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Analysis of the Effect of Regional Creativity on Regional Economic Growth within New Economic Geographical Models

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Abstract

Among the theories explaining the relationship between creativity criteria in cities and economic growth, "Human Capital Theory" by Glaeser and "Creative Class theory" by Florida can be mentioned. Accordingly, present paper aimed at analysis of the creativity effect on regional economic growth and is presented in two theoretical and experimental parts. Considering the results of the current paper, there are no studies within new economic geographical theory in which the creativity explicitly points out to the growth model. In this paper, such research gap is filled and a model is presented within a new economic geographical theory as a theoretical achievement. The growth model is solved as a numerical model through using calibration technique as well as required data and information of Iranian Economic. The results obtained from sensitivity analysis show that the relation between growth and creativity is positive and concave. The concave of this model shows that growth in ration of creativity has the descending returns.

Keywords: Creativity, Creative Capital, Creative Class, Economic Growth, New Economic Geography.
JEL Classification: R11, R12, E24, O40.

1. Introduction

Creativity has a significant role in stimulating the economic growth in cities and regions (Stam et al., 2008). There are different theories in association with creative city, creative regions and economic growth. Human Capital Theory and Creative Capital Theory are among such

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theories. The presented theories are in associate with human resources and business for accessing to economic growth of cities. Such theories discussed what factors are important for achieving economic growth of the cities and what characteristics of a place absorb such factors.

Human capital theory presented by Glaeser (2005) showed that economic growth of cities is caused by human capital and that these factors make cities move towards creativity. Jacobs in 1984 suggested that cities have high capacity for absorbing creative people and consequently for economic growth. Human capital includes individuals, especially professional and learned ones. Where skilled people concentrated, human capital is concentrated too. Skilled and learned people are able to produce and absorb knowledge. Therefore, they are more generator (Marlet and Woerkens, 2007). Education and skill levels of human capital in a place show the growth of that region, that is, the higher the education and skills in a special region, the higher and faster growth of that region is (Glaeser et al., 2001; Marlet and Woerkens, 2007; Mathur, 1999). As Lucas considered the effects of efficiency resulted from human capital clustering as a factor of regional economic growth.

Therefore, the important factors of economic growth in human capital theory including: conglomeration and sharing knowledge, information and ideas among people and firms finally increase the innovation and creativity in special technology. Regarding higher and fast raise of income, consumption increases in this place too. Consequently, more human capital will be absorbed into such places. Therefore, much more knowledge is shared and creativity appeared which leads to population and economic growth (Glaeser and Saiz, 2004; Glaeser, 1998). Then, according to such ideas suggested by Glaeser, higher human capital leads to an increase in creativity and ultimately, to higher economic growth of region. Some experimental studies showed that human capital is the main factor of regional growth. We can point out to some of them as follows (Glaeser, 1998; Glaeser, 2000; Rauch, 1993; Simon, 1998; Simon and Nardinelli, 1996; Mathur, 1999).

Another theory related to the city and creative regions is called Creative Capital Theory suggested by Florida. Florida suggested that people are a key factor for growth and development of cities and regions in his book titled as “The Rise of the Creative Class” in 2004. It is interesting that the creative class is not distributed equally throughout cities and regions. As Florida says the creative class is absorbed by places with higher tolerance. Those regions with more creative people outperform economically, because they produce more innovation, they have higher entrepreneurship level and absorb creative business.

The creative class of Florida focused on the presence of people in creative professions. In fact, Florida suggested three main factors in relation between creative level and economic growth including: Talent, Tolerance and Technology.

The presence of the creative class leads to a social environment in which minority and their points of view are accepted (Tolerance). Also, the presence of the creative class causes the attraction of a region to be increased as the place of educated people for living (talent). Social variation, creativity and talent create an attractive place as a region for high-technology companies in which innovation of organizations is facilitated (technology). Finally, these 3T's lead to relatively higher economic growth. Some experimental studies showed that the indices of creative class and education are proper predictors for urban and regional growth (Mcgranahan and Wojan, 2007). Also the rates of talent, tolerance and technology of cities and regions are considered as the most important indices of future economic success. There are some studies in this regard such as the studies by effort of Lee et al. (2004) and Florida in 2004.

In this paper we used new economic geographical models which are the compound of economic geographical models and endogenous growth models to analyze the effect of creativity on economic growth of cities. In NEG models, it is focused on the manner of establishment of economic conglomerations and of activities through the basic microeconomics mechanism and within general equilibrium (Fujita and Mori, 2005; Fujita and Thisse, 2003). In NEG models, the endogenous growth models are compounded with new economic geographical models and R&D section was added to new economic geographical framework.

Endogenous growth theory suggests that human capital and knowledge are concentrated in cities because many educated and professional people interact with each other and then, increase their knowledge (Lucas, 1988). The main hypothesis of this approach emphasized on the fact that a definite level of human capital concentrated at one place resulted to an increase in knowledge spillover compared to the same level of human capital spread over several places (Martin and Sunley, 1998). Endogenous growth models aim at analyzing how new economic activity (economic growth) is created through innovation. The aim of NEG model is to analyze how economic activities are created and why they are concentrated spatially. Therefore, in NEG models, there are processes of creating economic activities and that establishment and growth are as interconnected processes.

In new economic geographical models, a raise in the rate of local demand of a region causes industrial firms to be absorbed into that region. Subsequently, the production of firms and regional growth increase (Fujita and Krugman, 1995). If innovation section uses the products of industrial section as the intermediate goods, it would be encouraged to be situated in a region in which industrial firms are established due to transportation expenses. Patent, knowledge spillover and technology changes are increased through conglomeration of innovation section in the region. Then, a wide spread of different goods is created and real income of the region is increased due to creation of different goods. The raise in real income of a region attracts new labor, consumers and firms to that region. Consumption demand of a region is increased through permanent raises of income (i.e. regional growth) and industrial firms would be conglomerated in a region through an increase in the knowledge spillover. Such cycle is continued cumulatively and results to growth and more activity conglomeration of that region (Baldwin and Martin, 2003).

It should be noted that creativity is important for the establishment of the innovation section in a region. This paper introduces creativity index to the new economic geographical models for the first time and aims at analyzing the effects of creativity on the regional economic growth. Studying creative cities and regions and the economic growth has been regarded since the beginning of the 21th century. For instance, the study by McGranahan et al. (2011) showed that absorption of creative workers into a place leads to economic growth of that place. In this paper, talent is considered as an economic growth engine. Moreover, Boschma and Fristch (2009) found that characteristics such as tolerance and openness have a positive and significant effect on the share of creative people in a region. Also, available occupational opportunities have an effect on creative population of that place. The results of this study showed a positive relation between creative class, entrepreneurship and employment growth in a region.

The plan for the remainder of the paper is as follows: In the second part, we analyze the effect of creativity on the new economic geographical models through using the framework of new economic geographical models. This model is contribution of this paper. In the third part, regional growth is on the sensitivity analysis against creativity through using the calibration technique. In the fourth part, the conclusion and political suggestions are discussed.

2. Theoretical Fundamentals

To analyze the effect of creativity on regional growth, we assume that there are two regions such as A and B in a country. The regions have the same population L and initial stock of knowledge capital. Both regions have the same population density d and if the population density is not the same, the population density in region A must be more than that of region B. The occupants of each region (L) are considered as consumers, producers and labors. Therefore, the population of each region is equal to labor which is assumed that they are not transferrable between two regions[1].

In this studied model, we also assume that two categories of goods are produced. The first category is homogenous goods H so called traditional goods and the second category is differentiated goods M so called modern goods.

All goods are considered as the final goods which have a final consumption but modern goods are used as intermediate input in the innovation section. A producer needs innovation for producing new modern goods. The innovation is created by the innovation section. So, based on this assumption, the innovation section is in associate with the production section of modern goods, that is the goods produced in modern section is used in research and development section for producing innovation .Moreover producing any new modern goods requires innovation.

Any innovation is registered and we assume that the patent has unlimited time. The first ownership of the patent belongs to the region

1. On this assumption, work force is separated from the conglomeration path.

in which the innovation is created. After registering the innovation, such patent is sold only to one producer either in region A or B.

In this model, we assume that both regions A and B have the equal value of patent (so called knowledge capital). The knowledge capital of each region is assumed as K_0. As mentioned previously, the global capital stock is produced by research and development section R&D and may move freely between two regions.

In this model, we assume that labor has no capacity of movement but knowledge as the patent, may move between the regions. It means that the research and development section which produces the innovation may sell its patent to the producer firms of modern goods in regions A and B.

The research and development section takes act towards selling the bonds in an inter-regional capital market and the return $r(t)$ is paid to these bonds and they are riskless.

It should be noted that this model is a general equilibrium model composed of two parts of consumption and production. To have a better explanation for this model, variables of the model are presented in table 1.

Table 1: The Variables Used in the Model

variable	Variable definition	variable	Variable definition
d	Population density	λ	Cost of each work (marginal cost of production)
L	Population equal to labor	φ_{AB}	Transportation facility between regions A and B
L_R	Researchers	φ_A	Transportation facility within region A
H	Traditional goods (homogenous)	φ_B	Transportation facility within region B
M	Differential goods (modern)	$S_M(t)$	The amount of supply of modern goods
K_0	Initial knowledge capital (patent)	$\beta(t)$	Share of the firms located at region A from the existing firms
K^T	global capital stock	$\dot{K}(t)$	Flow of the knowledge in time is t
ρ	Time preferences rate	$0 < \varepsilon < 1$	Share of modern goods is in the innovation section
$\alpha \in (1,0)$	Share of the expenses allocated to modern goods	A(t)	Productivity of all factors in research and development section
σ	Own-and cross-price elasticity of demand of modern goods	μ	Knowledge spillover intensity
N(t)	Total number of modern goods	ω	Parameter and its value is positive (production elasticity in ratio of

variable	Variable definition	variable	Variable definition
			creative index)
P_H	Price of traditional goods	ψ_A	Rate of knowledge diffusion from the firms of region A to the research and development region A limited by the cost of transportation
P_i	Price of modern goods i produced at region A	ψ_{AB}	Rate of knowledge diffusion from the firms of region B to research and development region A limited by the cost of transportation
P_j	Price of modern goods j produced at region B	W	Price of labor (wage)
$E(t)$ $E^*(t)$ $\dot{E}$	Consumer's expense at region A Consumer's expense at region B Expense growth	$\pi(t)$	Profit
P(t)	Price index of modern goods	$v(t)$	Value of patent
τ_A	Cost of transporting the modern goods within region A	MC(t)	Marginal cost of innovation production
τ_{AB}	Cost of transporting the modern goods between region A and B	g	Growth
τ_B	Cost of transporting the modern goods within region B	CCI	Regional creative index

Regarding that both regions A and B are identical in terms of the initial inventory of production factors (labor and Knowledge capital), to find the growth path, region A is considered as the representative, then we obtain the growth path. If, at first, we analyze region B and region B is considered as the representative region, the same results will be obtained.

A. Consumption Section

In this part, we assume that the form of utility function of the representative consumer who resides at region A is as the fixed relative riskless and logarithm whose intertemporal substitution elasticity is equal to 1. Utility of the whole life of the representative consumer is as follows:

$$U = \int_{t=0}^{\infty} \log[M(t)^{\alpha} H(t)^{1-\alpha}] e^{-\rho t} dt \qquad (1)$$

where ρ is time preferences rate and H is homogenous goods consumption. Homogenous goods are considered as numeraire good. M is a modern goods consumption, considered as a compound good. In this function, α is the share of cost allocated to M. M has diversity subject to Dixit and Stiglitz (1977) and its index is as follows:

$$M(t) = [\int_{i=0}^{N(t)} M_i(t)^{1-\frac{1}{\sigma}} di]^{\frac{1}{1-\frac{1}{\sigma}}} \qquad \sigma > 1 \tag{2}$$

As mentioned in table 1, σ is both the own-and cross price elasticity of demand of modern goods. N(t) is total number of modern goods produced in both regions. $M(t)$ is a consuming basket of modern goods with constant elasticity substitution (CES) and $M_i(t)$ is the consumption of modern goods i.

E is the consumer's budget (labor), the representative in region A.

$$E = \int_{i=1}^{n} p_i M_i + \int_{j=n+1}^{N} p_j M_j + P_H H \tag{3}$$

In equation 3, P_H is the price of traditional goods. p_i is the price of diversity of i (th) in region A and p_j is the price of diversity of j (th) in region B and n is the number of diversities produced in region A and n^* is the number of diversities produced in region B.

$$N = n + n^* \tag{4}$$

By maximizing the utility of the representative consumer in ratio of budget constrain, we can see in any period, workers spend α % of the expenses of $E(t)$ for modern good and $1 - \alpha$ of their expenses for traditional goods. Share of expenses for modern good is distributed on them in comparison to the relative price of these modern goods.

With utility maximization of the representative consumer (equation 1) in comparison to the budget constrain (equation 3), the functions of modern and traditional demand are obtained as follows:

$$M_i = \frac{p_i(t)^{-\sigma}}{P(t)^{1-\sigma}} \alpha E(t) \tag{5}$$

$$H = (1 - \alpha) E(t) \tag{6}$$

The price index of modern goods is as follows (Minerva and Ottaviano, 2009; Martin and Ottaviano, 2001; Martin and Ottaviano, 1999; Fujita and Thisse, 2003):

$$P(t) = [\int_{i=0}^{N(t)} p_i(t)^{1-\sigma} di]^{\frac{1}{1-\sigma}} \tag{7}$$

With indirect utility maximization subject to intertemporal budget constrain:

$$\frac{\dot{E(t)}}{E(t)} = r(t) - \rho \tag{8}$$

B. Production Section

In this section, we assume that traditional good is produced under constant returns to scale and perfect competition. Labor is the only required input for producing the goods. For simplicity without getting far from the general subject, we assume that each production unit of traditional good requires one unit of labor. Then, the profit of firm is as follows:

$$\pi_H = TR - TC = P_H * H - W * L = H - W * L \tag{9}$$

To simplify the equations, it is assumed that traditional good is numeraire good. Then, its price is normalized to 1. According to maximization condition of the firm's profit under perfect competitive condition as well as assuming that a unit of labor is required for producing a unit of traditional good, then we have $P_H = W$ and because $P_H = 1$ then W $= 1$.

Also we assume that demand for traditional good in total economic is grand enough so that only production at a region is not enough for all demands. This assumption guarantees that both regions produce traditional good in equilibrium. As we assume that there are inter-regional and intra-regional trades of traditional goods without any charges of transportation, this results to the same price of traditional good and wage at both regions.

Modern goods are produced under monopolistically competitive conditions and increasing returns to scale. There are fixed and variable costs for producing modern goods. Variable costs of the firm are related to the labor then, we need λW unit of labor cost for any unit of modern goods production. Since the labor wage is 1, the cost of any unit of labor is λ. Fixed cost of the firm is related to purchase of the patent and its variable cost is related to the wage of labor.

Global capital Stock $K^T(t)$ is equal to total number of modern goods available in total economic due to this fact that producing new modern good needs new invention. Any modern good is produced by one firm, then $K^T(t)$ is equal to total number of firms too. We assume that global capital stock is freely traded between the regions then, diversities created as endogenous ones are defined based on the decision to enter the firms.

In this model, transporting modern goods between and within regions is limited by the transportation cost. For inserting the transportation cost into the model we use Iceberg Cost concept based on literature of new economic geography. The cost of carrying the modern good is τ so that for transporting modern good M, $\tau_A > 1$ and $\tau_{AB} > 1$ unit of good should be sent by the firm of region A until one unit of good will be available for the consumer at regions A and B respectively and $\tau_B > 1$ and $\tau_{BA} > 1$ are units of goods supposed to be sent by the firms of region B until one unit of good will be available for the consumers of regions A and B respectively. τ's (intra and inter regional transportation costs) shows worse transportation infrastructure. Here while complying with Minerva and Ottaviano (2009), we assume that intra-regional transportation has less cost than inter-regional transportation and also region A has better transportation infrastructure than that of region B, then:

$$\tau_{AB} = \tau_{BA} \qquad \text{and} \qquad \tau_A < \tau_B < \tau_{AB} \tag{10}$$

According to the above mentioned assumption, region A is considered as the developed center and region B as the developing periphery region.

Regarding the assumption, that modern good is produced in Monopolistic competition market, in this market the profit is maximized if marginal revenue equal to marginal cost.

Marginal Cost: $$MC = W\lambda \tag{11}$$

Marginal Revenue: $$MR = P(1 - \frac{1}{\sigma}) \tag{12}$$

Then, we have:

$$p = \frac{W\lambda\sigma}{\sigma - 1} \tag{13}$$

As the wage is equal to 1, the price will be:

$$p = \frac{\lambda\sigma}{\sigma - 1} \quad (14)$$

Operating profit of the producer of modern good who uses one patent is equal to revenue mines costs of labor as follows:

$$\pi(t) = pS_M - W\lambda S_M = \frac{\lambda S_M(t)}{\sigma - 1} \quad (15)$$

In equation No. 15, $S_M(t)$ is optimal supply of the product of a producer firm of modern good in equilibrium.

The important note is that the cost paid by the consumer for goods include transportation cost too. Then, the consumer price (delivered price) while complying Minerva and Ottaviano (2009) is as follows:

$$p_A = p\tau_A \qquad p_B = p\tau_B \qquad p_{AB} = p\tau_{AB} \quad (16)$$

Using price index of equation 7 and considering equation 16, price index is as follows:

$$P(t) = pN(t)^{\frac{1}{1-\sigma}}[(\tau_A)^{1-\sigma}\beta_t + (\tau_{AB})^{1-\sigma}(1-\beta_t)]^{\frac{1}{1-\sigma}} \quad (17)$$

In equation 17, share of the firms located at region A from total available firms is equal to $\beta(t) = \frac{n(t)}{N(t)}$ and $(t) = K^T(t)$ which shows total number of available firms that is equal to global capital stock.

Parameters $\varphi_A = (\tau_A)^{1-\sigma}$ and $\varphi_B = (\tau_B)^{1-\sigma}$ and $\varphi_{AB} = (\tau_{AB})^{1-\sigma}$ respectively show the intra-regional and inter-regional transportation facility which ranges from 0 to 1. In this model we assume that intra-regional transportation infrastructure of region A is better than that of region B and intra-regional infrastructure is better than inter-regional one. Then, we have:

$$\varphi_A > \varphi_B > \varphi_{AB} \quad (18)$$

This assumption is due to this fact that better transportation infrastructure causes the marginal cost of innovation production to be decreased at region A and also causes the modern firm to be absorbed at region A. Having been absorbed at region A causes region A act as the center and region B act as the periphery and the designed model placed in a framework of core-periphery equilibria.

C. Innovation Section

As mentioned before, innovation which is the source of producing new modern goods as well as the source of region growth is created in research and development section. This section creates ideas which can be registered then their patents are sold to the producers of both regions who need a new invention for starting to produce new differential products .the value of patent is equal to the value of the firm who purchases the patent and starts to produce differential good. Production in innovation section continues in a long term due to spillovers resulted from the last innovation and spillover resulted from the innovation in other regions which increase the productivity of the researchers through capital accumulation . Innovation section acts under complete competitive condition and constant return in the ratio of the scale (Minerva and Ottaviano, 2009).

The production function of innovation section while complying with Minerva and Ottaviano (2000) is as follows:

$$\dot{K}(t) = A(t)[\frac{M(t)}{\varepsilon}]^{\varepsilon}[\frac{L_I}{1-\varepsilon}]^{1-\varepsilon} \quad (19)$$

That $\dot{K}(t) = \frac{dK}{dt}$ is the flow of knowledge created in time t and L_I is a labor employed in research and development section and $M(t)$ is a basket of modern goods. $0 < \varepsilon < 1$ is the share of modern goods in the innovation section production. A(t) is total productivity of all factors in the research and development section affected by knowledge spillovers.

Here, while complying with Minerva and Ottaviano (2000), A(t) is a function of global capital stock and knowledge spillover. Also while complying with Boix-Domenech and Soler-Marco (2017), who believe that creativity increases the regional capacity for production and combination of new ideas and consequently increases the production of innovation, resulted to an increase in productivity.

Then, according to the presented studies, we may conclude that A(t) is a function of regional creativity . Then, A(t) is equal to:

$$A(t) = \bar{A}K^T(t)^{\mu}CCI^{\omega}[\psi_A\beta + \psi_{AB}(1-\beta)]^{\mu} \quad (20)$$

In the equation 20, $\bar{A}$ is a constant value. CCI is an index of a creativity and $K^T(t)$ is global capital stock available in two regions. μ and ω are positive parameters. μ is knowledge spillovers intensity. β is share of firms available in region A from total firms available in both regions. ψ_A and ψ_{AB} which range from 0 and 1 respectively are the rate of knowledge diffusion from the firms of region A to the research and development section of region A and the amount of knowledge diffusion from the firms of region B to the research and development section of region A which is limited by the communication cost. Communication cost including cost for communicating one firm with another firm and the better communication infrastructure is, the less cost is. As mentioned before, we assume that the infrastructure of region A is better than that of region B and intra-regional infrastructure is better than inter-regional infrastructure[1]. Then, we have:

$$\psi_A > \psi_B > \psi_{AB} \tag{21}$$

Using the production function of innovation section and duality theorem, cost function of this section may be obtained, so that marginal cost related to the cost function is as follows:

$$MC(t) = \frac{P(t)^{\varepsilon} w^{1-\varepsilon}}{A(t)} = \frac{\eta}{N(t)CCI^{\omega}[\psi_A\beta + \psi_{AB}(1-\beta)]^{1-\frac{\varepsilon}{\sigma-1}}[\varphi_A\beta(t) + \varphi_{AB}(1-\beta(t))]^{\frac{\varepsilon}{\sigma-1}}} \tag{22}$$

In equation No.22, $\eta = \frac{P^{\varepsilon}}{A}$ is a constant positive value and $w = 1$. Moreover, to have a path for long-term, we have[2] $\mu + \frac{\varepsilon}{1-\sigma} = 1$ (Minerva and Ottaviano, 2009; Martin and Ottaviano, 2001; Baldwin and Forslid, 2000; Evans et al., 1998). Through increasing $N(t)$, the marginal cost of the innovation will be decreased and the condition $\mu + \frac{\varepsilon}{1-\sigma} = 1$ guarantees this decrease. If such condition is not existed then growth rate model will be presented that it is increasing and

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1. Having this assumption is due to this fact that better transportation infrastructure caused the marginal cost of producing the innovation to be decreased in region A also caused the modern firms to be absorbed in region A .having been absorbed in region A caused the region A to act as the center and region B act as the periphery and the designed model placed in the framework of Equilibria core-periphery model.
2. As Lucas (1988) showed the endogenous growth models have constant growth rate in steady state only when the assumption of Knife-edge is employed on the parameters.

decreasing during time and it may not be solved for a constant growth rate.

Due to this assumption that communicative infrastructure in region A is better than that of region B and the heterogeneous effect on knowledge diffusion in region A is better than that of region B and population density is identical in both regions, the marginal cost of innovation is less in region A. therefore, under complete competitive condition in innovation section production, the research and development section is located in region A and long-run growth is totally created from the innovation of region A.

As showed in equation 22, marginal cost of production will be decreased through increasing the creativity in a region.

As mentioned before, the value of innovation (the patent) is equal to the value of the firm which use that patent. To calculate the value of firm, current value of profit flow of the firm should be calculated as follows:

$$\nu = \int_t^{\infty} e^{-(R(s)-R(t))} \frac{\beta S_M(t)}{\sigma - 1} ds \tag{23}$$

$R(t)$ is a cumulative discount, the following equation will be driven by the above equation in the ratio of time:

$$\frac{\beta S_M}{\sigma - 1} + \dot{\nu} = r\nu \tag{24}$$

Then:

$$r(t) = \frac{\dot{\nu}(t)}{\nu(t)} + \frac{\pi(t)}{\nu(t)} \tag{25}$$

Equation 25 is called arbitrage and interest rate of $r(t)$ on asset is paid without risk. The above equation showed that the interest rate should be equal to investment return in knowledge which investment return on knowledge is divided into two parts that $\frac{\dot{\nu}(t)}{\nu(t)}$Capital gain percent and $\frac{\pi(t)}{\nu(t)}$ showed that each unit of knowledge creates what extent profit for the modern firm (Minerva and Ottaviano, 2009; Martin and Ottaviano, 2001; Martin and Ottaviano, 1999).

If we maximize the profit of research and development firm, we have:

$$\nu(t) = MC(t) \tag{26}$$

D. The Effect of the Economic Growth on the Firms Location (Location and Agglomeration of the Firms as a Regional Economic Growth Function):

In Arbitrage condition equilibrium of equation 25, we pointed out to this subject that all firms have the same profit neglecting where they are established. Since the profit is equal to $\pi(t) = \frac{\beta S_M(t)}{\sigma-1}$ then, according to profit equation and arbitrage condition, all firms should access to the same scale of producing the production $S_M(t)$. Using equation 5 and 16, the market clearing conditions (the equal supply of demand) for the firms of regions A and B are as follows:

$$S_M(t) = \frac{P^{-\sigma}{\tau_A}^{1-\sigma}}{P(t)^{1-\sigma}}\left[\alpha E(t)L + \varepsilon MC(t)\dot{N}(t)\right] + \frac{P^{-\sigma}{\tau_{AB}}^{1-\sigma}}{P^*(t)^{1-\sigma}}\alpha E^*(t)L \tag{27}$$

$${S_M}^*(t) = \frac{P^{-\sigma}{\tau_B}^{1-\sigma}}{P^*(t)^{1-\sigma}}\alpha E^*(t)L + \frac{P^{-\sigma}{\tau_{AB}}^{1-\sigma}}{P(t)^{1-\sigma}}\left[\alpha E(t)L + \varepsilon MC(t)\dot{N}(t)\right] \tag{28}$$

$S_M(t)$and ${S_M}^*(t)$ respectively are the amount of supply of the productive firms of modern goods in regions A and B regarding the research and development firm is located in region A[1].

Innovation growth (new diversities growth) in this model is considered as the regional growth source. then, $g = \frac{\dot{K}^T(t)}{K^T(t)} = \frac{\dot{N}(t)}{N(t)}$ and the equations of the optimal price $p = \frac{\lambda\sigma}{\sigma-1}$ and $P(t) = pN(t)^{\frac{1}{1-\sigma}}[(\tau_A)^{1-\sigma}\beta_t + (\tau_{AB})^{1-\sigma}(1-\beta_t)]^{\frac{1}{1-\sigma}}$ employed on equations 27 and 28, through solving $S_M(t)$ and ${S_M}^*(t)$ at the same time and also regarding that two values are equal according to arbitrage condition , the equilibrium value of product will be obtained as follows:

$$S_M = \left(\frac{\sigma-1}{\lambda\sigma}\right)\left(\frac{2\alpha EL + \varepsilon MCNg}{N}\right) \tag{29}$$

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1. * above the variables shows the related variable in region B.

And the establishment of the firms in region A is as follows (Minerva and Ottaviano, 2009):

$$\beta = \frac{1}{2} + \frac{1}{2}\left(\frac{\varphi_{AB}(\varphi_A - \varphi_B)}{(\varphi_A - \varphi_{AB})(\varphi_B - \varphi_{AB})} + \frac{\varphi_A \varphi_{\boldsymbol{B}} - \varphi_{AB}^2}{(\varphi_A - \varphi_{AB})(\varphi_B - \varphi_{AB})}\left(\phi - \frac{1}{2}\right)\right) \quad (30)$$

According to the equation 30, the transportation cost is a proxy for economic distance which effects on the firms' agglomeration and in equation 30, ϕ is equal to:

$$\phi = \frac{\alpha EL + \varepsilon MCNg}{2\alpha EL + \varepsilon MCNg} \quad (31)$$

In this equation, ϕ is the demand share for the good of modern section produced by the firms of region A. the more the size of market is (labor, firms and innovation section), according to equation 30, ϕ is larger. The more ϕ is, the more firms' agglomeration and β are in region A.

We assume that the share of the regions from the first asset is equal. Then, we have $E = E^*$ since $\varepsilon MCNg > 0$ then, $\phi > \frac{1}{2}$ according to this equation as well as better transportation infrastructure in region A than that of region B considering the transportation infrastructure of any region is better than inter-regional transportation infrastructure , based on equation 31, we conclude that $\beta > \frac{1}{2}$ it means more productive firms of modern goods are placed in region A.

Through employing equation 31 on equation 30 we have:

$$\beta = \frac{1}{2} + \frac{1}{2}\left(\frac{\varphi_{AB}(\varphi_A - \varphi_B)}{(\varphi_A - \varphi_{AB})(\varphi_B - \varphi_{AB})} + \frac{\varphi_A \varphi_{\boldsymbol{B}} - \varphi_{AB}^2}{(\varphi_A - \varphi_{AB})(\varphi_B - \varphi_{AB})}\left(\frac{\alpha EL + \varepsilon MCNg}{2\alpha EL + \varepsilon MCNg} - \frac{1}{2}\right)\right) \quad (32)$$

This equation shows that firms agglomeration is a function of growth.

E. Economic Regional Growth:

To define long-run economic growth path, we should focus on the balanced growth path during which the expenditures *E* are constant like growth rate. The growth rate will be 0 if the expenditures are constant.

Then, according to equation 8, $r=\rho$. If β and MCN are constant in equations 30 and 22, we have:

$$-g=\frac{\dot{v}}{v}=\frac{\dot{MC}}{MC} \quad (33)$$

The equation 33 shows that marginal cost of innovation MC and final benefits of innovation v are both decreased with the same constant rate. Considering equations 12, 22, 26, we have:

$$\rho=-g+\frac{2\alpha EL+\varepsilon MCNg}{\sigma MCN}=\frac{2\alpha EL}{\sigma MCN}-g(\frac{\sigma-\varepsilon}{\sigma}) \quad (34)$$

This model is presented through imposing the market clearing condition of labor, so that total labor in economic (regions A and B) is $2L$ which is completely employed.

The amount of labor in innovation section:	$L_I=(1-\varepsilon)MCNg$	(35)
The amount of labor for producing the modern goods:	$L_M=\left(\frac{\sigma-1}{\sigma}\right)(2\alpha EL+\varepsilon MCNg)$	(36)
The amount of labor for producing homogenous goods(traditional):	$L_H=2(1-\alpha)EL$	(37)

Then, full employment condition is as follows:

$$2L=\frac{\sigma-\varepsilon}{\sigma}MCNg+2\left(\frac{\sigma-\alpha}{\sigma}\right)EL \quad (38)$$

We conclude that expenditures are equal to revenue in equilibrium through solving equation 34 altogether whith 38.

$$2EL=2L+\rho MCN \quad (39)$$

$2L$ is the income of labor and ρMCN is additional income from the first global capital stock (Minerva and Ottaviano 2009).

Regarding equations 34,38 and 39 , the growth rate is as follows:

$$g=\left(\frac{\alpha}{\sigma-\varepsilon}\right)\left(\frac{2L}{MCN}\right)-\rho(\frac{\sigma-\alpha}{\sigma-\varepsilon}) \quad (40)$$

Equation 40 shows that the establishment of the firms may affect growth through marginal cost of innovation MCN. Specially considering equation 22, more agglomeration in region A leads to cheaper innovation and faster growth. If the marginal cost of innovation (equation 22) employed on the above equation, the growth rate will be:

$$g = \left(\frac{\alpha}{\sigma - \varepsilon}\right)\left(\frac{2L \times CCI^{\omega}}{\eta}\right)\Big[[\psi_A\beta + \psi_{AB}(1-\beta)]^{1-\frac{\varepsilon}{\sigma-1}}[\varphi_A\beta(t) + \varphi_{AB}(1-\beta(t))]^{\frac{\varepsilon}{\sigma-1}}\Big] - \rho\left(\frac{\sigma-\alpha}{\sigma-\varepsilon}\right) \tag{41}$$

Feedback of equation 31 shows which changes in innovation cost ΔMC and growth of Δg and ΔE affect the demand share of region A and consequently the firms' establishment. Through equations 39 and 40, the demand share of region A may be rewritten as follows:

$$\phi = \left(\frac{1}{2}\right) + \left(\frac{1}{2}\right)\left(\frac{\varepsilon}{\sigma}\right)\left(\frac{g}{g+\rho}\right) \tag{42}$$

Then, equation 30 is rewritten as follows:

$$\beta = \frac{1}{2} + \frac{1}{2}\left(\frac{\varphi_{AB}(\varphi_A - \varphi_B)}{(\varphi_A - \varphi_{AB})(\varphi_B - \varphi_{AB})}\right) + \frac{1}{2}\left[\frac{\varphi_A\varphi_{\boldsymbol{B}} - \varphi_{AB}^2}{(\varphi_A - \varphi_{AB})(\varphi_B - \varphi_{AB})}\right]\left[\left(\frac{\varepsilon}{\sigma}\right)\left(\frac{g}{g+\rho}\right)\right] \tag{43}$$

This equation shows that the agglomeration is a growth function.

The above equation shows the main results of new economic geographical framework: there is a cumulative causality between agglomeration β and growth g so that growth enhances the agglomeration and agglomeration enhances growth. That is, changes in the innovation cost influence the cost and growth of region A and consequently affects the demand share of region A and establishment of the firms in region A. This leads to agglomeration of the firms in region A and subsequently the growth through decreasing the cost of innovation.

It should be noted that the growth model presented in this section, is the first model in the new economic geographical framework that creativity variable altogether with agglomeration of firms influence the regional growth which are theoretical achievement of the present paper.

3. Calibration of the Model

Based on equation 41, the required parameters are shown in the following table:

Table 2: The Variables Used in the Model

Parameter	Abbreviation	Calibration Criteria	Numerical Value
Price Elasticity of industrial good	σ	Martin and Ottaviano (1999)	2
Share of family's cost on industrial goods	α	Dehghan Shabani (2011)	0.43
Share of consuming goods on innovation production	ε	Dehghan Shabani (2011)	0.259
Time Preferences Rate	ρ	Dehghan Shabani (2011)	0.01
Industrial activity concentration	β	Dehghan Shabani (2011)	0.7
Technology elasticity on population density	ω	Dehghan Shabani (2011)	0.329
Regional creative index	CCI	Zanganeh Shahraki et al. (2016)	0.957
The ratio of labor to total population	L	Research calculation using regional statistics of statistical center of Iran[1]	0.35
$\eta = \frac{P^{\varepsilon}}{A}$	η	Dehghan Shabani (2011)	0.258
Transportation Cost average of each ton of good per kilometer intra- and inter-provinces of the center	τ_A	Research calculating using statics of road transport statistical yearbook[2]	152.7296
Transportation cost average of each ton of good per kilometer inter-provinces	τ_{AB}	Research calculating using statics of road transport statistical yearbook	173.886
Improving the transportation cost in the central region	φ_A	Research calculating using statics of road transport statistical yearbook	0.0065
Improving the inter-regional transportation cost of	φ_{AB}	Research calculating using statics of road transport statistical yearbook	0.0057
Cost of the idea transferring inter and intra-provinces of center	ψ_A	Dehghan Shabani (2011)	0.99545
Cost of idea transferring inter-provinces	ψ_{AB}	Dehghan Shabani (2011)	0.99485

1. https://www.amar.org.ir/english
2.http://www.rmto.ir/en/SitePages/Road%20Maintenance%20And%20Transportation%20Organization.aspx

Dehghani Shabani (2011) used Nakamura and Paul Index (2009) for calculating the industrial activity concentration index. Based on this index, the concentration of industrial activities in central provinces of Iran is on average 0.7 and in periphery regions is 0.3.

The creativity index is adapted from the studies of Zanganeh Shahraki et al. (2016). In this study, the creativity index was calculated for Tehran Province using Vikor Method. Based on Vikor Index, if the index is closer to 1, it shows less creativity in the region and if the index is closer to 0, it shows more creativity of that region. The result of sensitivity analysis of regional economic growth in ratio of the creativity index is presented in table 3.

Table 3: Sensitivity Analysis of Regional Economic Growth in Ration of the Regional Creativity Index

	Low creativity		←							→		High creativity
Creativity index	1	0.957	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
$1-CCI$	0	0.043	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Regional growth	-0.009	0.055	0.075	0.097	0.112	0.124	0.134	0.143	0.151	0.158	0.165	0.171

Source: The results of the study.

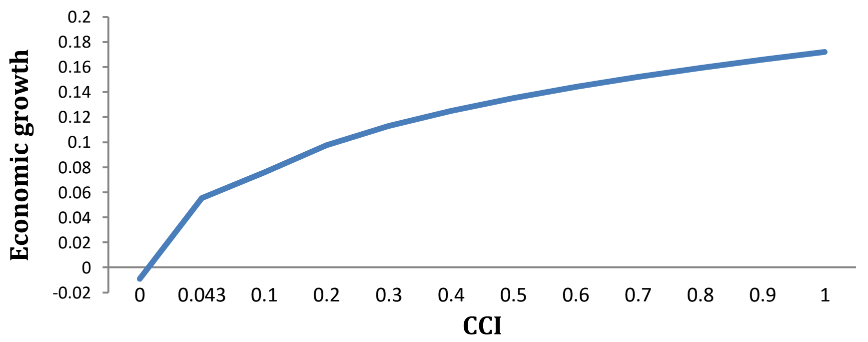

Figure 1: The Relation between Regional Economic Growth and Regional Creativity Index

Source: The results of the study.

Figure 1 shows the relation between regional economic growth and creativity index. Based on this figure, the relation between regional growth and creativity index is positive and concave. This concave function shows that growth in the ratio of creativity has diminishing returns.

4. Conclusion and Political Suggestions

In this study, we used new economic-geographical models to analyze the effect of creativity on regional economic growth. To this purpose, Minerva and Ottaviano Model (2009) was used and the regional creativity index was employed on this model. Therefore, production function of innovation section of this model is a function of regional creativity (creativity index) which is affected by knowledge capital and knowledge spillovers.

The results obtained from solving this model shows that creativity in a region causes economic growth to be raised in that region. In other words, the leading factors to creativity in a region cause reduction in marginal cost of production and consequently, economic growth increases in that region. Therefore, we used the extracted growth equation (equation 41) as well as calibration technique. Based on required data and information of Iran, this model was solved as a numerical one and regional growth was on a sensitivity analysis against creativity. Subsequently, the regional growth was on a sensitivity analysis against the changes of creativity index. Based on figure number 1, the relation between growth and creativity is positive and concave. Such concave function shows that growth in the ratio of creativity has a descending return.

Considering that Tehran city, is the most important city of Iran and is a metropolis too, however it has a very low creativity index. Regarding the presented model and obtained results, it has very low economic growth too. Therefore, economic policymakers are recommended to enhance the criteria which result in higher creativity of cities and regions of Iran and direct those cities towards more creativity so that they achieve higher economic growth.

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