict (WFC) it may be postulated, $LS = f(t, WFC, WF)$, where $\partial LS/\partial t < 0$; $\partial LS/\partial WF > 0$; and $\partial LS/\partial WFC < 0$. Therefore, we can consider the urban household utility function (1) or any of its subsequent extensions to serve as a proxy for *LS*, by further modifying it to include work flexibility (WF) and work-family-conflict (WFC)

$$\max U\{(q, x, L, t, WF, WFC\}$$

subject to $$p(t)\,q + x + c(WF, t) = wW + y$$

and $$W(w) + L(WFC) + t(WF) = T \tag{18}$$

The solution to the maximisation problem given by (18) must satisfy the conditions:

$$\frac{\partial U/\partial q}{\partial U/\partial x} = p(t) \tag{15}$$

$$\frac{\partial U/\partial L}{\partial U/\partial x} = w \tag{16}$$

$$\frac{\partial U/\partial t}{\partial U/\partial x} = \frac{\partial c}{\partial t} + q\frac{\partial p(t)}{\partial t} + \frac{\partial U/\partial L}{\partial U/\partial WFC} * \frac{\partial t}{\partial WF} * \frac{1}{\partial U/\partial x} \tag{17}$$

$$\frac{\partial U/\partial WFC}{\partial U/\partial x} = \frac{\partial U/\partial L}{\partial U/\partial x} \tag{18}$$

and $$\frac{\partial U/\partial WF}{\partial U/\partial x} = \frac{\partial c}{\partial WF} + \frac{\partial u/\partial L}{\partial U/\partial x} * \frac{\partial t/\partial WF}{\partial L/\partial WFC} \quad (19)$$

Equations (15) and (16) represent the usual marginal values of housing and leisure. In equation (17), the last term suggests that the marginal value of commute time is now impacted directly by the marginal value of leisure concerning work-family conflict and indirectly by the marginal value of work flexibility. Equation (18) suggests that the marginal value of work-family conflict is directly proportional to the marginal value of leisure and equation (19) suggests that the marginal value of work flexibility increases as the cost of commute decreases with WF ($\partial c/\partial WF < 0$), and the marginal value of commute time with respect to work flexibility decreases through increasing the marginal value of leisure with respect to work-family conflict (WFC). This model specification indicates life satisfaction (LS) to be increasing with less commute time influenced by greater work flexibility (WF). WFC is also expected to be lowered as less commute time allows the labour to allocate more domestic time between pay and non-pay work. A word of caution warrants here – a longer time spent at home environment may also create psychological and mental health disorders which manifest in higher domestic violence and suicidal rates. These factors can create family tension and have a negative life satisfaction (LS). Under the scenario of complete WFH however, *t* disappears from the utility function and the assumption of spatial relationship between workplace and residence in the monocentric city becomes irrelevant. Household time is now allocated between work (pay and domestic) and leisure.

5. WORK-FROM-HOME AND URBAN SPRAWL

Ever since the COVID-19 pandemic has mandated social distancing, several scholarly research has been undertaken to study the impact of social distancing on various aspects of the economic and social fabric. As has been evidenced in the previous section, longer commute times to work reduce life satisfaction for households in the form of less time for leisure and otherwise. The pandemic-induced work-from-home (WfH) has reduced the disutility of commutes and is a blessing in disguise for long-distance commuters. Some scholars tried to study the impact of changing commute patterns on shifting city structure and sizes (Lennox, 2020; Delventhal *et al.*, 2020) while others showed interest in studying the spatial changes of employment leading to decentralisation and polycentricity (Zheng *et al.*, 2017, Cheng & Shaw, 2021). In major

metropolitan cities all over the world, the commercial real estate market was hit hard. Office complexes were lying vacant because people were required to maintain social distancing (at least until lifesaving vaccines were available in the market).

Some research tried to study the impact of less commuting traffic on urban environmental quality (Kerimray *et al.*, 2020, Sharifi & Khavarian-Garmsir, 2020). Work traffic-related air pollutants such as CO and NO_2 were reduced significantly in the cities under study during COVID-19. However, the temporal reduction in air quality was hard to capture due to temperature variations. These studies also found other non-traffic sources of pollution during the pandemic such as coal-fired heat and power plants remained in play. Moeckel (2016) found that telecommuters were undertaking more pleasure-related trips which discounted the improvement in air quality achieved through a fall in commuting traffic. There are also a few studies that have tried to study the impact of work flexibility on household relocation on urban density (Liu & Su, 2020), on inter-city and intra-city relocation causing housing-price gradient changes (Brueckner, Kahn, & Lin, 2021; Alexander & Karger, 2020). Most of these studies are empirical testing of the traditional urban spatial theories.

In this research, the impact of *WF* on urban sprawl can be captured by modifying the household utility function (1) as follows:

$$\max U(q, x, L, WF, h)$$

subject to $$p(h,WF)q + x + c(h,WF) = wW + y$$

and $$W + L + t = T \tag{20}$$

where y is consumer income, and the price of goods bundle x is normalised. Both, the price of housing and the cost of commute is now a function of work flexibility – specifically, $\partial p/\partial WF > 0$ and $\partial c/\partial WF < 0$

The standard first-order conditions for a maximum are

$$p(h,WF) = \frac{\partial U/\partial q}{\partial U/\partial x} \tag{21}$$

$$\frac{\partial u/\partial WF}{\partial u/\partial x} = q\frac{\partial p}{\partial WF} + \frac{\partial c}{\partial WF} \tag{22}$$

and

$$\frac{\partial p}{\partial WF} = -\frac{\partial c/\partial WF}{q} > 0 \tag{23}$$

Equation (23) is the equilibrium bid-rent schedule for the consumer when work flexibility is an option, suggesting that households are willing to incur higher prices for land as the commuting costs per unit of land go down with work flexibility. This phenomenon has been empirically tested in some of the prior studies (Moeckel, 2017; Brueckner, Kahn, & Lin, 2021; Alexander & Karger, 2020) and it has been found that with less commuting, households are moving further away from the CBD to the periphery causing urban sprawl. The demand for bigger land/housing space is also anticipated to increase in the periphery, as social distancing has caused family members to function mostly from home (schoolwork, office work, sales work, etc.) and they require more space.

6. CONCLUSION AND POLICY IMPLICATIONS

In this research, a literature review has been done investigating the extensions to the traditional urban space theories suggested by various economists over time. In addition, two extensions have been proposed by the author in light of the current pandemic-induced social distancing that has mandated most of us to work from home. This 'new norm' of work flexibility in the labour supply market affects the utility function of a household in terms of time and budget allocation among the alternative goods consumed and times spent. An attempt has been made to theoretically capture the effects of WfH on utility optimising behaviour of a household in section 4 and to link life satisfaction (LS) with work-family conflict (WFC). An individual labour's time in a day is distributed between work, leisure, and domestic chores. Each of these components is at odds with each other in the sense that if a labourer is spending more time working away from home and has to commute to work, then it leaves less time for childcare, dinner prep, or other domestic chores as well as less time for leisure. This affects life satisfaction- one's perception of the quality of life as a whole, and in this model extension it has been suggested that higher WF can lower WFC and thereby ensure a higher level of LS. It is to be reminded that the utility functions represent a household where there could be one or more working adults. No attempt was made to capture the impact of the mental health of the workers on their LS in this model. In section 5, a different model extension is proposed to link the aspect of work flexibility with the housing location decisions of labour. This model lends theoretical support to the current body of empirical research evidencing the change in urban density and the increase in urban sprawl.

There are, however, a few more limitations in this research. No attempt has been made to test either of the model extensions proposed in sections 4 and 5 using real-time data. Moreover, the model extensions were proposed only in light of the current pandemic-induced social-distancing issue. Other shocks arising from the social, political, or medical aspects of the society impacting the work-life balance of labour as well (and thereby his/her life satisfaction) are ignored. Further research may be worthwhile by incorporating some of these aspects as well as individual labour's preexisting conditions like savings, inheritance, etc. to study how these may impact their location and work-hour decisions.

Nevertheless, this research provides some meaningful policy implications. First, the fact that partial work flexibility may lower work-family conflict and raise one's life satisfaction, should allow employers and organisations to think about innovative strategies to allow these flexibilities yet keep labour productivity at par with the in-person working environment. Wages and other compensations could be restructured at the organisational level. For the urban planners, the model findings in section 5, can be an opportunity to pause and rethink how the urban spaces can be put to alternative uses like parks and gardens to generate revenue for the city while maintaining social distancing. A fall in urban density need not necessarily lead to a fall in city revenue when public events in open-air spaces can be appropriately monetised.

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