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# Impact of urban residential location choice on housing, travel demands and associated costs: Comparative analysis with empirical evidence from Pakistan

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ABSTRACT

A deep understanding of housing and travel demands and respective costs based on residential location choice is the most important decision that reflects the behaviour of a household. This article aims to analyze how travel and housing demand and associated costs are affected by urban residential location Choice. Using the Residential location choice theory, which assumes that household's demand for travel and housing is derived by their location choice. While choosing a location the monetary calculus of rent and commuting cost also play an important role in deciding to choose where to live, as there is a trade-off between rent and commuting cost in the monocentric city model. Results of comparative static suggest that transport accessibility to the house will lead to an increase in house rent and demand for housing in that area. Moreover, due to availability of transport, in the form of a diverse choice of frequent and affordable public transport, increases the travel demand as the commuting cost will be significantly reduced. Similarly, the effect of income on the commuting cost and house rent shows that due to the rise in income, commuting cost and house rent will increase. The results from the GMM analysis on the socio-economic survey conducted from Rawalpindi and Islamabad, Pakistan provide supportive empirical evidence.

## 1. Introduction

The eleventh goal of Sustainable Development Goals (SDG) emphasis on making cities and human settlements inclusive, safe, resilient and sustainable. However, inclusive and sustainable human settlements are highly linked with the component of location based accessibility to opportunities (in the form of urban amenities), which decrease as the distance from the central business district. Moreover, urban residential location theory states that residential choices of tenants are associated with the proximities to urban amenities, accessibility of public transport and associated costs of commuting and accommodation. However, identifying the opportunities for integrated land use and transport for the residents by improving the access to public transport and non-motorized will lead to sustainable communities and help to meet the targets of SGD 11.

Keeping in view the whole scenario abovementioned to achieve the SDG 11, the national governments have considerable pursuing on the transport and housing but fragmented influence over critical policy areas. It seems like the interaction of land use and transport policies seems to be a secondary or tertiary consideration in most countries. The focus on urban highways, flyovers and road widening programs indicates that urban policies are focused too narrowly on economic efficiency, rather than how transport and housing physically guide spatial development. Ironically, the resulting urban sprawl and declining accessibility have measurable economic costs. Therefore, the residential location choice theory is the basis for the land use and transport interaction by introducing the spatial aspects seen as critical infrastructure or linked to transport planning, that rarely conceptualized in the housing policy that allows both policies to work simultaneously to achieve the SDG 11.

The proximity to urban amenities and public transport accessibility will ensure that tenant households will bear low commuting costs but relatively high rent (Changjoo Kim, 2016). The economic theory suggests that every household a rational being and bounded by rationality conditions to make a home choices with the optimum choices. Furthermore, the interrelations between residential location choices of

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household-based on transport mode choices and housing and transport cost are on multiple levels. Residential choice can be seen as a trade-off between housing costs and transport costs (Scheiner, 2018).

The rate of urbanization is the highest in Pakistan among all South Asian countries, where the urban population is growing annually at a rate of 2.7% that lead to the construction of 0.15 million new urban housing units against a demand of 0.35 from different income groups (Hasan and Arif, 2018). This shortage of 0.20 million houses is primarily due to multiple factors including the inadequacy of housing finance and urban planning. It resulted in overcrowding as well as inaccessibility to utilities, creating urban slums and unplanned sprawl. The demand–supply gap is filled by the private rental housing market that caters mainly to the needs of major lower-income households.

Moreover, the quality of existing public transport service also remains inadequate in both cities. Approximately 95% of the transport fleet is made up of 12-seat pickups and 18-seat vans and buses operating along a couple of routes. Both cities lack a mass transit system or a decent public transport except a metro bus service started in 2015, containing both cities along with the densely populated commercial centers of Rawalpindi and Islamabad to the red zone where secretariat and other public offices are located. Due to low-income levels, affordability of public transport also remains a major problem for Rawalpindi and Islamabad residents (Adeel et al., 2016). Literature reports multiple factors influencing the location choice of households such as physical components (Zarabi and Lord, 2019), economic (Scheiner, 2018) and psychological components by Chen and Chao (2011). There are many studies (De Vos and Witlox, 2013; Nowok et al., 2018; De Vos and Witlox, 2016; De Vos et al., 2018) finding the impact of the availability of modes on residential location choices and associated cost at a locality. However, few studies show the interrelation between house and travel demand with residential location choice and investigate the effect through a theoretical model for tenants households. Both comparative static and empirical analyses are performed to capture the effect of exogenous variables on the travel and housing demand and associated costs. Moreover, in the previous studies, the literature supporting the argument of location choices (e.g., Cao and Chatman, 2016; Chatman, 2009; De Vos and Alemi, 2020) often ignore the possibility of the location choices of tenants. More specifically, the tenant's demand for housing and travel is unlike that of the owner, as the former in their decision-making process account for the usufructuary rights of the property only ignoring the future growth prospects of the property value.

Various studies survey in detail the literature on the relationship between housing and travel demand based on the location choice of the household. Initial studies were focused on the effects of the built environment on travel behavior, typically only controlled for socio-demographic variables (see e.g. Cervero and Kockelman, 1997; Næss, 2009). Further, the literature finds that socio-demographics capture mobility-related preferences and self-selection mechanisms only (Kitamura et al., 1997). Even in countries where the housing market is developed, many factors such as a lack of affordability and limited housing options may prevent households from settling in their preferred neighborhoods.

Most importantly, past studies predominantly used secondary data or travel dairy data in the context of the developed world to find the relationship between travel and housing demand of households doing residential self-selection (see De Abreu e Silva, 2014; Cao and Chatman, 2016). Contrary to the popular literature, based on satellite mapping and remote sensing and only deal with the land use land cover changes and rates of urbanization. The goals of these studies are to understand the extent of travel, housing demand and costs based on the residential location choice of tenant's households. Hence, the current literature is lacking the theoretical foundation of understanding the residential location theory.

In this study, an attempt is made to find out the possible theoretical relationship between the drivers of travel and housing demand, and associated costs. We have developed a theoretical model for travel and housing demands and associated costs based on residential location choice theory. Both comparative static and empirical analyses are performed to capture the effect of exogenous variables on the residential location choice. Comparative static suggests that transport accessibility to the house will lead to an increase in house rent and demand for housing in that area. Moreover, due to availability of transport, in the form of the diverse choices of frequent and affordable public transport, increases the travel demand as the commuting costs will be significantly reduced. Similarly, the effect of income on the commuting cost and house rent shows that due to the rise in income, commuting cost and house rent will increase. The results from the GMM analysis on the socioeconomic survey conducted from Rawalpindi and Islamabad provide supportive empirical evidence. The paper is organized in the way that, section two deals with the development of the household location choice utility function and the associated conditions of optimality. The comparative static analysis of the model is discussed at the end of section two. Section three consists of an empirical analysis of the household model findings. While section four concludes the paper.

## 2. Theoretical framework

The modeling approach relies on a "Classical Theory of land use" by Von Thu¨nen known as Thu¨nen Model of Agriculture Land in (1827). This theory explains the spatial organization of the agricultural land use on the basis of marginal productivity. In the classical era, after the industrial revolution American's classical economist while in the neoclassical era Martin Beckman (1968) presented the neoclassical model of land use known as "Location Theory" which is an extended version of the Von Thu¨nen Model. Beckman's model is quite important in the sense that stated in the urban context, that land-use intensity decreases more rapidly than the distance from CBD and the transportation cost to the center of the city is a linear function of distance and output/Acer.

In the Modern neoclassical's era, the Modern neoclassical theory of land use which is known as "Modern location theory" presented by Alonso (1964) which extended the argument presented by Beckman, in the way he includes the aspect of the size of the site along with the rent and commuting cost. Now, the tenant's household will determine equilibrium by the size of the site along with the rent and commuting cost. They will not only choose the residential location to minimize its cost of rent but also maximize the size of the site. After that Alonso model was extended by Muth (1969) and Mills (1972), in the way that they include the housing commodity instead of land. They assume that house is produced by land and non-land inputs. Hence, houses are produced by land and non-land inputs.

While, (Duranton and Puga, 2015) introduced the heterogeneous households with respect to income groups, and divided city into two rich and poor zone and analyze how commuting cost and house distance trade-off differs for rich and poor people. Many later theoretical and empirical studies endorse this theory (such as Muth, 1969; Mills, 1972; Brueckner, 1987; Fujita, 1989; Cheshire and Mills, 1999; Glaeser and Kahn, 2004).

The rent of the household is reflected by the hedonic price models (HPM) that estimate the monetary value of rent on a set of characteristics of the neighborhood including urban amenities. Several studies used HPM to examine the environmental attribute in housing prices. For example urban open spaces (Krsinich, 2011; Jiao and Liu, 2010); urban river pollution (Bin et al., 2017; Chen, 2017); forest (Schläpfer et al., 2015); water quality (Bin et al., 2017); transport access (Seo et al., 2014; Yuan et al., 2020) and waste management (Casado et al., 2017).

The standard model proposed by us can be distinguished from others because rent will not only be determined by house size but house characteristics including urban amenities play a phenomenal role in the decision. Secondly, the model captures the heterogeneity of household in term variation in income empirically in the context of the developing world keeping in view the transport and housing market. Thirdly, the component of transport accessibility is in the argument of the utility function, which is not captured by the previous strain of models in the literature. Based on these assumptions, the following model is a simple general equilibrium model of urban economics. The utility function for the tenant household is assumed to be strictly quasi-concave and has three goods vectors as an argument. These three are vectors of housing characteristics including urban amenities $L_i$; transport use and accessibility $T_i$; and composite good excluding transportation, amenities and house consumption $X_i$; given the socioeconomic variables $S_i$

So, the utility maximization problem can be put as follows.

$$MaxU(X_{ij}, L_{ij}, T_{ij}, ; S_{ij})$$

Subject to

$$I = L_{ij}R_{ij}^{p}(z_m) + X_{ij} + T_{ij}t_{ij}^{n}(z_l)$$

Such that

$$\frac{\partial U}{\partial X_{ij}} > 0; \frac{\partial U}{\partial L_{ij}} > 0; \frac{\partial U}{\partial T_{ij}} < 0 \ \frac{\partial^2 U}{\partial^2 X_{ij}} < 0; \frac{\partial^2 U}{\partial^2 L_{ij}} < 0; \frac{\partial^2 U}{\partial^2 T_{ij}} < 0$$

The budget constraint shows that income $\boldsymbol{I}$ equal expenditures representing hedonic price function $P_{Li}(z_i)$ that includes the vector of housing characteristics $Z_l$ and vector of urban amenities, $P_{xi}$ represents the prices of composite goods; $t_i$ is per unit commuting cost. So, an individual spends their given income (which is endogenous) on housing, commuting and composite goods.

Whereas, hedonic price function reflecting the vector of housing characteristics and vector of urban amenities is given as, $z_m$ that represents housing characteristics including urban amenities for a housing units. Similarly, $\beta_m$ is defined as the parameter vector, which is allowed to vary across markets, for each of the housing unit characteristics in $z_m$. Thus, the value of a Rent $R_{ij}^{p}$ will depend on the house characteristics along with urban amenities in the location.

$$R_{ij}^{p} = R(z_m; \beta_{m)}$$

$$R_{ij}^{p}(Z_m) = \beta_o + \sum_{l=1}^{n}\beta_l Z_l + \sum_{m=n+1}^{p}\beta_m Z_m$$

Similarly, commuting cost function will also depend on the vector of urban amenities is given as, $z_n$that represents urban amenities around the housing unit. Similarly, $\beta_n$is defined as the parameter vector, which is allowed to vary across markets, for each of the housing unit characteristics in $z_p$. Thus, the value of a Rent $t_{ij}^{n}$will depend on the proximities along with urban amenities in the location.

$$t_{ij}^{n} = R(z_l; \beta_{l)}$$

$$t_{ij}^{n}(Z_l) = \beta_o + \sum_{l=1}^{n}\beta_l Z_l$$

The vector $Z_i$ contains the housing characteristics such as age and size of a house. Whereas, the vector of urban amenities $Z_j$,contain variables such as the number of parks, schools and hospitals in the neighborhood of that locality.

The constrained optimization problem can be specified as the following Lagrange function.

$$\mathscr{L} = U(X_{ij}, L_{ij}, T_{ij}, ; S_{ij}) - \lambda(I - L_{ij}R_{ij}^{p}(Z_m) - X_{ij} - T_{ij}t_{ij}^{n}(Z_l)) \tag{1}$$

Let us assume the Cobb–Douglas utility function with elasticity coefficients conditions will be.

$$\mathscr{L} = X_{ij}{}^{\alpha}L_{ij}{}^{\beta}T_{ij}{}^{\gamma} - \lambda(I - L_{ij}R_{ij}^{p}(Z_m) - X_{ij} - T_{ij}t_{ij}^{n}(Z_l)) \tag{2}$$

$$\therefore \alpha > 0; \beta > 0; \gamma > 0 \alpha + \beta + \gamma = 1; \alpha > \beta > \gamma$$

Putting value of $X_i$ from (7, See appendix A) in to the budget constraint of the model, we will get

$$L_{ij} = \left(\frac{\beta}{\alpha+\beta}\right)\left(\frac{I - X_{ij}}{R_{ij}^{p}(Z_m)}\right. \tag{10}$$

$$L_{ij} = f\left(R_{ij}^{p}, z_m, I\right)$$

$$L_{ij}R_{ij}^{p}(Z_m) = \left(\frac{\beta}{\alpha+\beta}\right)(I - X_{ij}) \tag{11}$$

(11) is the housing demand function, which highlights the relationship between housing demand, hedonic price function of housing characteristics and urban amenities, which is explained by rents and income. According to the demand function, there is a negative relationship between house demand and per unit of house rent whereas, there is a positive relationship between income and housing demand. (Eq. (11)) is the linear expenditure system (LES), representing the expenditures borne by households in the form of accommodation expenses.

In the theoretical model, from (10) we have a demand function for land, from where we can find the equation for the rent.

$$R_{ij}^{p}(Z_m) = \left(\frac{\beta}{\alpha+\beta}\right)\left(\frac{I - X_{ij}}{L_{ij}}\right) \tag{12}$$

The general functional form of (12) is given below.

$$R_{ij}^{p}(Z_m) = f(L_{ij}, I, z_m) \tag{13}$$

(Eq.13) implies that per-unit rent is the function of transport accessibility, housing characteristics including urban amenities; commuting cost to the household for work and non-work trips, and income of a household. Putting value of $X_i$ from equation (viii) into the budget constraint of the model we will get,

$$T_{ij} = \left(\frac{\gamma}{\alpha+\gamma}\right)\left(\frac{I - X_{ij}}{t_{ij}^{n}(Z_l)}\right) \tag{14}$$

$$T_{ij} = f\left(t_{ij}^{n}, Z_l, I\right)$$

$$T_i t_{ij}^{n}(Z_l) = \left(\frac{\gamma}{\alpha+\gamma}\right)(I - X_{ij}) \tag{15}$$

(Eq.14) is the travel demand function, which has commuting costs, and income as arguments in the demand function. There is a negative relationship between transport demand and per unit commuting cost whereas, a positive relationship between income and travel demand. (15) is the linear expenditure system (LES) that represents the household expenditures on commuting.

Similarly, from (15) in the theoretical model, we have a demand equation for traveling, from where we can find commuting costs of households.

$$t_{ij}^{n}(Z_l) = \left(\frac{\gamma}{\alpha+\gamma}\right)\left(\frac{I - X_{ij}}{T_{ij}}\right) \tag{16}$$

The general form of the demand function is given below.

$$t_{ij}^{n}(Z_l) = f(T_{ij}, Z_l, I) \tag{17}$$

(17)) shows that commuting cost depends on the transport accessibility, land rents, amount of land use by household, and the income.

### *2.1. Comparative statics analysis*

**Proposition 1.** *Everything held constant, an increase in the transport accessibility would increase the house rent in the monocentric city model.*

$$\frac{\partial P_{Li}(z_i)}{\partial T_i} = \frac{-\gamma X_i{}^{\alpha}L_i{}^{\beta-1}T_i{}^{\gamma-1}[-\delta\{\gamma-1\}t_i + \beta\eta\{I - P_{Li}(z_i)\}]}{|Y|} > 0 \tag{18}$$

(18) explains how the transport accessibility affects the house rent in the monocentric model, the sign depends on the terms in the numerator. We need to explore whether the sum of the terms is positive or negative based on the elasticity coefficients and prior relationship. While scrutiny leads to the conclusion that it is positive. This can be explained in two ways. First, transport accessibility to the house will enhance the attractiveness of that house and will lead to an increase in the household's utility derived from the transport accessibility. This will further lead to an increase in the house rent due to transport accessibility. Secondly, by the signs of coefficients α, β, γ and reduce form parameter δ and $\eta$ we know that $-\delta\{\gamma-1\}t_i < \beta\eta\{I - P_{Li}(z_i)\}$by simple athematic analysis.

**Proposition 2.** *Everything is held constant, if there is an increase in the commuting costs of representative households, it would decrease their allocation for house rent in the monocentric city model.*

$$\frac{\partial P_{Li}(z_i)}{\partial t_i} = \frac{\gamma X_i^{\alpha} L_i^{\beta} T_i^{\gamma}\left[\frac{-\delta(\gamma-1)}{L_i T_i} + \frac{\eta}{T_i^2}\right]}{|Y|} < 0 \tag{19}$$

In the above (19), we have shown that there is a negative relationship between commuting costs and house rent as there exists a tradeoff between house rent and commuting cost. This can be explained in two ways. First, by the signs of coefficients α, β, γ and reduce form parameter δ and $\eta$ we know that$\frac{-\delta(\gamma-1)}{L_i T_i} > \frac{\eta}{T_i^2}$. Similarly, Muth-Mills condition validates the same results as if a household lives away from CBD, then it will pay less rent but will bear higher commuting costs.

Secondly, we can prove it by the graphical analysis as follows. In Fig. 1, we have shown the re-distribution of household income between house rent and commuting cost depending on residential location. At location A, away from CBD household choice set for rent and commuting cost will be$(t_1, P_{L1})$. When he moves near to CBD, then he has to bear more house rent and less commuting cost. It will shift to the choice set of $(t_2, P_{L2})$at point B, which shows the tradeoff between house rent and commuting cost that validates our result. In other words, rent will be the compensating factor for the residents living in the central city versus living in the suburban areas. As, the consumption bundles for housing and commuting will be changed due to more consumption on travel for suburban household as compared to a central city resident, that justify the tradeoff between rent and commuting cost theoretically.

**Proposition 3.** *Within the same cluster near or away from CBD in the monocentric city model, an increase in house size, would lead to an increase in house rent.*

$$\frac{\partial P_{Li}(z_i)}{\partial L_i} = \frac{\gamma X_i^{\alpha} L_i^{\beta} T_i^{\gamma-2}[-\delta\{(\gamma-1)(i - T_i t_i)\} + \beta\eta P_{Li}(z_i)]}{|Y|} > 0 \tag{20}$$

In the above equation, the signs depend on the terms in the numerator. The sign of this equation is a little ambiguous as rent only not depends on the house size but also depends on the urban amenities, which are associated with the location of the house that also distinguishes our model from Kwon (2005). After in depth analysis, we found that amenities are usually more associated with CBD. So, this analysis will hold for the fringes or clusters around the CBD. In every fringe or cluster, the house rent and house size will have a positive relation.

**Proposition 4.** *Everything is held constant, if there is an increase in the income of a household, this would increase their allocation of income for house rent and commuting in the monocentric city model.*

$$\frac{\partial P_{Li}(z_i)}{\partial I} = \frac{\partial t_i}{\partial I} = \frac{\delta\gamma X_i^{\alpha} L_i^{\beta} T_i^{\gamma-2}\left[\frac{(\gamma-1)}{L_i} + \frac{\beta}{T_i}\right]}{|Y|} > 0 \tag{21}$$

In the above (Eq. (21)), we have to find the impact of the rise in income on house rent and commuting costs of households, both terms are the same due to the same diagonal values of the Y matrix. A striking difference between the traditional models used by Wheaton (1974) and Kwon (2005) and the model used here is the effect of changes in income not only on the commuting cost but also on transport accessibility and the house rent, which is reflected in vector $z_i$, which presents the housing characteristics along with urban amenities. These equations can be explained in two ways. First, a rise in income increases the household's disposable income, and the household will prefer a house with a large set of housing characteristics and neighborhood amenities. Which leads to an increase in the household's welfare. Similarly, regaining equilibrium after the increase in income, the commuting costs will also increase due to more traveling and an increase in the number of vehicles.

Secondly, by the graphical analysis done in Fig. 2, an individual will have an income increase from $I_1$ to $I_2$, due to which the indifference curve shifts from point A to B. This leads to an increase in utility level from $u_1$ to $u_2$, which increases the commuting cost and house rent due to an increase in income.

**Proposition 5.** *Everything is held constant, if there is an increase in transport accessibility to the representative household, then this would decrease their commuting cost in the monocentric city model.*

$$\frac{\partial t_i}{\partial T_i} = \frac{-\gamma X_i^{\alpha} L_i^{\beta-1} T_i^{\gamma-1}[\beta\eta\{I - P_{Li}(z_i)\} - \delta\{\gamma-1\}t_i]}{|Y|} < 0 \tag{22}$$

Here we have found the individual impact of transport accessibility on the commuting cost of a household. Due to the availability of transport, commuting costs will be significantly reduced, due to diverse choices of frequent and affordable public transport. In the above equa-

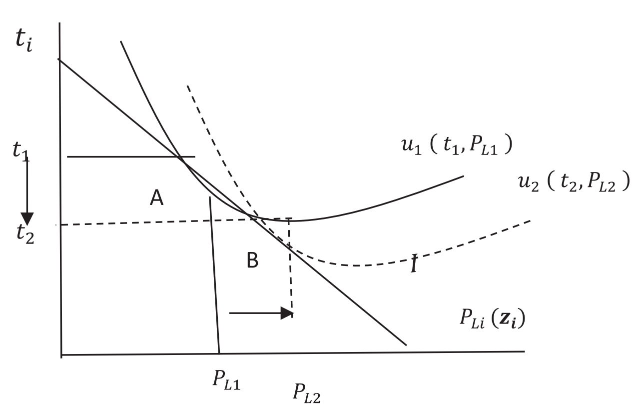


**Fig. 1.** Effect of house rent on commuting cost.

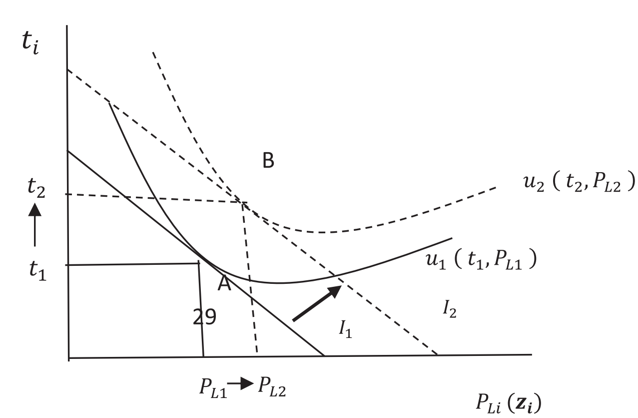


**Fig. 2.** Effect of income on house rent and commuting cost.

tion, the signs depend on the terms in the numerator, which is negative. Secondly, we need to explore whether the sum of the terms is positive or negative based on the elasticity coefficients and prior relationship. Signs of coefficients α, β, γ and reduction from parameter δ and $\eta$ we know that $-\delta\{\gamma-1\}t_i > \beta\eta\{I - P_{Li}(z_i)$by simple athematic analysis. Therefore, it is valid to consider that if transport is valid, it will reduce the commuting cost.

The results of the comparative static analysis are summarized in Table 1, showing the impact of explanatory variables on the key variables based on the results of the comparative static analysis of the urban residential location model with transport accessibility and urban amenities.

## 3. Empirical analysis

To test the theoretical relationship of the household model developed in section 2nd empirically, ideally one could use secondary data on the above variables. However, the availability of the data at the national, regional or local scale, especially in the case of developing countries, is a big problem. For example, data on the travel and housing and associated costs of commuting, specifically for tenants are not variable in the national census.

### *3.1. Case study area and data sources*

The study uses the data collected by the process of face-to-face interviews in the survey through a designed questionnaire from the nine hundred and ninety-five tenants household from Rawalpindi and Islamabad. We have asked about their income profile, proximities to urban amenities, access and availability of public transport modes, associated costs of commuting, accommodation, and their belonging to that specific location and distance from relatives that are used to construct the variables of the model.

### *3.2. Questionnaire design*

The Survey questionnaire used in the study comprised of the various open and close-ended questions. The first theme of the questionnaire contained questions used to obtain background information about household characteristics including marital status, family size and composition, levels of educational attainment of members and employment status and income. This data would provide the basis to differentiate households and individuals as heterogeneous entities and to determine how these attributes shape their location and mobility choices.

Moreover, in the other section we have asked about the distances from the workplace, proximities to the central business district and urban amenities; behavioral or cultural factors that are relevant to the choice of a specific location such as norms and distance from parents and relatives. Questions were formulated to obtain data on home to work, school, park, and relative's mobility patterns, transport mode use, travel frequency and travel time and commuting cost. The specific questions focused on work trips start and return times over 5 days and the commuting cost associated with it. Questions on transport mode for work purposes over 5 days were also included.

**Table 1**
Effect of exogenous variables on commuting cost and House Rent.

| | Effect on Commuting cost | Effect on House Rent |
|---|---|---|
| Income | Positive | Positive |
| Transport Accessibility | Negative | Positive |
| House Rent | Negative | – |
| House Size | Negative | Positive |
| Commuting cost | – | Negative |

### *3.3. Sampling design and questionnaire administration*

The sampling technique used in this study is two-stage stratified random sampling. In the first step, clusters are selected from Rawalpindi and Islamabad ensuring sufficient geographical coverage and spatial variations. In the second step, tenants househlds are randomly' selected from each cluster ensuring that the sample is representative that allows us to generalize the findings. The below Table 2, present the selected samples from the twin cities of Rawalpindi and Islamabad.

To contextualize the study area further in Fig. 3, Islamabad is a well-planned new city with a grid structure with the current state of parking lots, public and environmental spaces and public transport that is much better when comparing with any other city of Pakistan. Rawalpindi on the other hand is an old city with an organically developed structure that evolved and is more congested, lacking a coordinated planned effort and fewer strict land-use planning restrictions. The urban area in both the cities is 3723 $km^2$ and 95% of people in Islamabad are living in urban areas while 63% of people living in urban areas of Rawalpindi. Islamabad contributes 1%, while Rawalpindi contributes approximately 4% to the country's GDP. The economy of Rawalpindi has a diverse industrial base, whereas in Islamabad it is based on services sectors and state-owned companies. To dig deep further we have shown a glimpse of the outcome variables in the frequency distribution bar graph in Figs. 4–7 to develop a comparison for both cities.

Fig. 4 indicates that among 546 tenant's households, 309 lives in five marla or small house in Rawalpindi. However, the number is 173 for Islamabad, which indicates that the majority of households lives in Rawalpindi live in small houses as compare to Islamabad.

Fig. 5 indicates that among 546 tenant households, 396 paying rent between 10,000 to 20,000 Pakistani Rupees (PKR) in Rawalpindi. However, the number is 179 for the Islamabad, which indicates that the majority of households lives in Rawalpindi live in small houses and rent are low in Rawalpindi as compare to Islamabad due to lack of urban amenities.

Fig. 6 indicates that among 546 tenant households, in 328 households, the commuting cost per person per month is under 5000 Pakistani Rupees (PKR) in Rawalpindi. However, the number is 153 for Islamabad, which indicates that majority of households live in Rawalpindi using bikes or public transport as compared to wealthy tenants in the capital city of Islamabad. The other peak between having the commuting costs between 35,000 to 40,000 PKR are those commuters that are living in the suburban areas and they have intracity commuting.

Fig. 7 indicates that among 546 tenant households, in 381 households, the travel distance per person per day is between zeros to 20-kilometer bin size in Rawalpindi. However, the number is 188 for Islamabad, which indicates that the majority of households lives in Rawalpindi travel less as compare to tenants in the capital city of Islamabad.

### *3.4. Variables discerption*

The below Table 3, show the measurement unit, discerption and construction of variables that we are using in the regression analysis

Therefore, that data can only be collected through an anthropological survey. For conducting econometric analysis, we have collected information on the variable that is central to our theoretical model through a household survey.

### *3.5. Statistical methodology*

In our study, Generalized Moments Methods (GMM) is an appropriate model that can fulfill our research objectives. There are two main reasons for using the GMM. Firstly, the GMM estimates are more sensitive than OLS estimates to the prevalence of zeroes in the data. Secondly, the analysis also involves the trade-offs between commuting

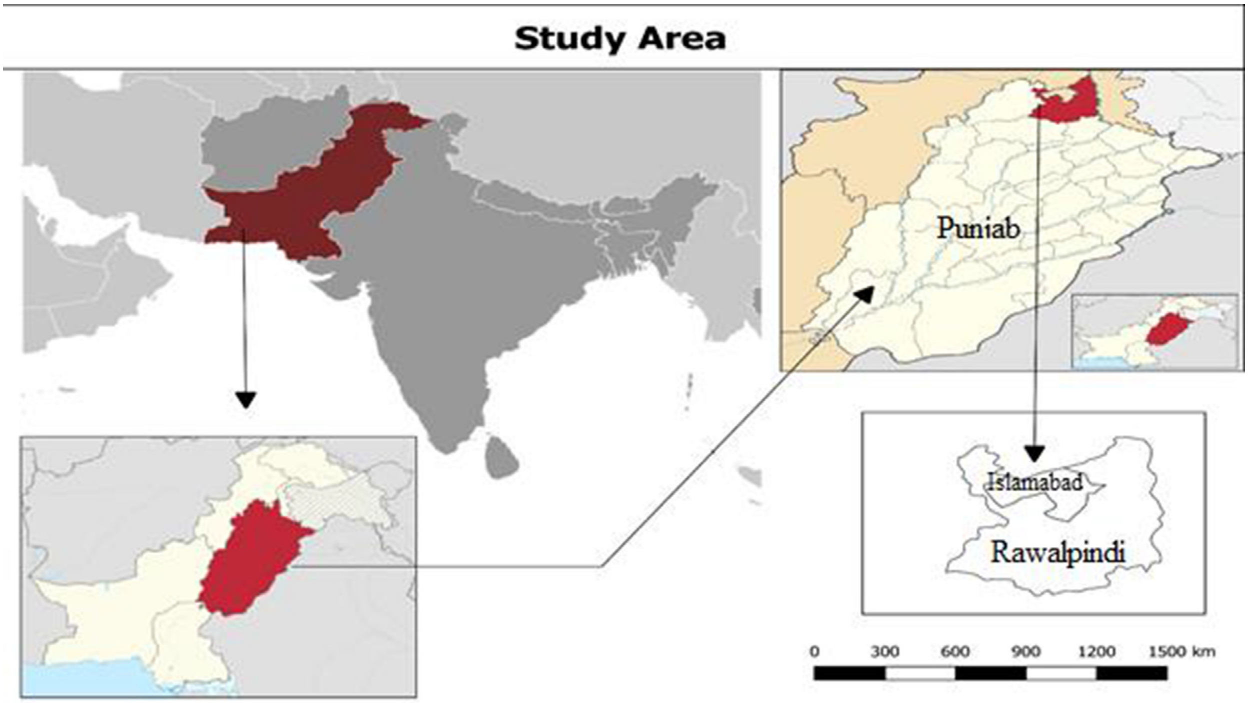


**Fig. 3.** Study Area.

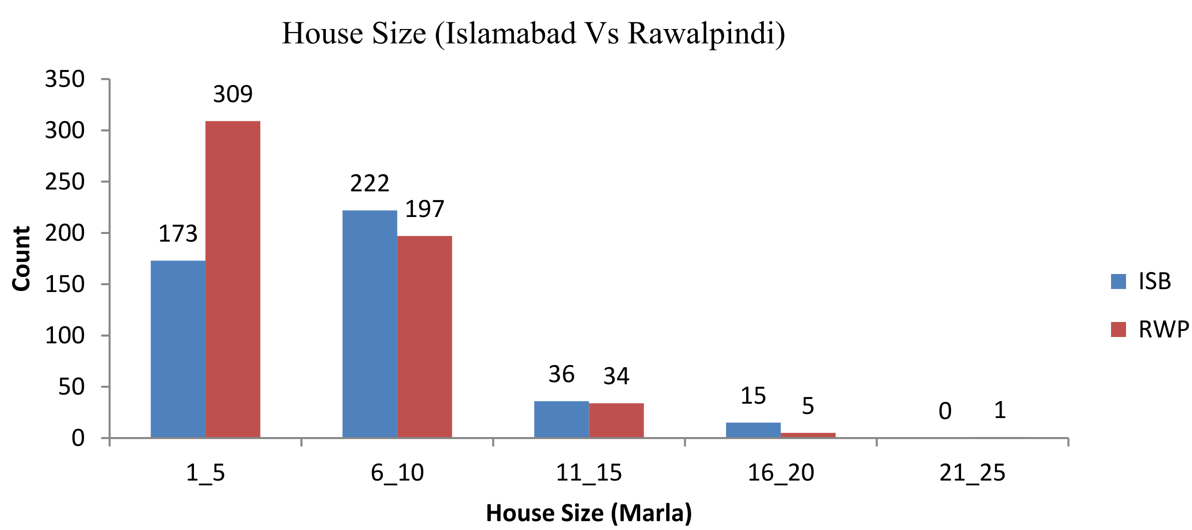


**Fig. 4.** Frequency distribution of House size in Rawalpindi and Islamabad.

and rent, hence the choice is simultaneous and it creates one form of the simultaneous model, and to tackle this endogeneity issue GMM is the most robust model.

## 4. Results

Table 4 provides the coefficient and t-values of the regression coefficients affects the travel, housing demand, commuting cost and rent of tenant's households. A total of 995 observations were included in the empirical analysis. Results of Table 4 also revealed the commuting cost of tenants based on the income profile of household, number of cars and bikes in their assets, access & availability of public transport and distance to their workplace. Regression results reveal that proximity to urban amenities, the number of working people and the number of school-going children significantly influence the commuting cost of tenant's households, which confirms the results of Liao et al. (2015). Furthermore, the results in Table 4 highlight that number of motorbikes tenants household having influenced the commuting cost less as compared to the number of cars. Moreover, the majority of tenant's households have motorbikes, which reveals tenant-level of consciousness towards the costs associated with traveling as they are paying a huge amount for accommodation.

The regression results suggest that the income profile of tenant's household, house characteristics including urban amenities approximate, and public transport accessibility influences the house rent. Physical factors such as distance from workplace and schools are highly significant with a negative sign, showing that the house rent will be high in the proximity of the workplace and school in a location. In addition to it, results suggest that tenant's income profile of the

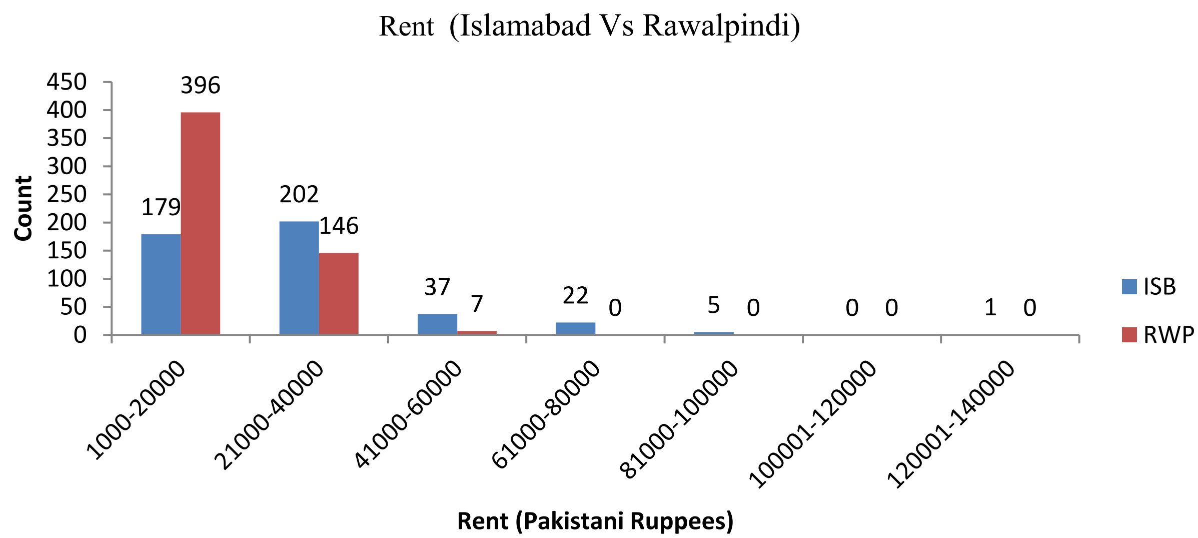


**Fig. 5.** Frequency distribution of House Rent in Rawalpindi and Islamabad.

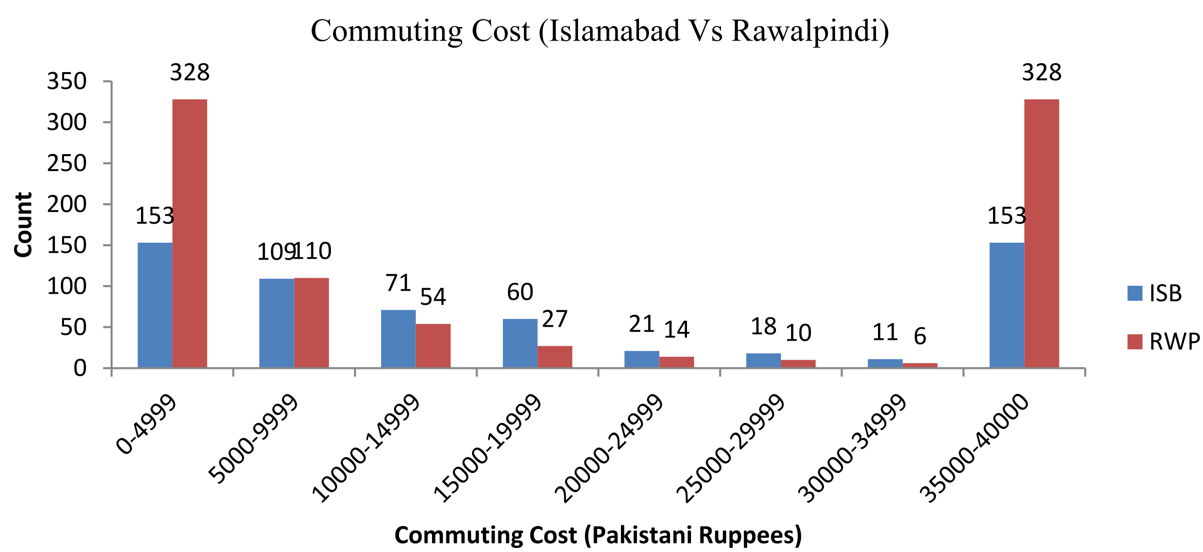


**Fig. 6.** Frequency distribution of commuting cost per person per month in Rawalpindi and Islamabad.

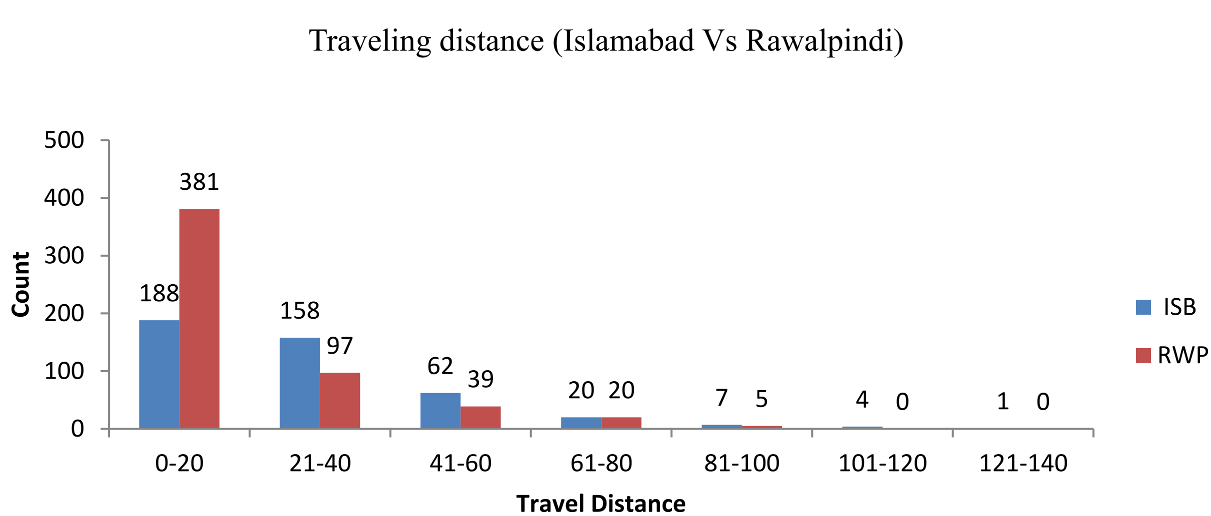


**Fig. 7.** Frequency distribution of Travel distance per person per day in Rawalpindi and Islamabad.

**Table 2**
Sample Selection, and the details of selected clusters.

| Division | Sub Divisions |
|---|---|
| *Islamabad* | |
| Islamabad Div-I | Sector G-6, F-6, G-8 |
| Islamabad Div-II | Sector F-10, I-8, I-9, G-13 |
| Islamabad Div-IIII | Ghori Town, Gulberg, Jinnah Gardens, PWD, Sawan Garden |
| *Rawalpindi* | |
| City Div | Liaqat Bagh, Jabbar Colony, Raja Bazar, Dhok Hasu |
| Cantonment Area | Saddar, Chaklala Scheme III, Adlyala |
| Satrelite Town Div | 6-Road, Satelite Town, Gulzar-e-Quaid, Commerical Market |
| Westrege Div | Dhok Chodrian, Koh-e-Noor |

**Table 3**
Description and Measurement of Variables.

| Variable Name | Unit | Description and Definition of Variable |
|---|---|---|
| Housing Demand | Marla | Housing demand represent the covered area of the house |
| Travel Demand | Kilometer | Travel demand is measured by the average distance travel by household |
| Rent | PKR | Amount paid by tenants in term of accommodation cost per month |
| Commuting cost | PKR | Commuting cost means the average cost of travel of the household on a daily basis |
| Household Income | PKR | The income of household. |
| Household Size | Count | Household size represents the number of people in a household |
| No of Bathrooms | Count | This variable measured by the Number of bathrooms in each HH |
| No. of Cars | Count | This variable measured by the Number of cars used by each HH |
| No. of Bikes | Count | This variable measured by the Number of Bikes used by each HH |
| Dist from Bus stop | Kilometer | It is measured by the distance between the house and from the most used bus stop |
| Modes Availability | Count | Public transport options available in the neighborhood of the locality |
| Dist form School | Meters | Average distance traveled by household children per day to their school |
| Dist from Workplace | Kilometer | Average distance traveled by household per day for work |
| House Age | Count | House age Resprents the number of years of construction of the house |
| Lawn | Binary | It represents the availability of lawn in a house |
| Garrage | Binary | It represents the availability of a garage in a house |
| No. of Bedrooms | Count | This variable measured by the Number of bedrooms in each HH |

tenant's household house characteristics including urban amenities and public transport accessibility influence the derived housing demand. Additionally, economic factors such as the rent are highly significant with the negative sign, as an increase in the house rent will reduce the demand for housing on the location, which resonates with the results of the Scheiner (2018). A similar unexpected negative influence of distance from a bus stop and positive influence of availability of transport modes are also the key decision factors in the choice. In addition to it, results of the derived travel demand of rational tenants based on income profile, number of cars and bikes in their assets, access & availability of public transport and distance to their workplace. Additionally, the significance of the number of bikes that tenants household are having influences more the derived demand as compared to the number of cars, which reveals tenant's level of consciousness towards the costs associated with traveling as they are paying a huge amount for accommodation.

## 5. Discussion and conclusion

This article aims to analyze the comparative statics of the urban residential location theory, which states that there is a trade-off between commuting cost and house rent in a monocentric model employing the urban residential location theory by extending the analysis in Wheaton (1974) and Kwon (2005). A weakness of that analysis was the omission of the important factor of transport accessibility and house characteristics along with urban amenities that was reflected in the house rent, which then affected the commuting cost.

In contrast to the results of that conventional model, the comparative static analysis and GMM analysis on a socioeconomic survey conducted from Rawalpindi and Islamabad provides supportive empirical evidence lead to the number of conclusion and policy implications. First, results suggest that the income profile of a tenant's household, house characteristics including urban amenities approximate and public transport accessibility influence the house rent. Second, Regression results reveal that proximity to urban amenities, the number of working people and the number of school-going children significantly influence the commuting cost of tenant's households. Third, the results highlight that number of motorbikes tenants household having influenced the commuting cost less as compared to the number of cars. Fourth, Physical factors such as distance from the workplace and schools are highly significant with a negative sign, showing that the house rent will be high in the proximity of the workplace and school in a location. Five, tenant's income profile of tenant's household house characteristics including urban amenities and public transport accessibility influence the derived housing demand. Six, economic factors such as the rent are highly significant with the negative sign, as an increase in the house rent will reduce the demand for housing on the location. Seven, A similar unexpected negative influence of distance from a bus stop and positive influence of availability of transport modes are also the key decision factors in the choice. Lastly, the significance of the number of bikes that tenants household are having influences more the derived demand as compared to the number of cars, which reveals tenant's level of consciousness towards the costs associated with traveling as they are paying a huge amount for accommodation.

These findings highlight the important reality that the behavioral foundations for the development of integrated land use and transport decision support systems for Rawalpindi and Islamabad and other cities. Ultimately, empirically grounded planning support systems

**Table 4**
Empirical Evidence.

| GMM Model | | | | |
|---|---|---|---|---|
| Variables | Commuting cost | Rent | Travel Demand | Housing Demand |
| Household Size | 0.0312** | 0.023* | 0.0077** | |
| Household Income | 0.00111* | 0.0279** | 0.0127** | 0.000747** |
| House Size | −0.157*** | 2.327** | 0.0126*** | |
| No. of Bedroom | | 0.3172*** | | 0.107*** |
| House Age | | 0.6101** | | 0.07456* |
| Garage | | | | 1.018** |
| Lawn | 1.225* | | | 0.0591* |
| No. of Bathrooms | | 1.172** | | 1.092** |
| Distance from Bus Stop | 0.115** | 0.694*** | −0.890*** | −0.214*** |
| Distance from Workplace | 0.321*** | −0.0484** | 0.127*** | −0.157*** |
| Distance from Schools | 0.217** | −0.137** | 0.365* | −0.0786* |
| No. of Modes | −2.4386*** | 1.666*** | 0.832** | 0.1478** |
| No of Cars | 1.228*** | | 0.909** | |
| No of Bikes | 0.1333* | | 2.275*** | |
| Commuting Cost | | −0.327* | −0.0296** | −1.088*** |
| Rent | −0.609** | | −0.137** | −0.0303*** |
| Observations | 995 | 995 | 995 | 995 |
| R-Square | 0.771 | 0.817 | 0.743 | 0.729 |
| Standard errors in parentheses | | | | |

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

would provide the basis for inclusive urban development policies that integrate strategies to meeting the housing job needs of the population with wider urban growth and travel demand management strategies aimed at bringing about sustainable development outcomes. Moreover, these findings suggest that tenants and homeowner, different city structure, cannot be treated equally, as one size does not fit for all. These variations were not in the cost for housing and transportation, which creates a problem with the most of transport and housing policies.

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