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Effective Factors on the Growth of Provinces of Iran: A Spatial Panel Approach

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Abstract

In order to have a successful regional planning policy, one needs to know exactly the effective factors on the growth of the provinces. Thus, determining and evaluating these growth rates are important for urban and regional planners. The main goal of this study is to determine the effective factors on the growth (population growth and per capita income growth) of Iran's provinces. In this regard, three groups of factors, economic, social and locational, were considered. The population growth and per capita income growth models were considered via spatial panel for the period of 2007-2015. We have also studied the spatial dependence as well as spatial spillovers between the provinces on regional growth. The results show that there have been meaningful growth spillovers between the provinces of Iran. Therefore, any change in one province, besides having its effect on that province also has spillover effects on neighboring provinces. Also the results show that real per capita income, transportation infrastructure, the index of service specialization, the index of production specialization and the index of competitiveness are the most important factors on the growth of the provinces of Iran.

Keywords: Population Growth, Per Capita Income Growth, Spatial Panel, Spillover Effects.

JEL Classification: C23, R11, R23.

1. Introduction

Population growth and increase in migration over the past decades have raised population density in some Iranian cities and provinces. Uneven growth of population and expansion of large cities and provinces on the one hand, and inequalities in people's level of

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livelihood on the other hand, have brought up problems such as unbalanced concentration of capital, environmental degradation, traffic crisis and many others. Therefore, it is necessary to balance the country's urban system to prevent such problems. Many different factors affect population growth of cities and provinces. Identification of these factors helps policy makers to apply the managerial process to control the regional growth before it is stopped spontaneously as a result of negative outcomes.

The regional population growth is explained through the natural population growth and factors leading to regional migration. Development of an area is a process that directly or indirectly affects all regional systems. Regional growth is a complex system which includes physical, economic, social and environmental dimensions. According to the theoretical foundations of regional growth, a region is a dynamic system which constantly adapts itself to the evolution of society. Regional growth is influenced by factors such as income level, rate of natural population growth, migration flows and changes in people's lifestyles. Population movement cannot be considered separate from the economic development, social changes and society's political situation. In other words, every movement, even on the smallest scale is rooted in society's economic, social and political conditions (Khalili Araghi et al., 2017).

There are several theories on the regional growth and factors involved. Most theories discussed in this area, have introduced economic and location factors as the most important factors affecting urban and regional growth. On the other hand, urban and regional growth process is different in developed and developing countries. One of the most considerable differences is simultaneity of industrialization and regional growth. In developed countries, for instance, the regional growth starts and continues with industrialization, while in developing countries, it is mainly based upon service sector growth, which results in population concentration in the service-oriented cities. Considering the uniqueness of the factors affecting regional growth and lack of focus on finding the effective factors influencing population growth in Iran's provinces, it seems essential to carry out a study in this area.

This study consists of 7 sections including introduction, theoretical foundations of regional growth, literature review, spatial panel econometrics, statistical data and modeling, and model estimation and results. In the end, the summary and conclusion will be presented.

2. Theoretical Foundations of Regional Growth

There are many theories on regional growth and factors affecting it, among which central place theory, cumulative causation theory, growth pole theory, economic base theory, industrial location theory and innovation diffusion theory can be pointed out. These theories explain the most important factors affecting regional growth.

2.1 Central Place Theory

Central place theory which was developed by Christaller and amended by Losch indicates that how spatial patterns of various industries are combined with each other to establish a regional system of cities with a small number of large cities and many small cities (O'Sullivan, 2011). The logic behind formation of cities and regions is mainly that when the production is concentrated in the center of firm's market areas, the population surrounding the area will be centered. Concentration of settlements around the production cores is the starting point of forming the cities and regions.

In fact, central place theory is the extended analysis of market areas. Market area varies by industry and is a function of economies of scale and per capita demand (McCann, 2013). Generally speaking, it can be stated that classical central place theory, despite its limitations, represents a valuable perspective on urban and regional growth.

2.2 Cumulative Causation Theory

Cumulative causation theory was first introduced by Myrdal and then developed by Kaldor, Dixon and Thirwall. The most important point about this model is that regional growth may be exacerbated under certain circumstances and continued and boosted increasingly. Terms of consolidation and sustainability in this Theory include some effects which were called Spread and Backwash effects by Myrdal. Accumulation and concentration of growth illustrated in the cumulative causation theory can be rooted in economies of scale and benefits from the specialization. Kaldor (1975) argued that regional growth can be determined by economies of scale in production and benefits from the specialization of manufacturing activities (Hoover and Giarratani, 1999).

2.3 Growth Pole Theory

The growth pole theory was originally developed by Perroux (1955) and then was further discussed by Hirschman and Hansen. While having a lot of similarities with cumulative causation model, it also offers more details about the mechanism of unbalanced regional growth. According to Perroux (1955), growth does not appear everywhere; it just appears in the poles and then reveals its final effects in the whole economy through interactions. The unbalanced growth and polarization effect in this model begin with several exogenous factors that, according to Perroux, technical progress is the most important one (Hoover and Giarratani, 1999). In general, growth pole theory introduces different factors influencing regional growth, among which agglomeration effect, industrial linkage, leading industries and polarization and trickling down effects can be named (Chung, Hwan - Yong, 1989).

2.4 Economic Base Theory

Economic base theory is one of the oldest theories of regional growth. Many researchers have contributed to this theory, including Hoyt (1939), Alexander (1954), Blumenfeld (1955), North (1955) and Tiebout (1956). In this theory, economic activities are divided into basic activities (based on exports) and non-basic activities. The theory is based on the grounds that the engine and driving force of regional economic growth is the income from the export sector (Chung, Hwan - Yong, 1989). This theory states that the basic activities are the main key to regional growth, as development of this sector will lead to the growth of non-basic sector and thus the entire economy. So, this theory confirms the significant role of export industries, especially manufacturing activities in regional growth.

2.5 Industrial Location Theory

Initially, industrial location analysis was derived from the efforts and viewpoints of Laundhart (1985) which was officially published by

Alfred-Weber in 1909. Industrial location theories, despite their wide variation, can be divided into three main groups: theories based on cost minimization approach, theories based on income maximization and theories based on profit maximization which is in fact the logical result of the first two approaches (McCann, 2013).

Industrial location theory includes the spatial arrangement of economic activities taking into account the geographical distribution of inputs and outputs and geographical variation in prices and costs. In short, what the industrial location theory states is the important role of location factors in urban and regional growth.

2.6 Innovation Diffusion Theory

Innovation diffusion theory dates back to more than a century ago and was initiated by Gabriel Trade. Innovation diffusion is a process where innovation is transferred to the members of a system through specific communication channels and over a period of time. Generally, regional growth can be defined as a set of basic innovations usually occur in the regions. In other words, rapid regional growth is subject to rapid information flow, rapid innovation diffusion, and finally quick adoption of new ideas. On the other hand, innovations are more likely to be adopted in regions with faster growth. So, regional growth is largely depend on the adoption and diffusion of innovations in the regions (McCann, 2013).

With respect to what was stated in this section, factors affecting urban and regional growth can be divided into several categories: economic or non-economic, structural or functional, static or dynamic, and partial or general factors. Existing regional growth theories have mainly focused on economic, structural, static and partial factors. Findings of the theories outlined in this section are summarized in table (1). In the economic aspect, the most important determinants of urban and regional growth are leading industries, industrial structure and basic industries. Location factors considered in existing theories include center place location and neighborhood effects. In short, most theories offered in this area have introduced economic and location factors as the most important factors affecting urban and regional growth.

Table 1: Urban Growth Factors Suggested by Main Regional Theories

Theories	Main Factor
Central Place Theory	**Central place location** **Interactions between core and its hinterland**
Cumulative Causation Theory	**Industrial structure** **Specialization** **Backwash and Spread effects**
Growth Pole Theory	**Leading industries** **Industrial structure** **Agglomeration**
Industrial Location Theory	**Economic factors** **Institutional factors** **Environmental factors**
Economic Base Theory	**Industrial structure** **Basic industries**
Innovation Diffusion Theory	**Innovation adoption** **Innovation diffusion** **Interactions with surrounding areas**

3. Literature Review

Determinants of urban and regional growth are one of the most significant debates in urban and regional economics, as well as, in the literature on economic growth. Most empirical studies in urban and regional growth focus on the experience of developed countries, especially America. Few studies have been performed in developing countries. Some of the most important ones will be mentioned here briefly.

Simon and Nardinelli (2002) examined the relationship between human capital and urban growth in U.S. cities between 1900 and 1990 and found that cities with higher average levels of human capital grew faster throughout the 20th century.

Glaeser and Shapiro (2003) identified three main determinants of growth of American cities in the 1990s: human capital bases, dryness and temperature, and public transportation.

Anderson and Ge (2004) examined the determinants of Chinese city growth. The results indicate that economic reforms played an important role in the city growth in China. Also, the results show that the industrial structure, openness to foreign direct investment, and human capital accumulation has a positive and significant effect on city growth.

Da Mata et al. (2007) investigated the determinants of city growth in Brazil and found out that reduction of intercity costs, increases in market potential for goods and labour force quality and decreases in rural income have significant effects on city growth in Brazil.

Lu (2013) investigated the urban growth of Guangdong province of China during 2000-2010. In this study, the initial size of the city, livelihood conditions, industrial concentration and spatial elements were recognized as the most important factors affecting population growth in this province. The results suggested that leading industries significantly and sustainably affects urban growth. While the impact of livelihood conditions and location on population growth varies from year to year.

Tan et al. (2014) examines the features and spatial determinants of urban growth in the Wuhan urban agglomeration (WUA) from 1988 to 2011. The results show that, all the levels of road network have a considerable effect on the urban growth, while distance to railway and highway do not show obvious effects. In addition, city center has an increasing effect on density, and a decreasing impact on the urban growth.

Zhang and Su (2016) examined urban and regional growth process and factors involved in 30 Chinese provinces during 1993-2012. The results suggest that economic growth, industrial development and industrial restructure are the most important economic factors determining urban growth in China. Further, factors such as population structure, urbanization and energy consumption were introduced as non-economic factors influencing urban growth.

Also, many empirical studies, restrict their attention to determinant factors of income growth in the provinces (Xu and Zou, 2000; Weeks and Yao, 2003; Demurger, 2001; Demurger et al., 2001; Zhang et al., 2001, Zhang, 2001). According to the results obtained from such research, factors like infrastructure, geographic location, human capital accumulation, regional policies and regional investment are the most important factors affecting regional income growth.

In Iran Dehghan Shabani and Shahnazi (2017), and Aghaei et al. (2013), examined the effect of human capital on economic growth of

Iran's provinces. However, no studies have been done about factors affecting population growth of Iran's provinces.

In conclusion, it should be pointed out those most empirical studies on determinants of population growth focus on the experience of developed countries, especially America. Few studies have been performed in developing countries like China. But there are no studies that have examined the determinants of population growth in Iran. Considering the uniqueness of the factors affecting population growth in each country and lack of focus on finding the effective factors influencing population growth in Iran's provinces, it seems essential to carry out a study in this area.

4. Spatial Panel Econometrics

The difference between spatial econometrics and traditional econometrics is the capabilities and application of the former to use the econometrics techniques for those data which have location components. When data has a locational component two problems arise: spatial dependence between observations, and spatial heterogeneity in the relationships we are modeling. Traditional econometrics has ignored these two problems that violate the traditional Gauss-Markov assumptions used in regression modeling.

Spatial dependence means that the observed data in one location, are dependent on observed data in other locations. The term spatial heterogeneity means that as we move from one location to another location, the distribution of sample data does not have constant mean and variance (LeSage and Pace, 2009).

As mentioned by Anselin, Le Gallo, and Jayet (2008), when specifying spatial dependence between observations, a spatial panel data model may incorporate a spatially lagged dependent variable, or the model may contain a spatially autoregressive process in the error term. The first model is known as the spatial lag model (SLM) and the second model is known as the spatial error model (SEM). A third model is the spatial Durbin model (SDM) that contains a spatially lagged dependent variable and spatially lagged independent variables. LeSage and Pace (2009) advocate the use of the spatial Durbin model, since it nests a number of other models as special cases.

The spatial lag model is like autoregressive time series models with the difference that in the time series model, the observations for the past periods are partially explaining the current observations, while in the spatial lag model the observations of neighboring locations explaining the dependent variable as well (Lesage, 1999). The spatial lag model is formulated as:

$$y_{it} = \delta \sum_{j=1}^{N} w_{ij}\, y_{jt} + \phi + x_{it}\beta + v_{it} \qquad (1)$$

Where y_{it} is the dependent variable for unit i, at time t. $\sum_j w_{ij} y_{jt}$ denotes the interaction effect of the dependent variable y_{it} with the dependent variables y_{jt} in neighboring units, where w_{ij} is the i,jth element of a $N \times N$ spatial weights matrix W, describing the arrangement of the spatial units in the sample and δ is called spatial autoregressive coefficient. ϕ is the constant term parameter. x_{it} a $1 \times K$ vector of exogenous variables, and β a matching $K \times 1$ vector of fixed but unknown parameters. v_{it} is an independently and identically distributed (iid) error term for i and t with zero mean and variance σ^2.

In the spatial error model, the error term of unit i, is taken to depend on the error terms of neighboring units j according to the spatial weights matrix W. The spatial error model has the following form:

$$y_{it} = \phi + x_{it}\beta + u_{it}$$
$$u_{it} = \rho \sum_{j=1}^{N} w_{ij}\, u_{jt} + v_{it} \qquad (2)$$

Where ρ is called the spatial autocorrelation coefficient.
The spatial Durbin model extends the spatial lag model with spatially lagged independent variables:

$$y_{it} = \delta \sum_{j=1}^{N} w_{ij}\, y_{jt} + \phi + x_{it}\beta + \sum_{j=1}^{N} w_{ij}\, x_{ijt}\theta + v_{it} \qquad (3)$$

Where θ just as β, represents a $K \times 1$ vector of parameters.

Many empirical studies use point estimates of spatial regression models to test the hypothesis as to whether or not spatial spillovers exist. However, LeSage and Pace(2009) point out that this may lead to incorrect conclusions. In the spatial Durbin model, the direct and indirect effects can be computed from the following relation

$$\begin{bmatrix} \frac{\partial y}{\partial x_{1k}} & \cdot & \frac{\partial y}{\partial x_{Nk}} \end{bmatrix}_t = \begin{bmatrix} \frac{\partial y_1}{\partial x_{1k}} & \cdot & \frac{\partial y_1}{\partial x_{Nk}} \\ \cdot & \cdot & \cdot \\ \frac{\partial y_N}{\partial x_{1k}} & \cdot & \frac{\partial y_N}{\partial x_{Nk}} \end{bmatrix}_t = (I-\delta W)^{-1} \begin{bmatrix} \beta_k & w_{12}\theta_k & \cdot & w_{1N}\theta_k \\ w_{21}\theta_k & \beta_k & : & w_{2N}\theta_k \\ \cdot & \cdot & & \cdot \\ w_{N1}\theta_k & w_{N2}\theta_k & \cdot & \beta_k \end{bmatrix} \quad (4)$$

LeSage and Pace define the direct effect as the average of the diagonal elements of the matrix on the right-hand side of the equation (4), and the indirect effect as the average of either the row sums or the column sums of the off-diagonal elements of this matrix (Elhorst, 2014a: 7-9).

In the spatial lag model, we have $\theta_k = 0$. Although all off-diagonal elements of the second matrix on the right-hand side of the equation (4) become zero as a result, the direct and indirect effects in the spatial lag model can be computed from the following relation:

$$\begin{bmatrix} \frac{\partial y}{\partial x_{1k}} & \cdot & \frac{\partial y}{\partial x_{Nk}} \end{bmatrix}_t = \begin{bmatrix} \frac{\partial y_1}{\partial x_{1k}} & \cdot & \frac{\partial y_1}{\partial x_{Nk}} \\ \cdot & \cdot & \cdot \\ \frac{\partial y_N}{\partial x_{1k}} & \cdot & \frac{\partial y_N}{\partial x_{Nk}} \end{bmatrix}_t = (I-\delta W)^{-1} \begin{bmatrix} \beta_k & 0 & \cdot & 0 \\ 0 & \beta_k & : & 0 \\ \cdot & \cdot & & \cdot \\ 0 & 0 & \cdot & \beta_k \end{bmatrix} \quad (5)$$

5. Statistical Data and Modeling

5.1 Data

The data in this study consisted of characteristics of all the provinces of the country during 2007-2015. The data is extracted from the Statistical Center of Iran. It should be noted that since Tehran is divided into two provinces (Tehran and Alborz) in the middle of the time period studied, data of these two provinces are aggregated into one province.

5.2 Model Representation

Empirical model of factors influencing the growth of provinces on the basis of previous empirical studies and theoretical framework is presented as follows:

$$Y_{i,t} = f(FR, Age, Income, UR, Transport, STRUC, PSI, SPEC, COMP) \quad (6)$$

Two variables, including population growth rate of the provinces (natural logarithm of population ratio in two consecutive years) and provincial income growth rate (natural logarithm of real per capita GDP ratio in two consecutive years) are considered as dependent variables. With regards to the research topic and data available, population and per capita income growth of the provinces are a function of economic and social factors which will be described below. Descriptive statistics of the variables are reported in table (2).

Fertility Rate (FR): This index is obtained through dividing the total number of live-born babies in one year by the average population of women of reproductive age (15 to 49).

Average Age (Age): This index is calculated through averaging individuals' ages in the provinces.

Provincial Income (Income): The measure of income in this study, is the real GDP per capita (in 2011 constant price).

Unemployment Rate (UR): One of the most important economic variables assessed, is the unemployment rate. The provincial annual unemployment rate is used in this study.

Transportation Infrastructure (Transport): Total length of freeway and highway per capita of each province is considered as the representative of transportation infrastructure.

Industrial Structure (STRUC): Just like study of Anderson and Ge (2004), we also used the ratio of value added of industry and mining sector to value added of service sector as an indicator of industrial structure[1].

Production Specialization Index (PSI): We use production data of disaggregate manufacturing industries to investigate the change in the regional specialization in Iran. Hoover's coefficient of specialization is applied as an indicator of production specialization. This coefficient is defined as:

$$H_i = \frac{1}{2}\sum_k \left|\frac{\sum_i E_i^k}{\sum_i \sum_k E_i^k} - \frac{E_i^k}{\sum_k E_i^k}\right| \tag{7}$$

1. It should be noted that another indices of industrial structure like the ratio of the industrial production value to the GDP were also examined, but in this study like the study of Anderson and Ge (2004), the ratio of value added of industry and mining sector to value added of service sector had more explaining power.

Where E_i^k is output (or employment) in manufacturing industry k for region i. It measures the difference between the industry structure of a particular region and the national production structure (Hoover and Giarratani, 1999).

Index of Service Specialization (SPEC): Measure of specialization of a sector in a province is the fraction of the province's employment that this sector represents in that province, relative to the share of the whole sector in national employment:

$$SPEC_i = \left(\frac{SE_i/TE_i}{TSE/TTE}\right) \tag{8}$$

Where SE_i represents the employment in the province i's service sector, TE_i shows total employment in the province i, TSE indicates total employment in the country's service sector and TTE is total employment in the country. The specialization index measures how specialized a province is in service sector relative to the service sector across the country. This variable corrects for situations in which a province-sector is large only because the province is large. High specialization of the service sector in a province could speed up growth of that sector and population in that province (Deliktas et al., 2013).

Competition Index (COMP): Our measure of local competition in an industry in a region is the number of firms per worker in this industry in this region relative to the number of firms per worker in this industry in Iran:

$$COMP_i = \left(\frac{MF_i/ME_i}{TMF/TME}\right) \tag{9}$$

where MF_i shows the number of firms which employ 10 or more workers in the region i's manufacturing industry and ME_i shows the employment in the region i's manufacturing industry while TMF represents the total number of firms in the country's manufacturing industry, and TME indicates the total employment in the country's manufacturing industry (Deliktas et al., 2013). A value greater than one means that manufacturing industry has more firms relative to its size in this region than it does in the whole country. The interpretation of the value greater than one is that the region is more competitive than other regions regarding manufacturing industry.

Table 2: Summary of Statistics of Variables

Variable	Observation	Mean	S.D.	Min	Max
Growth Rate of Population	240	1.2	0.5697	0.2172	3.0961
Growth Rate of Per Capita Income	240	0.0069	9.9563	-54.16	35.632
FR	240	64.201	14.569	42.079	132.92
Age	240	28.458	2.0382	22.106	33.64
Income	240	72.124	46.473	25.635	351.27
UR	240	11.444	2.9301	5.3	20.54
Transport	240	0.1998	0.1935	0.0047	1.1888
STRUC	240	1.0534	1.4408	0.2169	7.6547
PSI	240	0.4339	0.1247	0.1948	0.7848
COMP	240	1.2902	0.5265	0.4065	2.4941
SPEC	240	0.9337	0.1538	0.6513	1.3947

6. Model Estimation and Results

To **test for spatial interaction effects** in a cross-sectional setting, Burridge (1980) and Anselin (1988) developed Lagrange Multiplier (LM) tests. Anselin et al. (1996) also developed robust LM tests. These tests have become very popular in empirical research. Anselin et al. (2006) also specified the classical LM tests for a spatial panel (Elhorst 2014b, pp. 57-58). According to table (3) and results of Moran’s I, LR and LM tests, it is confirmed that there is a spatial dependence in the growth model of Iran's provinces at a significance level of 5%. Besides, according to the LM statistics, among spatial lag and spatial error models the spatial lag model is selected as the most appropriate one.

Table 3: Diagnostic Tests for Spatial Dependence

Test	Population Growth Model	Income Growth Model
Lagrange Multiplier (lag)	5.9356 (0.014)	**68.595** **(0.0000)**
Robust LM (lag)	198.428 (0.0000)	**72.417** **(0.0000)**
Lagrange Multiplier (error)	0.9174 (0.3382)	**52.101** **(0.0000)**
Robust LM (error)	193.41 (0.0000)	**55.923** **(0.0000)**
Moran's I	4.887 (0.0000)	**7.34** **(0.0000)**
LR	6.7778 (0.0092)	**72.567** **(0.0000)**

Note: P-values are in parentheses.

The results of diagnostic tests for spatial model selection are reported in table (4). According to the results, the spatial Durbin model is rejected in favor of both the spatial lag and spatial error models, at a significance level of 5%. Since the results of Lagrange multiplier tests also confirm the superiority of spatial lag model over the spatial error model, thus the spatial lag model is selected as the most appropriate model and applied in further analysis[1].

The fixed effect and random effect estimators are used as traditional estimators in panel models. Both of these estimators have some flaws and shortcomings. In case that the number of individuals is high, a fixed effect estimator will be less efficient. Further, it is not possible to estimate time invariant variable through the fixed effect method. On the other hand, if the assumption of independence of regressors and individual effects is rejected, the random effect estimator will not be consistent. Therefore, in this study, we use

1. For more details about spatial model selection see Elhorst (2014a).

Within-Between estimator which is in fact a variant of the specification proposed by Mundlak (1978).

The specification derived from Mundlak's 1978 Econometrica paper is as follows:

$$y_{ij} = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + \beta_3 \bar{x}_j + \varepsilon_{ij} \quad (10)$$

Where x_{ij} is a (series of) time-variant variables, $\bar{x}_j$ is the entity j's mean and z_j is a (series of) variables with little within-group variation. β_1 is an estimate of the within effect (as the between effect is controlled by $\bar{x}_j$); β_3 is the contextual effect that explicitly models the difference between the within and between effects. Alternatively, this can be rearranged by writing β_3 explicitly as this difference:

$$y_{ij} = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + (\beta_4 - \beta_1)\bar{x}_j + \varepsilon_{ij} \quad (11)$$

This rearranges to:

$$y_{ij} = \beta_0 + \beta_1 (x_{ij} - \bar{x}_j) + \beta_2 z_j + \beta_4 \bar{x}_j + \varepsilon_{ij} \quad (12)$$

This formulation is known as the Within-Between (W-B) specification. Now β_1 is the within effect and β_4 is the between effect of x_{ij}. Also β_2 represents the effect of time-invariant variable z_j, and is therefore in itself a between effect (Bartels 2008; Leyland 2010).

This Within-Between (W-B) formulation has three main advantages over Mundlak's original formulation. First, with temporal data it is more interpretable, as the within and between effects are clearly separated (Snijders and Bosker 2012, 58). Second, in the first formulation, there is correlation between x_{ij} and $\bar{x}_j$; by group mean centering x_{ij}, this collinearity is lost, leading to more stable, precise estimates. Finally, if multicollinearity exists between multiple $\bar{x}_j s$ and other time-invariant variables, $\bar{x}_j s$ can be removed without the risk of heterogeneity bias returning to the occasion-level variables (Bell and Jones 2015: 9-10).

W-B approach is in fact a way to combine the fixed and random effects approaches to obtain some of the virtues of both methods. That's why W-B approach excels both fixed and random effects estimators (Bell and Jones, 2015).

According to the above-mentioned discussion, and considering the fact that many variables in this study have very small within-group variances, W-B is the most appropriate method to estimate the model of this study. It should be noted that, like most studies, the minimum percentage of total variance due to within-group variation is considered 10%.

Table 4: Tests for Spatial Model Selection

Test	Null Hypothesis	Population Growth Model	Income Growth Model
Wald test for spatial lag	=0θ	17.56 (0.129)	**14.93** **(0.246)**
LR test for spatial lag	=0θ	17.52 (0.131)	**14.712** **(0.258)**
Wald test for spatial error	+θ =0βδ	20.55 (0.057)	**20.10** **(0.065)**
LR test for spatial error	+θ =0βδ	20.98 (0.051)	**19.363** **(0.08)**

Note: P-values are in parentheses.

It should be noted that in spatial econometric models, there are different techniques for quantifying the location and forming the spatial weights matrix. Studies dealing with geographical units often adopt a binary contiguity matrix with elements $w_{ij} = 1$ if two units share a common border and zero otherwise or an inverse distance matrix. In this study the inverse distance matrix have been used. In this technique the distance of each point in space is measured with respect to constant or central observations. The threshold distance is chosen in such a way that each observation has at least one neighbor[1].

1. An inverse distance matrix is preferable in most cases because the connectivity between nearby units will be stronger than those further away, this is related to the well-known first law of geography: “Everything is related to everything else, but near things are more related than distant things” (Elhorst and Vega, 2013: 11-12).

In this study, the spatial weights matrix (W) has been calculated for 30 provinces. This matrix is standardized for its rows, that is, the sum of each row is equal to one. With this transformation, the multiplication of the spatial weights matrix with dependent vector, we get a vector, which its elements are the mean of observations in the neighboring areas.

The results of estimation of both population growth and income growth models are shown in table (5). According to the table (5), spatial autoregressive coefficient, which shows the effect of growth in neighboring provinces on the growth of a province, is negative in population growth model and positive in income growth model, and both coefficients are statistically significant, which confirms the existence of spatial dependence in both models. Negative spatial dependence in population growth model shows that when the population growth rate is increased in neighboring provinces of province i, this province (province i) will experience a decline in its population growth rate. The reason is that increased population growth of the provinces, usually happens after improvement of living conditions (economically, socially, etc.) of that provinces and thus can lead to migration of neighboring province's residents to these provinces. This naturally reduces the population growth of that adjacent province.

In addition, positive spatial dependence in income growth model, shows that when income growth rate of neighboring provinces of province i is raised, the rate of income growth will be also increased in province i. This is because a provincial income growth could increase demand for goods and domestic savings. More demands are also leading to higher goods imports, which, as explained in the export base theory of growth, will increase the income of exporting provinces. On the other hand, according to Harrod-Domar model, with domestic savings raised, the neighboring areas will benefit from the advantages of access to more capital. Therefore, income growth in a region can increase per capita income in the adjacent regions and this happens through commercial communications and capital mobility.

The estimated coefficients in table (5) are used to calculate direct and indirect (spillover) effects of all explanatory variables on the dependent variable. The results are reported in tables (6) and (7). It should be noted that coefficients stated in table (5) have no particular meaning on their own. According to tables (6) and (7), each explanatory variable has a direct, an indirect and a total effect on the dependent variable. The Direct effect of each variable on population (income) growth specifies that if that variable, is changed in the province i, to what extent it will affect the population (income) growth of province i on average. Indirect (spillover) effect indicates that if each variable changes in the province, what impact on average it will have on the population (income) growth of other provinces. This shows the spatial spillover effects of that variable on population (income) growth of other provinces. The total effect of each variable on the population (income) growth suggests that if this variable changes in the province i, what impact on average it will have on the population (income) growth of all provinces (including province i). According to tables (6) and (7), among social variables, the fertility rate has a significant and positive effect in the population growth model, however, as expected, it has no significant effect in the income growth model. Also, the average age has a very weak significant effect in both models.

Table 5: Determinants of Provincial Growth

	Population Growth		**Income Growth**	
	Coefficient	**t-Statistic**	**Coefficient**	**t-Statistic**
FR	0.02 ***	6.63	-0.0133	-0.2
Age	-0.018	-1.21	0.7217	1.53
mean_ Income	0.011 ***	4.84	-0.1237 ***	-2.7
difIncome	0.0004	0.33	0.1223 ***	3.15
mean_UR	-0.092 ***	-3.26	-0.024	-0.09
difUR	-0.0002	-0.03	0.1363	0.45
mean_Transport	0.747 **	1.98	8.552 ***	2.63
difTransport	0.009	0.04	-10.21	-1.29
STRUC	-0.26 ***	-5.23	1.818	1.36
PSI	0.552 **	2.02	13.788 ***	2.74

	Population Growth		Income Growth	
	Coefficient	**t-Statistic**	**Coefficient**	**t-Statistic**
COMP	0.123 *	1.77	-3.568 ***	-3.23
SPEC	1.034 ***	3.81	11.785 **	2.54
CONSTANT	-0.317	-0.5	-26.6	-1.48
Rho (Spatial)	-0.185 **	-1.9	0.4917 ***	8.08
R^2 **-between**	0.62		0.8	
R^2 **- within**	0.439		0.16	
R^2 **-overall**	0.59		0.24	
Log-likelihood	26.0287		-837.6593	

Note: *, ** and *** represent significance at the 10%, 5%, and 1%, levels respectively.

Table 6: Direct, Indirect and Total effects of independent variables on provincial Population Growth

Variable	Direct Effect	Indirect Effect	Total Effect
FR	0.021 *** (7.02)	-0.003 * (-1.9)	0.018 *** (6.28)
Age	-0.018 (-1.25)	0.003 (0.99)	-0.015 (-1.23)
mean_Income	0.011 *** (4/74)	-0.002 * (-1/78)	0.009 *** (4/46)
difIncome	0.0004 (0.33)	-0.0001 (-0.26)	0.0003 (0.33)
mean_UR	-0.092 *** (-3.33)	0.015 * (1.69)	-0.078 *** (-3.33)
difUR	0.0003 (0.04)	-0.0001 (-0.1)	0.0001 (0.02)
mean_Transport	0.75 ** (2.00)	-0.119 (-1.3)	0.632 ** (2.00)
difTransport	0.012 (0.06)	-0.005 (-0.14)	0.007 (0.04)

Variable	Direct Effect	Indirect Effect	Total Effect
STRUC	-0.26 *** (-5.08)	0.041 * (1.82)	-0.221 *** (-4.61)
PSI	0.539 ** (2.08)	-0.082 (-1.41)	0.11 * (1.92)
COMP	0.132 * (1.9)	-0.021 (-1.24)	-0.221 ** (2.13)
SPEC	1/036 *** (3.65)	-0.163 * (-1.7)	0.873 *** (3.56)

Note: t-values are in parentheses. *, ** and *** represent significance at the 10%, 5%, and 1%, levels respectively.

Table 7: Direct, Indirect and Total Effects of Independent Variables on Provincial Income Growth

Variable	Direct Effect	Indirect Effect	Total Effect
FR	-0.007 (-0.1)	-0.006 (-0.1)	-0.0134 (-0.1)
Age	0.807 (1.58)	0.698 (1.42)	1.505 (1.53)
mean_Income	-0.1308 *** (-2.6)	-0.113 ** (-2.19)	-0.244 ** (-2.5)
difIncome	0.1307 *** (3.22)	0.114 ** (2.49)	0.245 *** (2.98)
mean_UR	-0.017 (-0.06)	-0.0097 (-0.04)	-0.0268 (-0.05)
difUR	0.16 (0.49)	0.1326 (0.45)	0.2926 (0.48)
mean_Transport	9.156 *** (2.66)	7.996 ** (2.17)	17/152 ** (2.5)
difTransport	-10.837 (-1.24)	-9.358 (-1.18)	-20.196 (-1.23)
STRUC	1.933 (1.29)	1.656 (1.21)	3.59 (1.27)
PSI	14.504 *** (3.00)	12.719 ** (2.27)	27.224 *** (2.73)
COMP	-3.723 *** (-3.18)	-3.255 ** (-2.4)	-6.978 *** (-2.91)
SPEC	12.544 **	10.912 **	23.457 **

Variable	Direct Effect	Indirect Effect	Total Effect
	(2.48)	(2.05)	(2.35)

Note: t-values are in parentheses. *, ** and *** represent significance at the 10%, 5%, and 1%, levels respectively.

The variable group-mean of income, has a direct significant positive effect on population growth, while spillover effect of this variable is negative and significant. However, the group mean deviation of income has no significant effect on population growth. This means that provinces with a higher per capita income, will have a greater population growth rate. In addition, we can see a decline in the population growth rate of adjacent provinces as their residents migrate to that specific province with higher per capita income.

In the income growth model, however, we can see that group-mean of per capita income has a significant negative direct and indirect effects, and group mean deviation of per capita income, has a significant positive direct and indirect effects on income growth. This means that the rate of per capita income growth is lower in provinces with higher per capita income. However, as per capita income rises in a province, its growth rate also increases. In other words, provinces with lower per capita income will have higher per capita income growth rate, but as soon as they become a leading economy their growth rate will decline. This in fact refers to conditional convergence, which is derived from Solow-Swan growth model. Thus, it can be concluded that the results obtained, confirm the conditional convergence between provinces of the country.

Another important economic variable is the unemployment rate. As results suggest, group-mean of unemployment rate has a direct significant negative effect while spillover effect of this variable is positive and significant in the population growth model. However, the group mean deviation of unemployment has no significant effect on population growth rate. This means that provinces with lower unemployment rate will have a higher population growth rate. Also, we can see a decline in the population growth of adjacent provinces as their residents migrate to the province with lower unemployment rate. As seen in the income growth model, the group-mean of unemployment and group mean deviation of unemployment have the expected effects, though they have no significant effects on the income growth rate.

The variable of roads (total freeways and highways per capita) is also included in the model as a representative of transportation infrastructure. As displayed in tables (6) and (7), group-mean of transportation is significant and positive in both population growth and per capita income growth models. However, the group mean deviation of transport is not significant in any of these models. According to the results and as expected, provinces with more roads will experience higher population and income growth rates.

Industrial structure variable in the population growth model has a significant negative direct effect and a significant positive spillover effect on the dependent variable. However, in the income growth model, industrial structure has very weak significant direct and indirect effects. This highlights that the service-oriented provinces have a higher population growth than the manufacturing provinces. This is what we have expected, because unlike developed countries whose growth starts and continues with industrialization, regional growth in developing countries is largely based on the growth of the services sector. Hence, service-oriented provinces attract more people to their side. Also, the index of service specialization has a significant and positive effect in both models, that is, provinces that encompass a larger share of employment in the services sector (specialized in this sector) have higher population and income growth rates. This confirms the centrality and importance of the service sector in the growth of the Iranian provinces.

According to the results, production specialization index has a positive and significant impact on the dependent variable in both models. This means that the more different the production structure of a province is from the national production structure (more specialized), the higher its population and income growth rates are. Furthermore, the competition index has a significant positive direct effect and a significant negative spillover effect in the population growth model. However, this index has the significant negative direct and indirect effects on income growth. This implies that the more firms the province has, relative to its size (more competitive), the higher population growth and lower income growth it will have. In other words, provinces with competitive structure attract more people to their side, but provincial income growth is higher under monopolistic conditions.

7. Summary and Conclusion

The successful implementation of regional and land use planning policies requires a detailed understanding of the factors affecting the growth of the country's provinces. Therefore, it is of great importance to urban planners and decision makers to explain and estimate population and income growth of the provinces. Considering the uniqueness of the factors affecting regional growth and lack of focus on finding the effective factors influencing population and per capita income growth in Iranian provinces in previous studies, it seems essential to carry out a study in this area. The main objective of the present study is to determine the factors affecting growth (population and income) of Iran's provinces.

As mentioned before, there are several theories on regional growth and factors involved. Most prominent theories proposed in this field have introduced economic and location factors as the most important factors affecting urban and regional growth. Thus, three economic, social and location factors were considered in this study. Lagrange multiplier tests were used to test the spatial effects. The results indicated the existence of spatial dependence in provincial growth models. Also, according to Lagrange multiplier test statistics and LM and Wald diagnostic tests, the spatial lag model was selected and evaluated as the most appropriate spatial regression model.

The results of the estimation of provincial growth models show that the spatial autoregressive coefficient is significant in both population and income growth models, which confirms the existence of spatial dependence in both models. Among the social variables, the fertility rate and among the economic variables, real per capita income, unemployment rate, transport infrastructure, industrial structure, index of service specialization, production specialization index and competition index are identified as the important factors affecting population growth of Iran's provinces. Also, according to the results, the most important factors affecting provinces' per capita income growth are, real per capita income, transport infrastructure, production specialization index, competition index and index of service specialization.

With regards to the results of this study, it is recommended that sustainable development plans be based on proportional distribution of employment centers among cities and provinces, in order to have an optimal distribution of population in the country and prevent irregular migration to large cities. Reducing unemployment rate, with attention to the potentials of the service sector and expansion of transport network can cause people to migrate to sparsely populated cities and decentralization of large cities and provinces. The most important consequences of implementing such policy are avoiding single polarization of the country, preventing irregular migration to specific centers, and avoiding traffic and environmental crisis and many others. In this regard, it seems essential to pay more attention to the matter of unemployment and potentials of the service sector in particular.

References

Aghaei, M., Rezagholizadeh, M., & Bagheri, F. (2013). The Effect of Human Capital on Economic Growth: The Case of Iran’s Provinces. *Quarterly Journal of Research and Planning in Higher Education*, *19*(1), 21–44.

Aghion, P., & Durlauf, S. N. (2014). *Handbook of Economic Growth*. New York: Elsevier.

Anderson, G., & Ge, Y. (2004). Do Economic Reforms Accelerate Urban Growth? The Case of China. *Urban Studies*, *41*(11), 2197–2210.

Anselin, L. (2005). *Exploring Spatial Data with GeoDa: A Workbook*. Retrieved from https://www.geoda.uiuc.edu/documentation.php#manuals.

Anselin, L., Le Gallo, J., & Jayet, H. (2008). Spatial Panel Econometrics. In: Matyas, L. & Sevestre, P. (Ed.). *The Econometrics of Panel Data, Fundamentals and Recent Developments in Theory and Practice* (3rd Ed, 627–662). Berlin-Heidelberg: Springer-Verlag

Chung, H. Y. (1989). *Urban Growth Determinants in Korea: with Special Reference to the Three Regional Metropolitan Cities*. (Doctoral Dissertation, Sheffield University, UK). Retrieved from http://etheses.whiterose.ac.uk/6070/1/419643.pdf.

Da Mata, D., Deichmann, U., Henderson, J. V., Lall, S. V. & Wang, H. G. (2007). Determinants of City Growth in Brazil. *Journal of Urban Economics*, *62*(2), 252–272.

Dehghan Shabani, Z., & Shahnazi, R. (2017). Analysis of Inter-Province Spatial Spillover Effects of Human Capital on Economic Growth in Iran. *Journal of Economic Research*, *52*(1), 89–115.

Delfmann, H., Koster, S., McCann, P. & Van Dijk, J. (2014). Population Change and New Firm Formation in Urban and Rural Regions. *Regional Studies*, *48*(6), 1034–1050.

Deliktas, E., Özlem Önder, A., & Karadag, M. (2013). The Size Distribution of Cities and Determinants of City Growth in Turkey. *European Planning Studies*, *21*(2), 251–263.

Demurger, S. (2001). Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China. *Journal of Comparative Economics*, *29*, 95–117.

Demurger, S., Sachs, J. D., Woo, W.T., Bao, S., Chang, G., & Mellinger, A. (2002). Geography, Economic Policy, and Regional Development in China. *Asian Economic Papers*, *1*(1), 146–197.

Elhorst, J. P., & Vega, S. H. (2013). On Spatial Econometric Models, Spillover Effects. and W. *ERSA Conference Papers*, Retrieved from http://wwwsre.wu.ac.at/ersa/ersaconfs/ersa13/ERSA2013_paper_00222.pdf.

--------- (2014a). Matlab Software for Spatial Panels. *International Regional Science Review*, *37*(3), 389–405.

Elhorst, J. P. (2014b). *Spatial Econometrics: From Cross-Sectional Data to Spatial Panel.* Berlin-Heidelberg: Springer-Verlag.

Glaeser, E. L., & Shapiro, J. M. (2003). Urban Growth in the 1990s: is City Living Back. *Journal of Regional Science, 43*, 139–165.

Henderson, J. V., & GunWang, H. (2007). Urbanization and City Growth: The Role of Institutions. *Regional Science and Urban Economics*, *37,* 283–313.

Hoover, E., & Giarratani, F. (1999). *An Introduction to Regional Economics* (3rd Ed.). Virginia: Regional Research Institute.

Khalili Araghi, M., Nobahar E., & Kabiri Renani, M. (2017). Determinants of Population Growth of the Cities of Iran: A Spatial Econometrics Approach. *Quarterly Journal of Economic Research and Policies*, *25*(83), 7–32.

LeSage, J. P., & Pace, R. K. (2009). *Introduction to Spatial Econometrics*. Boca Raton, FL: CRC Press Taylor & Francis Group.

Leyland, A. H. (2010). No Quick Fix: Understanding the Difference between Fixed and Random Effect Models. *Journal of Epidemiology and Community Health, 64*(12), 1027–1028.

Lu, C., Wu, Y., Shen, Q., & Wang, H. (2013). Driving Force of Urban Growth and Regional Planning: A Case Study of China's Guangdong Province. *Habitat International*, *40*, 35–41.

McCann, P. (2013). *Modern Urban and Regional Economics* (2nd Ed.). Oxford: Oxford University Press.

Mehrara, M., & Mohammadian Nikpey, E. (2015). Economic Investigation of the Crime and It's Inter-Provincial Spillover Effects in Iran: A Spatial Panel Approach. *Economic Modelling*, *9*(29), 43–62.

Meliciani, V., & Savona, M. (2015). The Determinants of Regional Specialization in Business Services: Agglomeration Economies, Vertical Linkages and Innovation. *Journal of Economic Geography, 15*, 387–416.

O'Sullivan, A. (2011). *Urban Economics* (8th Ed.). New York: McGraw Hill.

Pred, A. R. (1977). *City-Systems in Advanced Economics*. London: Hutchinson.

Rogers, E. M. (1995). *Diffusion of Innovations*. New York: Free Press.

Simon, C. J., & Nardinelli, C. (2002). Human Capital and the Rise of American Cities, 1900–1990. *Regional Science and Urban Economics, 32,* 59–96.

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modelling* (2nd Ed.). London: Sage Publications Ltd.

Tan, R., Liu, Y., Liu, Y., He, Q., Ming, L., & Tang, S. (2014). Urban Growth and its Determinants across the Wuhan Urban Agglomeration, Central China. *Habitat International, 44*, 268–281.

Weeks, M., & Yao, Y. (2003). Provincial Conditional Income Convergence in China, 1953–1997: A Panel Data Approach. *Econometric Reviews*, *22*(1), 59–77.

Xu, L. C., & Zou, H. (2000). Explaining the Change of Income Distribution in China. *China Economic Review*, *11*, 149–170.

Zhang, Z., Liu, A., & Yao, S. (2001). Convergence of China's Regional Incomes. *China Economic Review*, *12*, 243–258.

Zhang, W. (2001). Rethinking Regional Disparity in China. *Economics of Planning*, *34*, 113–138.

Zhang, Q., & Su, S. (2016). Determinants of Urban Expansion and their Relative Importance: A Comparative Analysis of 30 Major Metropolitans in China. *Habitat International*, *58,* 89–107.