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Estimating the Population and Employment in Tehran and Suburbs on the Base of Land Use Models

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Abstract

Transportation is an impressionable activity which itself effects on the other activities; therefore, it is one of the main factors in evaluating the requirements and needs of transportation planning. Estimating transportation demand in a region is impressed by social and economical activities in that area and the most important ones among them are population and employment. Population and its destiny in a region are considered as the main factors of transportation-demands Employment can be divided in two categories: Basic employment and non basic one.

The first one is related to external spatial factors and the latter to the internal ones.

Employment causes to make travels for job, services, etc. Regarding the importance of the above mentioned factors in Estimating travel demand, the production and distribution trip models are based on these two variants.

The essay has estimated the population and employment of Tehran and suburbs till 1390 on the base of Garin- Lowry Pattern. Because of its easiness, its strong effective, its casually structure and limited information necessities this model is one of the rare ones which has been accepted in land-use concerns. The results of this pattern, according to the essay, are shown the last table in the way that in the case of changing parameters, and for evaluating the different policies for settling the population and employment, the items and numerals could be changed.

Key words: Transportation Planning, Basic Employment, Non Basic Employment Land-use, Garin- Lowry Pattern.

برآورد جمعیت و اشتغال تهران و حومه براساس مدل‌های کاربری زمین

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چکیده

حمل‌ونقل فعالیتی است تأثیرپذیر و تأثیرگذار بر دیگر فعالیت‌ها؛ و به همین دلیل یکی از عوامل اصلی در برنامه‌ریزی، نیاز سـنجی حمل‌ونقل است. برآورد تقاضای حمل‌ونقل در یک منطقه متأثر از فعالیت‌های اجتماعی ـ اقتصادی آن منطقه است که مهم‌ترین آن‌ها جمعیت و اشتغال است. جمعیت و تراکم آن در یک منطقه از عوامل اصلی تقاضای حمل‌ونقل در منطقه به شمار می‌آیند. اشتغال را می‌توان به دو گونه تقسیم کرد:اشتغال پایه که وابسته به عوامل خارج از منطقه است، و اشتغال غیرپایه که وابسته به عوامل مکانی همان منطقه است.

اشتغال باعث ایجاد سـفرهای کاری، خدماتی و... می‌گردد. با توجه به اهمیت دو عامل پیش گفته در برآورد تقاضای سفر، مدل‌های تولید و توزیع سفر بر اساس این دو متغیر ساخته می‌شوند.

این مقاله به برآورد جمعیت و اشتغال تهران و حومه تا سال ۱۳۹۰ بر اساس مدل گارین ـ لاوری می‌پردازد مدل گارین ـ لاوری به دلیل سـادگی، سـاختار علت و معلولی نیرومند و نیازهای اطلاعاتی محدود، از معدود مدل‌های کاربری زمین است که مقبولیت یافته است. نتایج مدل گارین ـ لاوری در این مقاله بر طبق اطلاعات سال ۱۳۶۵ در جدول انتهای مقاله به گونه‌ای آورده شده است که در صورت تغییر پارامترهای مختلف و برای ارزیابی سیاست‌های مختلف برای جاگیری جمعیت و اشتغال می‌توان آن‌ها را تغییر داد.

کلید واژه‌ها: برنامه‌ریزی حمل‌ونقل، اشتغال پایه، اشتغال غیر پایه، کاربری زمین، مدل گارین ـ لاوری.

1. preface

Transportation is an activity derived from other activities. Therefore, to estimate the transportation demand, it is necessary to know about the social-economical activities in understudy region. Two main factors indicating the social-economical activities are population and employment. In studies of a city's economical bases, employment is divided into two types of basic and non basic. So we can consider the three factors of population, basic and non basic employment as the indicators of type and amount of social-economical activities.

To describe this issue that why population and employment are the indicators of social-economical activities of a region and so are the references of travels in that region, we should know that population is the travel productive and employment is the travel attraction.

Employment from one side causes job travel (which is attracted in the job place) and from the other side service employment cause travels with the "shopping" goal. It is obvious that population existence in a place is equal to travel production in that place.

It is exactly for this reason that production and distribution trip models are constructed based on population and kinds of employment variants. The purpose to prepare land use models is to prepare an implement to reach the population and employment amounts for the future, to the purpose of sustenance the travel demands' models to estimate the future trips volume in the understudy region.

2. Existing models of Estimating the Population and Employment

The existing methods of estimating the urban activities' process, and specially population and employment is reviewed using Mayer and Miller as economic evaluation, Introductory, Imagery and scenario making. In these methods usually total regional employment and population is supposed external and the role of mentioned models is to distribute employment and population between different regions. The amount of total population and employment are estimated through different methods. To estimate the population proportion process, group maintenance, economical base, and 1.5 or 10 years growth rate and to estimate the employment which is harder, out finding, data analysis and expert judgement methods are used.

Economic evaluation model in estimating the population and employment, which its sensible instance is economic evaluation model, includes a set of simultaneous linear questions which shows the change of each areas' population share from the total region's population (for instance, income segregation) and employment of each area from the total region's employment (for instance, income segregation) in

two periods as a function of external variables.

Inventive models of population and employment estimation, which its famous instance is luwry model, do the activity devotion to the space from its special inventive method.

The remarkable specification of imagery models is their dynamic nature and their effort to explain the important events easy and short which happen in the period of time. The effort of these models is to justify the gradual development of an urban region in some time period as the result of reciprocal rivalry effects in the society.

In scenario making method, the probable scenarios for future are made through identifying amounts of these variables.

2.1. choosing the population and employment model

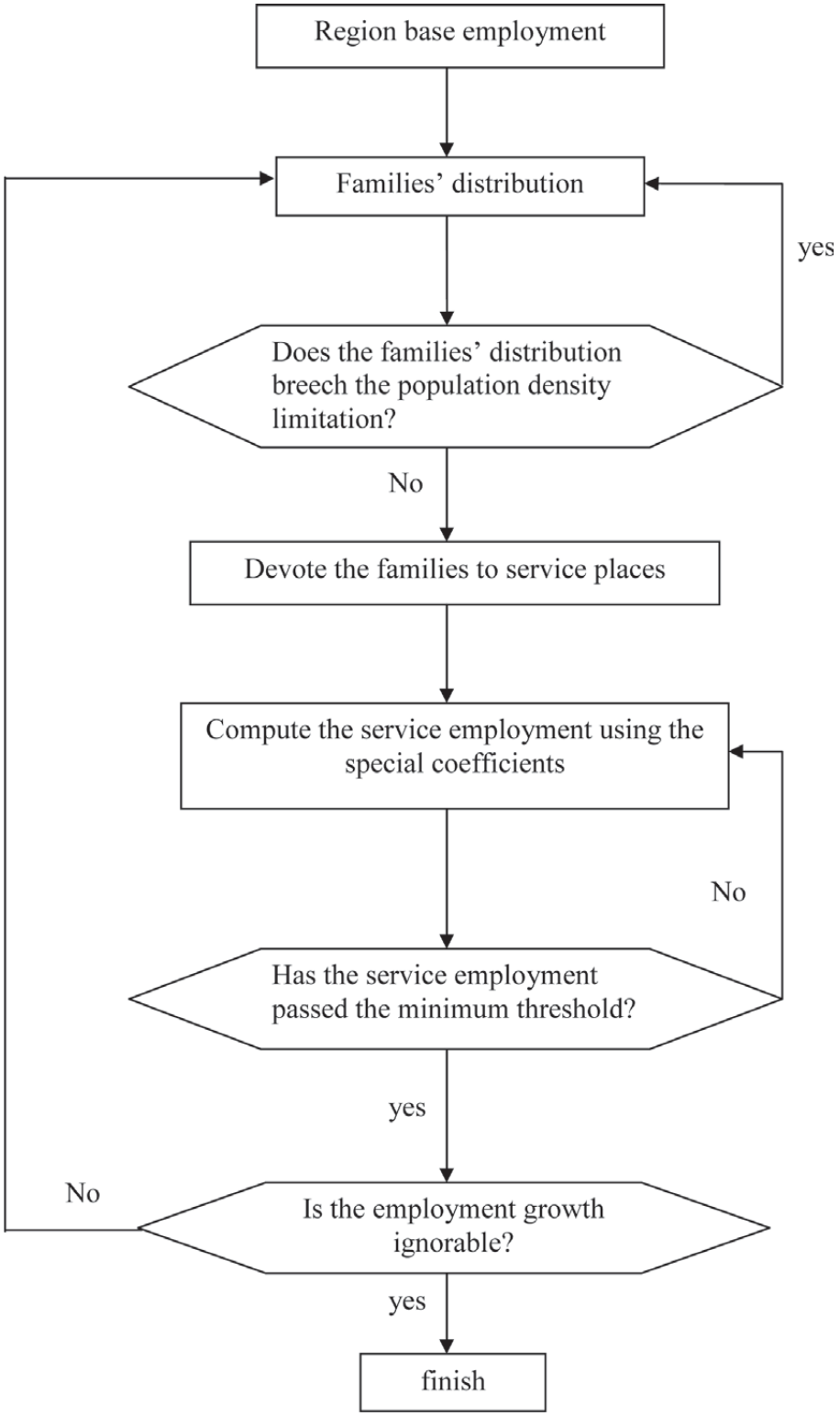
choosing the population and employment model for the understudy limits happens based on the criterion of model simplicity and having a strong theoretical base; in other words the chosen model considering cause and effect relationship in the issue and reciprocal variable effect, should be in a way that necessary information are accessible and estimating the model's parameters paying attention to the existing information should be easy. paying attention to these criterions, the chosen model for understudy limit is a special kind of Lawry model called Garin-Lawry model that beside having high conditions, has shown its efficiency in various studies so far.

3. Garin-Lawry Model

Beginning 1960s Lawry presented a model for a Metropolis.

The main concept of this model is employment division into two categories of base and non base employment, in the way that base employment from the amount and place perspective is depended on the place and its special geography and non base employment from the amount and place perspective is depended on the population. Base employment and its distribution in the region are the models data. Models based on a distribution of work-to-home function devote the employment in employment places to the residential places. Population made of this procedure causes the non base employment to give services to this population, this happens through a distribution of home-to-shop function. This new employment (service) should be settled in a place that causes a new service employment and this procedure continues. This way, model makes a kind of increasing effect in population and employment. Each new employment (base or non base) cause a new non base (service) employment and this continues to reach the balance. Figure 1 shows the Lawry model.

Figure1- symbol of cause and effect in Lawry model



After him the Lawry model attracted a lot of attention from different aspects. It developed and universalized. One of these developments is the model that Garin introduced.

We can summarize the model's frame work like figure 2. The space distribution of base employment level place in understudy region is the model's input and the output is the model of space distribution of employment and population level in the region. As it is obvious in figure 2, the method of Garin-Lawry model is like this: space distribution of base employment in the understudy region which is determined external, will be given to model, first the model finds the residential place of employment level, then based on the available information, calculates the population settled related to the mentioned employment.

Calculating the service requirements of this population is the next step, that based on the distribution of base employment service level and employed population in the understudy region has been calculated, then it is turn to calculate the depended population on this non base employment and its distribution in (various regions) understudy region. New population make new services requirements in understudy regions and the model settles new service employed based on these requirements and then determines the amount and residential place of the population related to them. This procedure continues until the base employment (service) of everyone is prepared and distributed in the region.

This procedure is practically convergent, if not there should be an explosion of population and service employment with a specific level of base employment, and this is what doesn't really happen, therefore the amount of new created population and employment in each above level reduces slowly to the time that this amount of increase becomes very little and in fact a kind of balance between population and base employment will be created. Balance means that the whole created service employment is respondent to the whole residented population.

Garin-Lawry model is one of the few land use models which is accepted widely because of three positive and sensible specifications. These three specifications are:

1. Model simplicity
2. Strong cause and effect structure
3. Determinate information requirements

Therefore, researchers and planners have used all their attempts to redound the mentioned negative points of Garin-Lawry model. It's sign is the development of Garin-Lawry model in different aspects.

Garin-Lawry model's negative points can be summarized as below:

1. It is static and time doesn't have any effect on it.

2. It is not sensitive to the price (land, building and etc.)
3. It doesn't pay attention to the fact that infact population and employment go to special places because of economy existence and distribute employment and population in an unidentified plain.
4. This model has the supposition of a sudden balance in population and employment for a specific base employment with a distinct distribution, when in fact cities from the population and employment point of view are always unbalanced. The cities base employment is increasing (or changing) and therefore we can not find that which part of population and employment increase is related to that of base employments.

Variables

A=Area
C=Confine
P=Population
e=employment
d=distribution trip factor

Subscripts and up scripts :

u=unused land
h=household
b=base
nb=non base
k=kind of non base employment (=1 to m)
i,j=understudy area s (=1 to n)
s,q,g,f,c,b,a=models parameters

Land use:

$$A_j = A_j^u + A_j^b + A_j^{\boldsymbol{b}} + A_j^h$$

Service part:

$$e^k = a^k P$$

$$e_j^k = b^k \left(\sum_{i=1}^{n} \frac{c^k p_i}{d_j^k} + f^k e_j \right)$$

$$ej = e_j^b + \sum_{k=1}^{m} e_j^k$$

$$A_j^{nb} = \sum_{k=1}^{m} g^k e_j^k$$

Household part:

$$p = q \sum_{j=1}^{n} e_j , P_j = s \sum_{i=1}^{n} \frac{e^i}{d_j}$$

Limitations:

For each j and k:

$$e_j^k > C_j^k \;\; or \;\; e_j^k = 0$$

$$P_i < C_j^h A_j^h$$

$$A_j^{nb} < A_j - A_j^u - A_j^b$$

5. It is depended a lot on employment duality (base/non base) and in fact other things except base employment are effective in population settlement and employment placement and their amounts.
6. This model itself requires other models to estimate the people's behavior in choosing the residential or work place or other parameters.
7. This model depends on base and non base employment definition and its recognition and being base/ non base of employment is different based on each occasion.

8. Because cities are always unbalanced, determining the balance information in each special base employment level to glaze the model is difficult.

In the researchers opinion except two first and second negative points, other points are not very important or like the third point. Other models have the similar problem, too or their stratagems in this part can be used in Garin-Lawry model. Therefore, attempts made to reduce the first and second negative points in Garin-Lawry model; for this reason model's "statics" with making it "semi dynamic" and "non sensitivity of it through prices" using the concept of "capacity" or price substitute variable, become inconspicuous.

13.1 . Garin-Lawry model developed from this study

The whole structure of Garin-Lawry model developed from this study is explained below:

The base employment amount and place is determined for the understudy region: People after employment think about their residential places and choose one based on remaining capacity of residential areas and trip "cost" from work place to residential place. Population along employment settles in its related residential place. This population after settlement has service requirements that come up as service request. The base employment determines its place based on related existing capacities in different places in the way that answer these requests then they make service request themselves and require a new non base employment and the above procedure happens again. Figure 2 has shown this procedure simply.

e= employment level (horizontal vector e_i with the size of 1×n, n: area numbers of understudy region)

e^b =base employment level (horizontal vector e_i^b with the size of 1×n, n: area numbers of understudy region)

P=Population residence (horizontal vector p_i with the size of 1×n, n: area numbers of understudy region)

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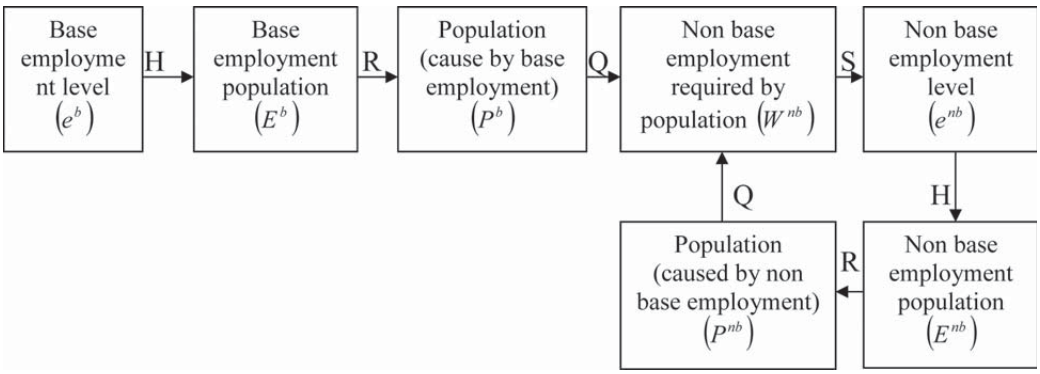
Figure 2- Garin-Lawry model's framework, S,Q,R,H are the converting tools of amounts inside rectangles



H= H_{ij} matrix, a proportion of employment level in i region that settles in j region $\left(\sum H_{ij}=1\right)$

S= S_{ij} matrix, a proportion of employment in i region that work in j region $\left(\sum S_{ij}=1\right)$

Q, R=n×n diagonal matrix that all its numbers are zero except the numbers on the diagonal that in order are R_i and Q_i.

R_i =proportion of population in I region to employed population in there.

Q_i =proportion of non base employment required by population in i region to the population residence in there.

M=HR, N=QS

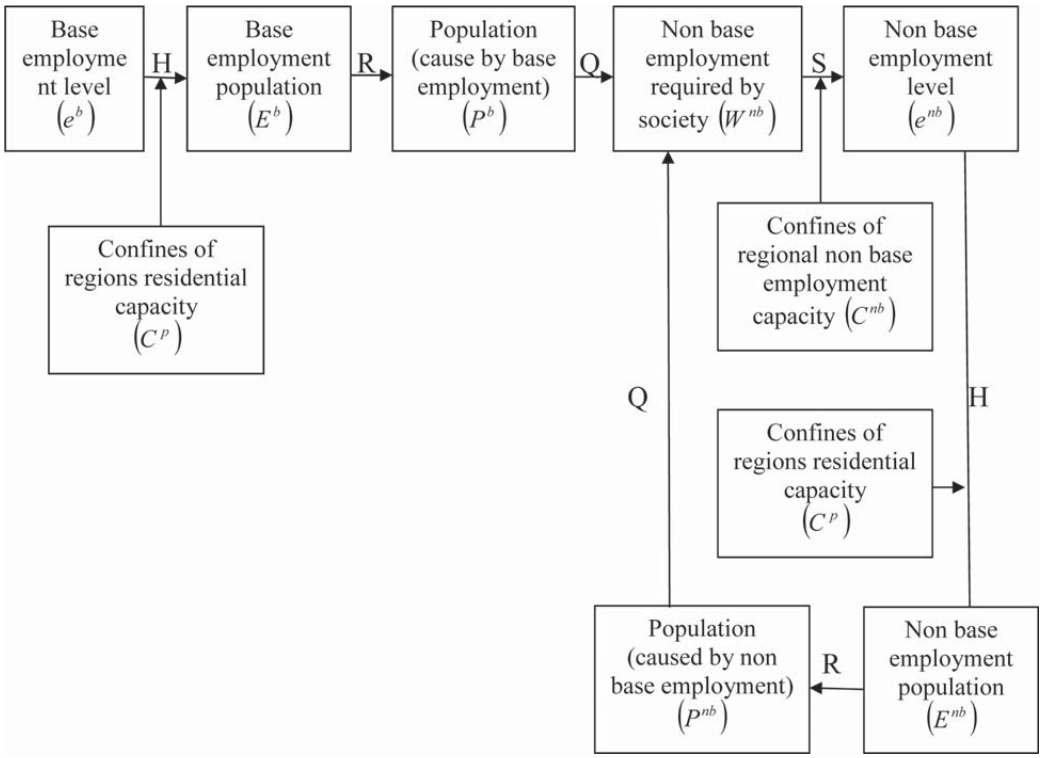
Now if we suppose that choosing residential place function (from work place) and choosing shopping place function (from residential place) in order have their population and employment capacity, the developed model is like this:

$$e = e^b (I - MN)^{-1}$$

$$p = eM$$

In addition to considering the population and non base employment capacities, a process is applied in this model, that migration between areas considers the population based on existing information, and in the model the ability to change the Rand Q parameters is applied. Changing R, for instance its reduction, means that the population's existing unemployment rate reduces in the understudy region, and existing

Figure 3- Garin-Lawry model procedure with limitation of population and non base employment capacities



family members get the new jobs. Changing Q, for instance its increase, means that the existing population need more non base (service) employment, or more varied non base jobs appear to give services to the population.

It is necessary to say that population and employment model is determined through S, Q, R, H parameters, considering what is mentioned before we can suppose the H parameter as a residential place choosing model, from logit model is described as below:

$$H_{ij}^{wh} = \frac{e^{u_{ij}^{wh}}}{\sum_k e^{u_{ij}^{wh}}} \qquad (1)$$

Which in it u_{ij}^{wh} is the j region desirability function as residential place (h) for a worker in the area of work place (w), this function can be described as below:

$$u_{ij}^{wh} = u^{wh} \qquad (2)$$

Glazing the model needs the H_{ij}^{wh} function's information and u_{ij}^{wh} desirability function's variables in the mentioned relationship. Information related to the function in model 1 can be estimated as below:

$$H_{ij}^{wh} = \frac{T_{ij}^{wh}}{\sum_k T_{ij}^{wh}} \qquad (3)$$

That in it T_{ij}^{wh} is the number of visits from work place i to residential place j in a year, in other words, it is supposed that residential probability in j region with the I region's worker is proportionate with the number of trips from a special work place to different residential places in the understudy region. This information is accessible through origin- destination collecting statistics of Tehran's residents and origin-destination of its gates in 1373. So we can glaze model 1 with 2 desirability function using the maximum amount of it. Having this model, one of Garin-Lawry's parameter is accessible.

Parameter R for each region with P_i population and E_i employed population in one year is equal to:

$R_i = P_i$ on E_i

Paying attention to the definition of parameter Q, this parameter changes the population to base employment, so we can make an estimation of Q proportion as below:

$$Q_i = \frac{\sum_{i \in s} e_i^{nb}}{\sum_{i \in s} P_i} \qquad i \varepsilon s \qquad (4)$$

Which in it S is a group of understudy regions, meaning that we can suppose that the required non base employment in that region has been created.

S parameter determines that what percentage of non base employment required by one region is in another region.

If we suppose that population's service requirements (employment) is proportionate to the number of visits, meaning that if we suppose that non base

employment required by population of i region who are employed in j region is proportionate to the number of i Region's population to j region to get the service, then we can estimate the non base employment level of a region caused by the residented population in other regions. Number of one region's visits can measured by the number of resident's trips from i region to j region.

So we can have an estimation of S_{ij} as below:

$$S_{ij} = \frac{T_{ij}^{hs}}{\sum_k T_{ik}^{hs}} = \frac{T_{ij}^{hs,v} + T_{ij}^{hs,w}}{\sum_k \left(T_{ik}^{hs,v} + T_{ik}^{hs,w}\right)} \qquad (5)$$

Which in it, $T_{ij}^{hs,x}$ = service trips' number of i region's population to j region, (x=v, w) and up scrips. Show the two kinds of coming with a car or on foot in these trips. We can glaze the model S using the information gained from understudy residents' colleting statistics, gate colleting statistics and residents and traveler's social economical information.

It is necessary to mention that collecting statistics of understudy internal region's residents in Aban 1373 did not include the trips on foot; because all models of this study are being made based on trips by car, it is obligatory to estimate the on foot trips' volume in planning years. This can be done as below.

It is obvious that the on foot trips' volume proportion done in a region is a function of car personal possession capitation in that region.

$$\frac{T_i^{hs,w}}{T_i^{hs,w}} = a\left(\frac{1}{car_i / p_i}\right)^{\beta} \qquad (6)$$

Which in that $T_{ij}^{hs,x}$ is the trips' volume with the created services in M_i region in the way that (x=w) or by car (x=v). In other words, the more capitation is, the less volume in on foot trips in the region and vise-versa.

$$\frac{T_i^{hs,w}}{T_i^{hs,v}} = a\left(\frac{car_i}{p_i}\right)^{-\beta} \qquad (7)$$

Now we suppose that on foot trips' distribution around their creation place in each region is like below:

$$T_{ij}^{hs,w} = T_i^{hs,w} . f_{ij} \qquad (8)$$

With the supposition of Gama famous distribution, as below for on foot trips' volume around one region that creates it, i:

$$f_{ij} = \gamma d_{ij}^{\delta} e_{ij}^{-\theta d} \qquad (9)$$

Which in it d_{ij} is the distance from i region's centre to j region and if $\sum_k f_{ik} = 1$ concludes that:

$$\gamma = \left(\sum_k d_{ij}^{\delta} e_{ij}^{\theta d}\right)^{-1} \qquad (10)$$

and from that we can write:

$$f_{ij} = \frac{d_{ik}^{\delta} e_{ik}^{-\theta d}}{\sum_k d_{ik}^{\delta} e_{ik}^{-\theta d}} \qquad (11)$$

from the other side it is supposed that : $P_{ij}^{hs,v}$ = probability of car trip from i region to j to get service, so:

$$T_i^{hs,v} = T_i^{hs,v} P_{ij}^{hs,v} \tag{12}$$

Now trip probability from i to j to get service is a function of i origin to j destination's specifications. If trip desirability by car j region and its population is shown by $U_{ij}^{hs,v}$, with supposition of log it choice function to choose trip destination to get service, we can write:

$$P_{ij}^{hs,v} = \frac{e^{u_{ij}^{hs,v}}}{\sum_k e^{u_{ik}^{hs,v}}} \tag{13}$$

So, it's enough to identify the variables of $U_{ij}^{hs,v}$ function, and suppose that:

$$P_{ij}^{hs,v} = \frac{T_{ij}^{hs,v}}{T_{ik}^{hs,v}} \tag{14}$$

And using the origin-destination trips' volume from statistics of 1373 from Tehran's residents and its gates, to determine the right part of 14 formula, and using the information determining $U_{ij}^{hs,v}$ function in this year we can estimate the 13function' parameters.

Model's glaze can be done through maximum tendency method.

Now, placing the 7 and 11 formulas in 8 formula $T_{ij}^{hs,v}$ will be determined, that with 12 formula places in 5 formula, concludes that:

$$S_{ij} = \frac{T_{ij}^{hs}}{T_{ik}^{hs}} = \frac{T_{ij}^{hs,v} + T_{ij}^{hs,ww}}{T_{ik}^{hs,v} + T_{ik}^{hs,w}}$$

$$s_{ij} = \frac{T_{ij}^{hs,v} + \left[a\left(\frac{p_i}{car_i}\right)^{\beta} T_i^{hs,v}\right]\left[\frac{\gamma_{ij}^{\delta} e^{-\theta}}{\sum_k \gamma_{ik}^{\delta} e^{-\theta}}\right]}{\sum_k \left\{T_{ij}^{hs,v} + \left[a\left(\frac{p_i}{car_i}\right)^{\beta}\right] T_i^{hs,v}\left[\frac{\gamma_{ij}^{\delta} e^{-\theta}}{\sum_k \gamma_{ik}^{\delta} e^{-\theta}}\right]\right\}}$$

$$s_{ij} = \frac{P_{ij}^{hs,v} + a\left(\frac{p_i}{car_i}\right)^{\beta}\left[\frac{d_{ij^e}^{\delta^{-\theta d_{ij}}}}{\sum_k d_{ik^e}^{\delta^{-\theta d_{ik}}}}\right]}{\sum_k p_{ik}^{hs,v} + \sum_k a\left(\frac{p_i}{car_i}\right)^{\beta}\left[\frac{d_{ik^e}^{\delta^{-\theta d_{ik}}}}{\sum_k d_{ik^e}^{\delta^{-\theta d_{ik}}}}\right]}$$

$$s_{ij} = \frac{P_{ij}^{hs,v} + a\left(\frac{p_i}{car_i}\right)^{\beta}\left[\frac{d_{ij^e}^{\delta^{-\theta d_{ij}}}}{\sum_k d_{ik^e}^{\delta^{-\theta d_{ik}}}}\right]}{1 + a\left(\frac{p_i}{car_i}\right)^{\beta}}$$

13.2 . Population migration

In the prediscussed population and employment model a function is applied that supposes the known migrations. It is supposed that the aims of these migrations are from central city areas toward the country, this is a phenomenon that happens in most big cities. In central city areas because of more facilities and services, trip attraction has an increasing procedure. So, land price in this area increases, the economical activities and crowd cause a reduction in environmental quality

and make life difficult for people in this area. This propulsion from one side and price increase for trade usage from another side, make it easier for central resident's migration to suitable areas to live, and maybe cheaper in the country, this has increased in Tehran in recent years and still increasing.

If M_i is the migration from i region in a specific year, the total population migrated from different regions (internal regions in understudy region, i) in this year is equal to:

$$M = \sum_{i \in I} M_i \qquad (16)$$

Unfortunately there is no information showing the resident migration between regions in Tehran, therefore in absence of these information it is supposed that population considering the remaining capacities in other regions, go to those regions. In other words, suppose that the extra population of i region because of total migration M, ΔpM_i in the mentioned year equals:

$$\Delta pM_i = M \frac{\Delta P_i . CAP_i}{\sum_{i \in IUO} \Delta P_i . CAP_i} \qquad (17)$$

That in it M according to formula 16 ΔP_i is the new entered population to i region because of base and non base employment increase in the understudy region in mentioned year, and CAP_i is the remaining capacity for population to settle down in i region.

In that formula i is the total internal regions and O is the total country regions. Doing these calculations, the regional employed population because of mentioned migration is corrected. M_i can be calculated as below for the sending population regions (7).

$$M_i^{n-1,n} = P_i^{n-1} r_i^{n-1,n}$$

That in it $M_i^{n-1,n}$ is the amount of in n-1 year when $P_i^{n-1,n}$ population in n-1 time, $r_i^{n-1,n}$ is the (negative) development rate of population in n-1 to n year. P_i^{n-1} is available. There fore, to calculate $M_i^{n-1,n}$ we should have an estimation of two r_i^{n-1}.

Statistic analysis of population growth changes in internal regions of understudy region shows that an increase in region's population (in average) cause a reduction in growth rate changes' limitations. In other words if the mentioned region's population is divided like chart 1 the growth rate changes' limitations of each group's region decreases by the increase of mentioned regions' average population. An analysis from this phenomenon based on regional population observations in 1365 and 1370 years and with supposition of two rates rmax=1.9, rmin= -1.2 is done and these two models are gained:

$$r_{\max}^{n-1,n} = 1.9 + 36.0283 e^{-0.00012314 p^{n-1}} \qquad (18)$$

$$r_{\min}^{n-1,n} = -1.2 - 10.7289 e^{-0.000171777 p^{n-1}}$$

That in it $r_{\max}^{n-1,n}$ is the maximum limit and $r_{\min}^{n-1,n}$ is the minimum limit of population growth rate in the time of n-1 year and P^{n-1} average regional population in year n-1.

To determine a difference between population growth rate in internal regions that have a high remaining population capacity and other regions with a similar population level that do not have this capacity we can explain a population adjustment coefficient:

$$f_i = \frac{kc}{c_i^p}$$

That in it c_i^p is the population capacity of i region, and C is the average population capacity of internal understudy regions and K is model adjustment parameter and k>1, therefore f_i if $i \notin M$ is supposed equal to 1.

we can calculate the adjusted population of i region in n time, P_i^n:

$$\overline{P_i^n} = P_i n(Min\{f_i, 1\} \quad (19)$$

That in it P_i^n is the i regions' population in n time. therefore, using chart 1 population growth rate limit in a year of i region can be calculated in wanted time period in mentioned functions' structure (5 years):

$$r_{\min^{n+1}}(i) = r_{\min}(P_i^n) \quad (20)$$

$$r_{\max^{n+1}}(i) = r_{\max}(P_i^n) \quad (21)$$

If it is supposed that the i regions' population growth rate in next year in period $r_{\min^{n+1}}(i)$, $r_{\max^{n+1}}(i)$ has the same place between the regions grouped with i region, we can calculate an estimation of population growth rate in i region as below:

$$r_i^{n+1} = r^{n+1}\min(i) + g_i.(r^{n+1}\max(i) - r^{n+1}\min(i)) \quad (22)$$

that in it g_i is the population growth rate distance proportion of i region in time O from minimum of this rate for other region in its group, to all the rate changes for population group regions i:

$$g_i \frac{r_i^o - r^o \min^{(i)}}{r^o \max - r^o \min(i)} \quad (23)$$

Now if a region in O time is migrate sender $(r_i^o < O)$ this region till the end of planning period 1390 is migrate sender and growth rate (pure) of migration from there based on formula (229) is estimated that is used by formula 17 to calculate the mentioned pure migration.

In population calculation of this study, we prevent from each year population growth in each region more than maximum rate limit in that region's group, meaning that maximum population of i region in the understudy year equals to:

$$P_i^{n,\max} = P_i^{n-1}(1 + r_{(i)}^{\max}) \quad (24)$$

Row	Population group bottom limit	Population group top limit	Average population in population group	Growth rate limits of regions existing I population group (percentage)		Growth rate limits' estimation of regions existing in population group (percentage)	
				Minimum rate	Maximum rate	Minimum rate	Maximum rate
1	0	3000	1500	-7.3	30.2	-9.49	31.85
2	3000	4000	3500	-11.8	21.9	-7.08	25.31
3	4000	5000	4500	-4.6	21.1	-6.15	22.59
4	5000	6000	5500	-3.9	24.8	-5.37	20.19
5	6000	7000	6500	-59.2	18.3	0	0
6	7000	8000	7500	-3.7	14.3	-4.16	16.20
7	8000	9000	8500	-8.0	18.0	-3.69	14.54
8	9000	1000	9500	-3.5	21.6	-3.30	13.08
9	1000	11000	10500	-3.1	12.5	-2.97	11.78
10	11000	12000	11500	-1.6	11.9	-2.69	10.63
11	12000	13000	12500	-0.9	17.9	-2.45	9.62
12	13000	14000	13500	-1.9	5.9	-2.26	8.73
13	14000	15000	14500	-1.8	3.4	-2.09	7.94
14	15000	16000	15500	-1.4	4.8	-1.95	7.24
15	16000	17000	16500	-3.3	3.2	-1.83	6.62
16	17000	18000	17500	-0.8	2.0	-1.73	6.07
17	18000	19000	18500	-0.5	5.5	-1.65	5.59
18	19000	20000	19500	-0.3	2.3	-1.58	5.16
19	20000	21000	20500	-2.0	4.7	-1.52	4.78
20	21000	22000	21500	-1.8	4.3	-1.47	4.45
21	22000	23000	22500	-0.9	2.0	-1.42	4.15
22	23000	24000	23500	-0.8	2.5	-1.39	3.89
23	24000	25000	24500	-1.1	3.1	-1.36	3.66
24	25000	26000	25500	-0.1	3.0	-1.33	3.46
25	26000	27000	26500	-1.0	-1.0	-1.31	3.28
26	27000	28000	27500	-0.6	10.6	-1.30	3.12
27	28000	29000	28500	-1.3	2.4	-1.28	2.98
28	29000	30000	29500	0.4	1.9	-1.27	2.85
29	30000	31000	30500	-0.3	1.4	-1.26	2.74
30	31000	32000	31500	-1.2	1.3	-1.25	2.64
31	32000	34000	33000	-0.8	1.1	-1.24	2.52
32	34000	35000	34500	-0.8	-0.3	-1.23	2.41
33	35000	36000	35500	-0.5	-0.5	-1.22	2.35
34	36000	37000	36500	-0.5	-0.5	-1.22	2.30
35	37000	42000	39500	-0.2	-0.2	-1.21	2.18
36	42000	44000	43000	-2.1	2.1	-1.21	2.08
37	44000	99999	72000	-1.2	1.9	-1.20	1.91

Chart 2- recognition standards of base/ non base employment

Importance level of standard	Base employment		Non base employment	
	Employment specification	Production specification	Employment specification	Production specification
1	1- depends on place	1-Has a powerful export aspect	1-depends on population	1-used by local population
2	2- basic decisions of activities out of region are made. 3- It has a productive aspect 4- Is known as the vanguard activity of basic activity 5-Has a whole sale aspect to out of region.		2-basic decisions of activities in regions are made.	

And if P_i^n reaches the $P_i^{n,\max}$ level, the model prevents more population for this region, therefore the population growth rate in regions in each year will be restricted in the top level of observed maximum population growth rate.

4. base employment and non base employment

Basic information to use the Garin-Lawry model is the base employment amount and distribution in the area. Non base employment is essential too, to satisfy the service demands of population. Therefore, determining the base and non base employment amount and distribution is one of the issues that we should face to use the Garin-Lawry model. Different researchers have represented different explanations of base employment.

The first definition of base/ non base employment first represented by Lowry himself, he put the base employment in the category of activities which their places are independent from population distribution and shopping malls and their productions are mostly exported. In his opinion the non base employment is a kind of employment which depends on population distribution and shopping malls. In Lowry's opinion making decision about base employment out of understudy region and decisions about

non base employment in the region take place; and the non base employment is proportionate with population.

So, we can consider the base employment a kind of employment which depends on the place and its productions have a powerful exportation aspect. Non base employment can be considered as an employment which depends on population and is the complementary for base employment, but we can not divide the employment into two groups of base and non base for economical-social activities with three standards of depending on place, depending on population or being the productions for export. Chart 2 shows other standards of employment kind determination (base/ non base). Standards of this chart are categorized into two degrees of land 1 and 2 that degree 1 is with more determination and probability. In other words although standards of two degrees are effective in determination of employment kind, but in some cases are not successful in this issue. For retail is a non base employment or however "plumbing" is a service activity for local population, but as a part of "building an apartment" is a base employment. So we can not distinguish the base or non base employment only based on some standards; and it depends on the special case and its conditions.

Population and employment estimation considering the existing cause and affect relation in the issue and the reciprocal variable's effect, should be in a way that information required be accessible and estimation of models' parameters using the existing information should be easy. Other problems exist in the way of employment kind determination. Each job can be base and non base, for instance, production of vegetable or flower; however it can basically be for local population. But in many cases it can have an exportive aspect for the understudy region. So, determination of employees in these kinds of employment that work for local people or exportation, is very hard, and more than that some of these activities may basically be base/ non base. But this activity in understudy region plays a vise versa role.

Paying attention to what mentioned the method of this study in employment division into two categories of base and non base is as below:

First the statistic zones of Iran's centre get connected to the understudy regions, then using a computer program, employed population in Iran's statistic centre regions that were accessible with an activity four digit codes from public population and home census in 1365, employed population with the mentioned four digit codes will be calculated for each understudy region.

Knowing the activity type, now we can easily talk about being base or non base employed population considering the cognition existed upon understudy

region, share of base employment from each four digit codes in activity type determined. Therefore, we can calculate the population base and non base employed in each region of understudy zone.

14.1. Estimating of base employment in future

Estimation of base employment in future happens using three employment levels estimation in three major country activities (agriculture, industry and mining, and service). Estimation major principals are as bellows:

First estimation in beginning in "zone" level the areas around understudy zone (d=1,2,000,D-1) and collection of internal areas as a zone (for instance, internal areas of understudy region) are required. This distribution takes place based on existing information from that zone. To do this, the programmed part makes a list of each employment type based on existing programs, the unprogrammed part of employment level as before or based on other suitable rates distributes in understudy region. The base of employment level estimation is population and home census in 1365; because these information have been the only existing information in the level of this study requirements.

5. Glaze of Garin-Lawry model's parameters

After employment level estimation, in this part the results of Glazing the Garin-Lawry model's parameters will be represented.

5.1. Glaze of work-to-home model

Work-to-home model is a model that says the way we choose residential place based on work place. The aim of this model is to explain that how the employees choose their residential place after choosing their work place. Work-to-home is logit type and as below:

$$P_{ij}^{hs,v} = \frac{e^{u_{ij}^{wh}}}{\sum_k e^{u_{ik}^{wh}}}$$

That in it U_{ij}^{wh} is desirability function of j residential place for i region's employee. Model is made for residents in understudy zone (i=1 to 575). The desirability function in this model is as below:

$$U_{ij}^{wh} = \sum_k b_k f_k\left(X_{ijk}\right)$$

That in it b_k is the desirability function's parameter and X_{ijk} is the variable amount like that for home-work couple (i-j). $f_k\left(X_{ijk}\right)$ can have a synthetic and non linear shape.

Chart 3 shows the desirability function parameter's estimation and shows the explanation and its variables. As we can see in the chart, all the desirability function's parameters are important in statistic's view and with more than 99% probability, we can decline their being zero supposition.

15.2. Estimation of population proportion to regional employed population

As mentioned before population proportion to regional employed population which is shown by R, is one from four main parameters of land use model. This parameter's usage is population estimation caused by employment. This model's parameter is calculated from each region population's P_i division by that region's employed population (E_i) in years of population and home census (for instance, 1365, 1375 years).

Chart 3- desirability function U_{ij}^{hw} parameters' estimation and its variables' explanation. (i=work place and j=residential

Estimation information shows that in previous years this proportion (R) in the country, and in Tehran has changed a lot. It seems like that (R)'s growth in 1365 caused by population increase (numerator) and employment level decrease (denominator). Paying attention to this phenomenon, to estimate regional amounts R means R the following method is used. First,

Row	Variable	Parameter	Statistic t	Variable's explanation
1	$D_{ij}Ind_{ij}$	-0.906010	-58.69	$D_{ij}=1$ if $i=j$, if not 0.
2	$(1-D_{ij})Ind_{ij}$	-0.148389	-15.18	$d_{ij}=$ space distance between I region to j region (kilometer)
3	$Dout_i.Ind_{ij}$	-0.241564	-2.56	$Dout_i=1$ if I is one of the regions around, if not 0.
4	$10^{-3}\cdot D_{ij}.d_{ij}$	-0.435776	28.50	$(*)$
5	$10^{-3}\cdot(1-D_{ij})d_{ij}$	-0.016267	-10.04	$(*)$
6	$D_{ij}In(1+P_j)$	0.875168	201.59	$P_j=i$ region's population (person)
7	$(1-D_{ij})In(1+P_j)$	0.141364	26.47	$(*)$
8	$D_{ij}In(1+e_j)$	0.122025	29.21	$e_j=j$ region's employment level (job)
9	$(1-D_{ij})In(1+e_j)$	0.114361	20.86	$(*)$
10	D_{1j}	0.017409	20.48	J regions' destination to 1 region (city centre) (kilometer)
11	CBD_j	-0.192382	-14.50	$CBD_j=1$ if j is one of the region in business district, if not 0.
12	ACO_i	-0.831533	-17.57	$ACO_i=$ average of percapita car owning in j region
13	$10^{-4}\cdot r_j(850-d_i^p)$	-0.008571	4.74	$r_j=$ average of population growth rate in years 1395-70 (percent) $d_j^p=$ population density in region (person per hectare)

$(*)$ *variable(s) are explained in other places in the chart*

R_n changes in n years for Tehran and its country were considered. In Tehran this 3.52 increased to maximum 4.32 in 1365 and from there to 3.72 in 1390, it is supposed that this proportion for Tehran as minimum seen in recent years (3.52) reach in 1390. For regions around understudy region, R proportion has reached 4.09 in 1375 from 4.52 in 1365. If we suppose the same decrease of 1365 to 1390 in Tehran (4.23-3.62=0.71) for other regions around it. R estimation for around reaches the average (4.52-0.71=3.81). Therefore with supposition of liner changes in R proportion for different regions in understudy region (from 1 to 575) we can estimate the proportion for i region in n year, R_{in} for internal regions (i=1 to 560) R_{in} from 1365 to 1370 decreases liner itself and then from 1370 with following reducer coefficient reaches the amount of 1371 to 1390:

$$f_n = 1 - \frac{n-1375}{15}(4.09-3.81), n = 1379,77,000,90$$

This coefficient multiply in $R.v.$ until we calculate the amount like the other years. For regions around (i=561 to 5750. The proportion amount for i region from 1365 decreases liner as 1375. Then reaches from 1375 with reducer coefficient below to amounts of 1376 to 1390:

$$f_n 1 - \frac{n-1375}{15}(4.09-3.81), n = 1376,77,000,90$$

Minimum level of R_{in} for all regions in all years is supposed 3.0 which is very rare and only has happened in some regions.

5.3. Estimation of required non base employment proportion to regional population.

Parameters of required non base employment proportion to population (Q_i) are explained before. The role of this parameter is to estimate the required non base employment in different regions. In this study this parameter is a true and fixed amount and its component are supposed equal to same amounts in 1365. Q_i for all internal regions in understudy region is calculated 0.133 and for each regions around is calculated based on 1375 population and home census. Regional estimations Q_i for areas around are average 0.111 that around %17 less than that is for total average of Tehran.

5.4. Glaze of home-to-service model

Home-to-service is a model that explains how people receive services through population; this model's aim is to explain how people receive service. Requirements to use this model which in previous parts are shown by $S_{ij} = S$ needs some sub models as below:

- Estimation model of on foot service trips' volume with home

destination

- Distribution model of on foot service trips' volume
- Home-to-service model with Tehran citizens' cars

5.5. Estimation model of on foot service trips' volume with home destination

To estimate on foot trips' volume to get service in future we suppose that different regions' car per capita.

$$\frac{T_i^{hs,w}}{T_i^{hs,v}} = a\left(\frac{car_i}{P_i}\right)^{-\beta}$$

To glaze this model we require on foot trips in a region to get service. From the point that the numerator and denominator of fraction belongs to same region, we can use a generalized type to find this proportion in the region. Volume of on foot and car trips in Tehran is available from 1371 census, with this presupposition that car owning's per capita has not remarkably changed in 1371 and 1373, we can use car owning's per capita information gathered in origin- destination census in Tehran to glaze the model. The glaze result of Tehran is as blow:

$$\frac{T_i^{hs,w}}{T_i^{hs,v}} = o.2954_{(7.5)}\left(\frac{car_i}{P_i}\right)_{17.7}^{-0.8132}$$

That in it, numbers in the parenthesis, are statistical like estimated model's parameters. These statisticals show that parameters are not zero.

Having amount of trips with car to get service in a day in next year (t) from trip production models and with estimation of average car owning per capita in a region from car owning model, we can estimate the produced daily trips in a region to get services in the year (t):

$$T_i^{hs,w}(t) = o.2954\frac{(car_i)}{(P_i)}T_i^{hs,v}(t)$$

Using the model of service on foot trips volume, we can estimate how these trips distribute in understudy region.

As mentioned before, one information source in the field of on foot trips in internal regions of understudy region is Tehran's origin-destination information in 1371. To estimate how on foot trips distribute around one region first the information base of service on foot and car trips from 1371 census was made. In this base origin, destination, trip type (on foot or by car), origin to destination's distance (space) and trip distance of different travelers are recorded.

$$T_i^{hs,w} = yd_{rj}^{\delta}e^{-\theta dri}$$

That in it, d_{ij} is the space distance (kilometer) from r to j. To distribute how people go on foot from origin r (home) to destination j (in group regions in the understudy region) we can glaze the model of Tehran. Model's glaze for Tehran using the mentioned information is calculated as below:

$$T_{ij}^{hs,w} = 2.605 * 10^9 d_{rj}^{8.517} e^{-12.542drj}$$
$$(0.72)\ (7.18)\ \ (-8.98)$$

That in it the numbers in the parenthesis are statistical t like estimated parameters and from the point that the goal is to get one on total valuate observations, and from the point that model's structure for on foot trips is logical, the model despite of y's amount not being important in statistics, This model is accepted. So a model as below is made:

$$f_{ij} = \frac{d_{ij}^{8.517} e^{-12.542 d_{ij}}}{\sum_k d_{ik}^{8.517} e^{-12.542 d_{ik}}}$$

5.6. Model of by car home-to-service trips distribution of Tehran's residents

Tehran's resident's home-to-service model which happens using a car is as below:

$$P_{ij}^{hs,v} = \frac{e^{u_{ij}^{hs,v}}}{\sum e^{u_{ik}^{hs}}}$$

That in it $U_{ij}^{k,v}$ is the desirability function for region's residents and P_{ij}^{k} is the supposed j region's probability to be chosen from i region to get service that Tehran's residents basically get their service from this city and therefore, i and j=1 to 560 (understudy internal regions). One regions desirability for another region's residents based on getting service is a function of many variables that can be divided into three categories: first category is the variables depend on (region) place of receiving the service; second category is the variables depend on (region) residential place of people requiring these services; and the third category is the variables depend on both (region) place of receiving service and residential place mentioned. The form of desirability in this study is $U_{ij}^{hs,v} = \sum k^a k^f k^{(x_k)}$ that in it a^k is desirability function's parameter and X_{ijk} is its variable. These variables' function can have a liner or synthetic shape.

Many researches have been done to identify the determining variable of mentioned desirability function and evaluate their effect on function. Results of these researches have made the variables and parameters as listed in chart 4. After model's glaze all variables in desirability function in surface are more important than 99%, in other words we can deny the supposition of them being zero with more than 99% probability.

Cha(*) variable(s) are explained in other places of chart.

(1) $DR_j = DR_j$, Attraction models $D444_j + [28]$, regions including big parks, religious places and Behesht Zahra .

(2) $DF_j + DB_j = DSH_j$, attraction models $[28]$, main squires and city

cart 4- $U_{ij}^{h,v}$ desirability function's parameters estimation and its variables explanation (i= home region and j=region for getting service)

Row	Variable	Parameter	Statistic t	Parameter's description
1	$Ln(1+e_j^{nb})$	0.137336	29.51	e_j^{nb} =j region's non base employment level
2	CBD_j	-0.098763	-8.22	CBD_j =1 if j is one of the regions in business district, if not 0.
3	ACO_j	1.127710	20.47	ACO_j =j regions car owning percapita average
4	$10^{-3} \cdot STU_j$	0.027255	62.13	STU_j =j regions students' number
5	DR_j	0.345548	25.72	DR_j =1 if j is a region of a special religious or entertaining region, if not0.(1)
6	DSH_j	0.065085	7.61	DSH_j =1 if j is a special shopping region, if not 0. (2)
7	DS_j	0.164947	6.26	DS_j =1 if j is a especial education region, if not 0. (3)
8	DA_j	0.253929	38.29	DA_j =1 if j is a region with daily shopping trips attraction more than 10000 if not 0.
9	$10^{-3} \cdot D_{ij}e_j^{nd}$	0.008636	4.31	D_{ij} =1 if i=j, if not 0.
10	$10^{-3} \cdot ACO_j - ACO_j e_j^{nd}$	-0.093706	-7.90	$(*)$
11	$10^{-3} \cdot d_{ij}$	-0.011784	-7.46	d_{ij} =I region's space distance to region (meter)
12	Lnd_{ij}	-0.513707	-72.17	$(*)$
13	D_{ij}	-0.113494	-7.74	$(*)$
14	$10^{-3} \cdot D_{ij}.d_{ij}$	0.803159	62.74	$(*)$

markets.

(3) $D128_j + DT_j = DS_j$, attraction models [28], Tehran university and polytechnic university.

Comparisons show that model's estimation with 1375 observations, even in regional level has a high compatibility.

6. Base employment estimation in future

Steps of base employment estimation growth rate are as below:

1) Country's all population growth rate estimation in different years (supposed that r_n = Country all population growth rate in n from n-1 to n)

2) Calculation of Iran's population in future years is based on population growth rate which mentioned I step 1 (supposed that P_O is country's population in a year and P_n is country's population at the end of n year) therefore, $P_n = P_O(1+r_n)n$

3) Determining a relationship between country's population and understudy region's population P_n. (supposed that this relationship in the period that we study is like $P_n / P_n = a + \beta n$ linear relationship, that we can calculate P_n having P_n)

4) Sponsorship rate estimation (population to employed population) in n year and R_n, and then understudy region employed population estimation (therefore, if E_n is whole employed population of country, $E_n = P_n / R_n$)

5) Having share of three parts agriculture, industry, mining and services from all employment in year qn^{k_n} (a=k agriculture, i=industry and mining, and s=services) determine the E_n^k employed population in k part from activities in understudy region (therefore, $E_n^k = E_n q_n^k$)

The method mentioned is an estimation of whole employed population divided in three categories of social-economical activities in different years. Having these quantities and with supposition that whole employed population of understudy region work in the same region, we can find $r_{n_k}^k$ an estimation from employment growth rate in three categories of social-economical activities in different time periods in future $n+m$.

$$r_n^k, n+m = \left(E_{n+m}^k / E_n^k\right)^{1/m}$$

7. Non base employment and population capacities

Land use model in this study has the ability to consider the non base employment and populatory capacities. One of the important information in population space distribution estimation is the capacity which is considered for population. Efforts to reach these important political numbers were not effective; first these capacities are not available in this study details level (traffic zones) and second that population determined in Tehran's plan for 1375 - means 7,857, 001person – did not come true. Based on home and population census in 1375, Tehran's population in this year around 6,820,000 people is announced. Therefore, this study did an effort to estimate these capacities to 1390 that

is explained below:

Tehran's population capacities based on 53 zones in this city began. These zones are made based on 20 regions division in a way that is equal as social-economical aspects. To estimate population capacities' estimation considering population average density for regions in each zone equal to average of this amount for related part, and having the surface of residential part of each region, an estimation of average capacity of that zone. If this number is less than the population in 1376, region's population goes in the capacities mentioned for other regions, remaining population capacity in each part will be divided based one land surface suitable in live on in each of them.

In this study, non base employment capacities are not considered because of land use programs and required information which are not in reach are not considered.

Statistic analysis of how population growth differences in internal regions of understudy regions show that population growth of a region (in average) cause a decrease in growth rate.

8. Reliability of employment and population estimation model

Based on what is said a program based on "Gauss" language was written, to make the Garin-Lawry model ready to estimate employment and population distribution in understudy regions in future years until 1390. The first step in this estimation is model's reliability.

Studies in the field of reliability consists of many things that one of the most important one is population estimation in 1370 based on employment and population in 1365 and based employment grow in years 1365-70. Considering the fact that statistic information of Iran's statistics centre gives us only population (and employed population) – and not employment level – it is enough to compare the regions' population estimation in 1370 observing it from Iran centre's census.

We can consider base employment a kind of employment based on place and its productions have a powerful export aspect. Non base employment can be considered an employment based on population and is base employment's supplementary.

9. Regional employment and population estimation in future years

Base employment estimation for future planned years based on Garin-Lawry model made a way to estimate population, employed population on regions and employment level

quantity	year	Internal regions ۵۶۰)-(۱	Regions -around ۵۶۱ ۵۷۵	Whole understudy region	Whole country
Population	۱۳۶۵	۶۰۶۲۹۴۳	۲۰۰۶۵۴۵	۸۰۶۹۴۸۸	۴۹۱۹۳۹۱۲
	۱۳۷۰	۶۵۱۴۳۳۵	۲۷۲۳۳۲۷	۹۲۳۷۶۶۱	۵۵۸۳۷۱۶۲
	۱۳۷۵	۶۹۲۱۳۸۹	۳۳۴۹۶۸۱	۱۰۲۷۱۰۷۰	۶۰۰۵۵۴۸۸
	۱۳۸۰	۷۲۶۹۳۷۱	۳۸۸۴۰۳۳	۱۱۱۵۳۴۰۵	۶۴۶۹۶۸۱۷
	۱۳۸۵	۷۶۲۲۴۴۵	۴۳۹۵۷۵۰	۱۲۰۱۸۱۹۶	۶۹۶۹۶۸۴۶
	۱۳۹۰	۷۹۶۷۵۶۸	۴۸۷۷۴۲۵	۱۲۸۴۴۹۹۳	۷۴۱۶۳۱۷۰
Population average growth rate in a year (percent)	۷۰-۱۳۶۵	۱,۴۴۶۶	۶,۲۹۹۲	۲,۷۴۰۹	۲,۵۷
	۷۵-۱۳۷۰	۱,۲۱۹۶	۴,۲۲۷۱	۲,۱۴۳۵	۱,۴۷
	۸۰-۱۳۷۵	۰,۹۸۵۹	۳,۰۰۴۴	۱,۶۶۱۹	۱,۵۰
	۸۵-۱۳۸۰	۰,۹۵۳۱	۲,۵۰۶۲	۱,۵۰۴۷	۱,۵۰
	۹۰-۱۳۸۵	۰,۸۸۹۶	۲,۱۰۱۴	۱,۳۳۹۵	۱,۲۵

in future years. The base of long term estimations in three mentioned important quantities is the 1365 observations of quantities. Garin-Lowry model's implementation has made results in chart 5.

Results in regional details made population and employment estimations to study transformation studies. These estimations are done based on expected amounts from many parameters that make the discussed model in this study and is the result of studies more than one hundred and thirty different and various conditions. Model is the thing which is important, that in changing of different parameters and for evaluation of different policies from employment and population placement, can make new estimations. It is necessary that required information in different years gathered and keep the model up to date according to existing conditions.

We can estimate the average capacity of a region supposing each region's population density equal to average of this amount for the part and having each region's residential place surface.

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