A DYNAMIC MODEL FOR REGIONAL COMPETITIVENESS BASED ON THE REGIONAL INNOVATION SYSTEM.

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ABSTRACT.

This paper presents a dynamic model designed to evaluate the impact of a science park on regional competitiveness. First, the paper analyzes the concept of competitiveness and its evaluation in terms of three regional indexes: productivity, quality and flexibility. Second, the concept of a national innovation system is adapted to a regional level. In the present proposal, the regional innovation system interacts with four regional systems. Third, the model basis and some of the cause-effects diagrams are presented. Finally, to test the model, simulation results for the Cuernavaca region (central Mexico) are shown. In this simulation, a technology park and technology-based firms is evaluated with regard to future regional competitive index improvement.

1. INTRODUCTION.

This paper establishes the basis for a dynamic model that relates technology-based firms (TBF) development to regional competitiveness. Regional competitiveness is defined in terms of three indexes: productivity, quality and flexibility of regional indexes. Each index depends on the behavior of four regional systems:

- The production, added value and profit system.

- The regional investment system.

- The regional employment system.

- Human resources formation system.

Besides these systems, the regional system of innovation (RSI) is established. This system is integrated by the units supporting the innovation process. The TBF is an important part of this system.

Science or technology parks are instruments to encourage the TBF development. The number of science or technology parks in the world has rapidly grown since the early eighties. Recently, some studies analyze the impact of the science parks on economies at the regional level (Monck et al. 1990, Luger 1992). Nevertheless, these studies show specific areas of impact (e.g., regional employment, technology diffusion) but not more global effects on regional competitiveness. Through the dynamic model put forth in this paper, the broader impact of the science park in the regional competitiveness can be determined.

2. REGIONAL SYSTEM OF INNOVATION.

Over the last ten years, the idea of the National System of Innovation (NSI) has been put forth. (Freeman 1988). Lundvall (1992) wrote that "...a system of innovation is constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and that a national system encompasses elements and relationships, either located within or rooted inside the borders of a nation state". More recently, other essays have identified the elements and relationships related to the NSI (Niosi 1993, Nelson 1993).

One way to make the NSI concept more workable is to apply it at a regional level. At this level, the relationships among elements within the innovation process are tighter. Further, there is a world-wide tendency to strengthen the regional dimension because..." the nation-state is too big to run everyday life..." (Newhouse 1997). Therefore, the application of NSI to the Regional System of Innovation (RSI) is warranted. Also, TBF and science or technology parks hold a growing importance in RSI.

3. REGIONAL COMPETITIVENESS APPROACHES.

The concept of competitiveness frequently refers to the capacity to part-take in economic development. Studies related to this concept can be classified in three groups: at the firm level, related with economic sectors, and within regions. The regional dimension analyzes the location conditions that allow one firm to be more competitive than another located elsewhere.

As OCDE establishes (Hatzichronoglou 1996), there are four approaches in regional competitiveness studies: that of engineering, the environmental/systemic, capital development, and the eclectic/academic approaches.

Each of these approaches consider the ability of regional systems to develop, to acquire and to diffuse technical knowledge. This ability is related to the Regional System of Innovation.

In several studies, the measurement of competitiveness has been relevant, including several that relate technological factors with regional competitiveness indicators (Papadakis 1995, Roessner 1996). These studies base measurement of competitiveness on national comparisons. Nevertheless, there is value in a regional indicator of competitiveness to evaluate the regional impact of some policies. This paper proposes an index of the regional competitiveness. The index depends on the regional levels of productivity, quality and flexibility.

The productivity and quality regional averages are important to recover production value within the market. The flexibility level is related to the capacity to adjust production to market changes. Likewise, these three aspects are related to the RSI performance.

4. DYNAMIC MODEL BASIS.

Fig. 1 Production system. Cause-effect diagram

Regional

Production

Regional Regional

Investment Competitiveness

Regional Added

Value

Regional Exchange

Profits Rate

Regional

Average wages Regional

Productivity

Regional competitiveness is related to the Regional System of Innovation and other regional systems' performance. An important part of the RSI is the TBF. The TBF development is encouraged by the technology parks. Therefore, a technology park may influence regional competitiveness improvement.

The relationship between regional production and regional competitiveness can be established as shown in Figure 1.

The exchange relation is the comparison between the export market prices and the import market prices. If the first grows more

than the second, the exchange rate will be positive to the region. Otherwise, this rate will be negative. Then, the exchange rate is related to two factors: the participation of knowledge-based work in regional production and regional flexibility to respond to market changes.

The regional investment process is relevant to the regional production system. It can divide the regional investment as shown in Figure 2.

Figure 2 Regional Investment classification.

Work capital and Infrastructure Investment for Investment in

Regional Maintenance Investment Enlargement Equipment

Investment

Capital Production Investment for Investment in

Formation Investment Modernization Reorganization

The investment for enlargement does not modify the manner in which regional production occurs. On the contrary, investment for modernization modifies the technical conditions in the production system. This modification can be made in two ways:

- Utilizing new machinery and technically better equipment.

- Developing investment projects related to new products, new production processes, quality and productivity improvement, reengineering, training programs, etc. This kind of investment is related to a reorganization of the production system.

The investment for modernization requires the regional availability of qualified human resources. These human resources play a double role: they serve as change agents promoting projects of modernization, and as technical support to develop these projects.

The improvement of the regional quality, productivity and flexibility indexes depends on the importance of the modernization investment. Also, these indexes are related with the regional availability of qualified human resources.

The TBF are formed by qualified human resources (QHR) that support the regional investment for modernization.

Qualified human resources refer to engineers and scientists at the graduate and post-graduate levels. The regional formation of QHR fosters TBF development. If the regional demand of QHR increases, then the formation of these human resources will grow as well.

Finally, the operation of a technology park will impact the regional development of the TBF. Figure 3 shows these relationships.

Fig. 2 TBF subsystem. Cause-effect diagram

Science

Park

TBF

Investment in

Regional HR Modernization

Formation

Qualified

Employment

5. DYNAMIC MODEL AND SCENARIOS.

A preliminary dynamic model was developed using Powersim software. This model was applied to the Cuernavaca region in the central area of Mexico.

Two scenarios were considered: one with the development of a technology park and the second without it. The initial time period corresponds to 1995. A run of the model completed for the first ten time periods. Main results are shown in Table 1.

Table 1. Main results of model run for Cuernavaca region. period 1 = 1995, period 10 = 2005.

	Initial	Scenario 1	Scenario 2
V A R I A B L E	Values	(without park)	(with park)
	(year 1995)	(year 2005)	(year 2005)
TBF employees (**)	730	1,480	1,830
Regional added value (*)	1.00	1.50	1.59
Average wage (*)	1.00	1.52	1.58
Regional employment (**)	350,000	355,270	354,220
Qualified employment (**)	10,000	14,850	15,880
Regional productivity (*)	1.00	1.40	1.48
Regional competitiveness (*)	1.00	1.40	1.47

Regional investment (*)	1.00	1.39	1.54

(*) Corresponds to an index with value "1.00" in the first time period.

(**) Corresponds to a number of persons.

6. CONCLUSIONS.

These results show the difference between two regional policies. The development of the technology park affects the number of TBF employees, estimated at 350 or more. Additionally, regional productivity and regional competitiveness indexes are positively impacted on.

The dynamic model could be used to plan other regional systems such as human resources formation and investment for modernization policies.

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