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REGIONAL COMPETITIVENESS AND TECHNOLOGY PARKS. A DYNAMIC MODEL.

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Abstract

This paper describes a model that relates technology parks development to regional competitiveness. Two relevant concepts are presented: the regional system of innovation and the regional competitiveness. The proposed model combines both concepts. Since the technology-based firms are an important part of the RSI, its development contributes to enhance the regional competitiveness.

The proposed model is based on the dynamics systems method and includes four regional systems: production, investment, employment and human resources education.

The model is applied to Cuernavaca region in Mexico and two scenarios are built. The results show differences in regional indexes like high and medium qualified jobs, competitiveness.

Key words: Technology park evaluation, regional competitiveness model, regional systems of innovation, dynamic system model.

1. INTRODUCTION.

This paper describes a dynamic model that relates technology parks development to regional competitiveness.
Two relevant concepts are presented: the Regional System of Innovation (RSI) and the Regional Competitiveness. The proposed model combines both concepts and considers that the development of the RSI can increase the regional competitiveness. Since the technology based firms (TBF) are an important part of the RSI, its development contributes to enhance the regional competitiveness.
Additionally, ...*the extant literature suggests that science parks could influence various dimensions of firm (TBF) performance, broadly defined* (Siegel et al. 2003). Then, it is possible to relate the science park contribution to a regional competitiveness enhancement.
These relationships are modeling through the dynamic system technique. The bases of a regional innovation system model are presented. The broader impact of the science park in the regional competitiveness can be estimated throughout this model.

2. REGIONAL SYSTEM OF INNOVATION.

Over the last fifteen 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*.
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. The Regional System of Innovation (RSI) is integrated by the units supporting the innovation process in the region.
The TBF is an important part of this system. Science and technology parks are instruments to foster the TBF. The number of science and technology parks in the world has rapidly grown since the early eighties. Some studies have analyzed the impact of the science parks on economies at the regional level (Monck et al. 1990, Luger 1991). Nevertheless, these studies show specific areas of impact (e.g., regional employment, technology diffusion), but not more global effects on regional competitiveness.

3. THE REGIONAL COMPETITIVENESS.

The regional competitiveness has been studied also over the last fifteen years.
The competitiveness could be defined as the ability to produce goods and services with better quality and low prices than the national and international competitors, and generating and increasing benefits to the nation inhabitants throughout the augmentation of real wages (Porter, 1990).
The studies related to competitiveness can be classified in three groups: at the firm level, related to economic sectors, and within regions.
The competitiveness of the firm is based in three concepts: productivity, quality and flexibility. The constant productivity and quality improvements are important in order to be

successful in global markets. The flexibility concept is related to the capacity in adjusting production to market changes.
The regional dimension analyzes the location conditions that allow one firm to be more competitive than another located elsewhere. In the regional dimension, it is possible to distinguish two types of competitiveness: quantitative and systemic.
The quantitative concept is related to measure the competitive level of a region. The Global Competitiveness Report (World Economic Forum, 2002) is the most known representative work of this approach. It presents the competitiveness of 80 countries analyzing and ranking the capacity of national environment to support the creation of added value.
The systemic competitiveness is also known as structural competitiveness. In this approach, the economic structure is the aggregation of different regional systems interacting in order to produce goods and services.
The manner that interacting different regional systems produces a competitiveness level. The systems interaction in national economy provides the most relevant lever to economic and employment growing (Bradford, 1994).
The RSI is an important system that contributes the productive system technological improvement. In particular, TBF promotes the technological change in the regional productive organization.

4. SYSTEM DYNAMIC MODEL.

In the late 1950's, professor J. Forrester at the Massachusetts Institute of Technology, developed the dynamics systems method for simulate different kind of systems behavior based in a model. Since then, this method has been applied to a wide variety of issues and problems in both the public and private sectors.
A simulation model is used to investigate the relationship that exists between the structure and behavior of a dynamic system. It permits to modeling real world systems considering its time evolution and feedback processes.
There are four kinds of structural properties in dynamic systems.

- The systems can be modeled by flows and levels; levels accumulate flows and flows cause the levels to change over time.
- There are delays or lags in actual systems; the delays distribute the effects of changes in variables throughout a system over time.
- The feedback exists in real world systems. The feedback loops have a tendency to stabilize or to destabilize a system.
- There are many non-linearities in the flows. Nonlinearity implies that system attributes influence each other in a non-proportional way.

To build a dynamic model is necessary to define the relevant variables that control the system. Then, with these relevant variables, cause-effect diagrams are constructed in order to identify the feedback loops. Finally, the dynamic model can be constructed considering four kind of variables: level, rate, auxiliary and constant.
In the next section, relevant variables for each regional systems are shown.

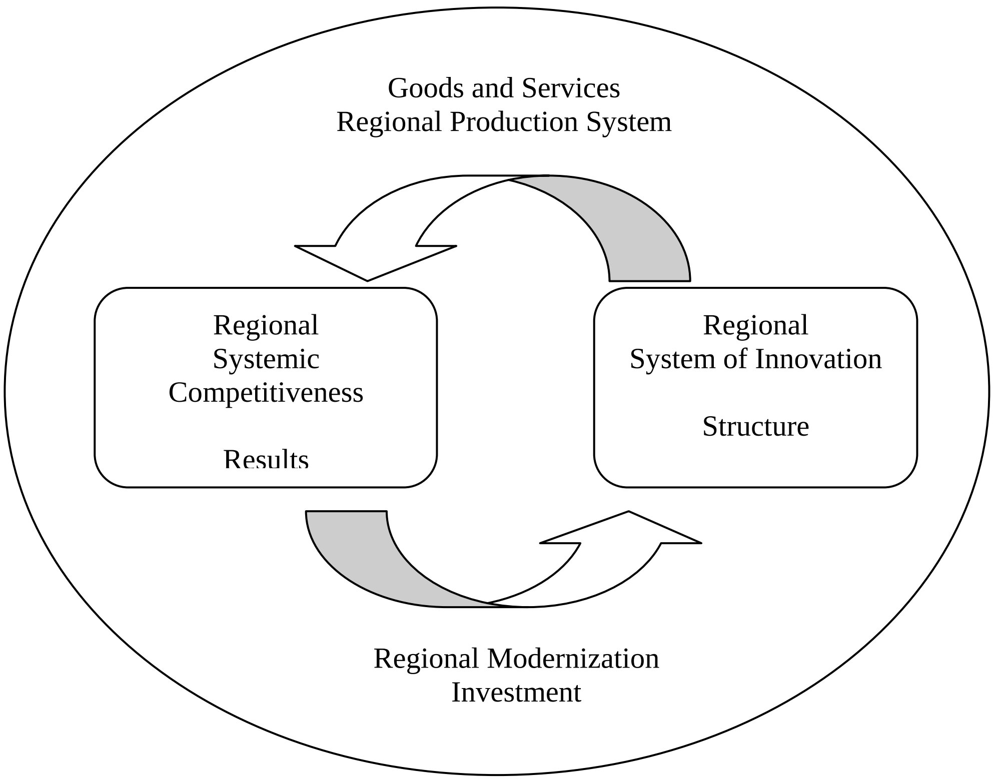
5. REGIONAL MODEL FOR COMPETITIVENESS.

The RSI affects the ability of the regional production system for developing, acquiring and to diffusing technical knowledge. This ability enhances the regional systemic competitiveness and the economic results are enlarged. This situation promotes the development of regional modernization investment and consequently the RSI is strengthened (see figure 1).

The regional model for competitiveness built considers four regional systems:

- The production system (goods and services production system)
- The investment system
- The employment system
- The human resources formation system.

Figure 1. Relationship between systemic competitiveness and regional system of innovation.

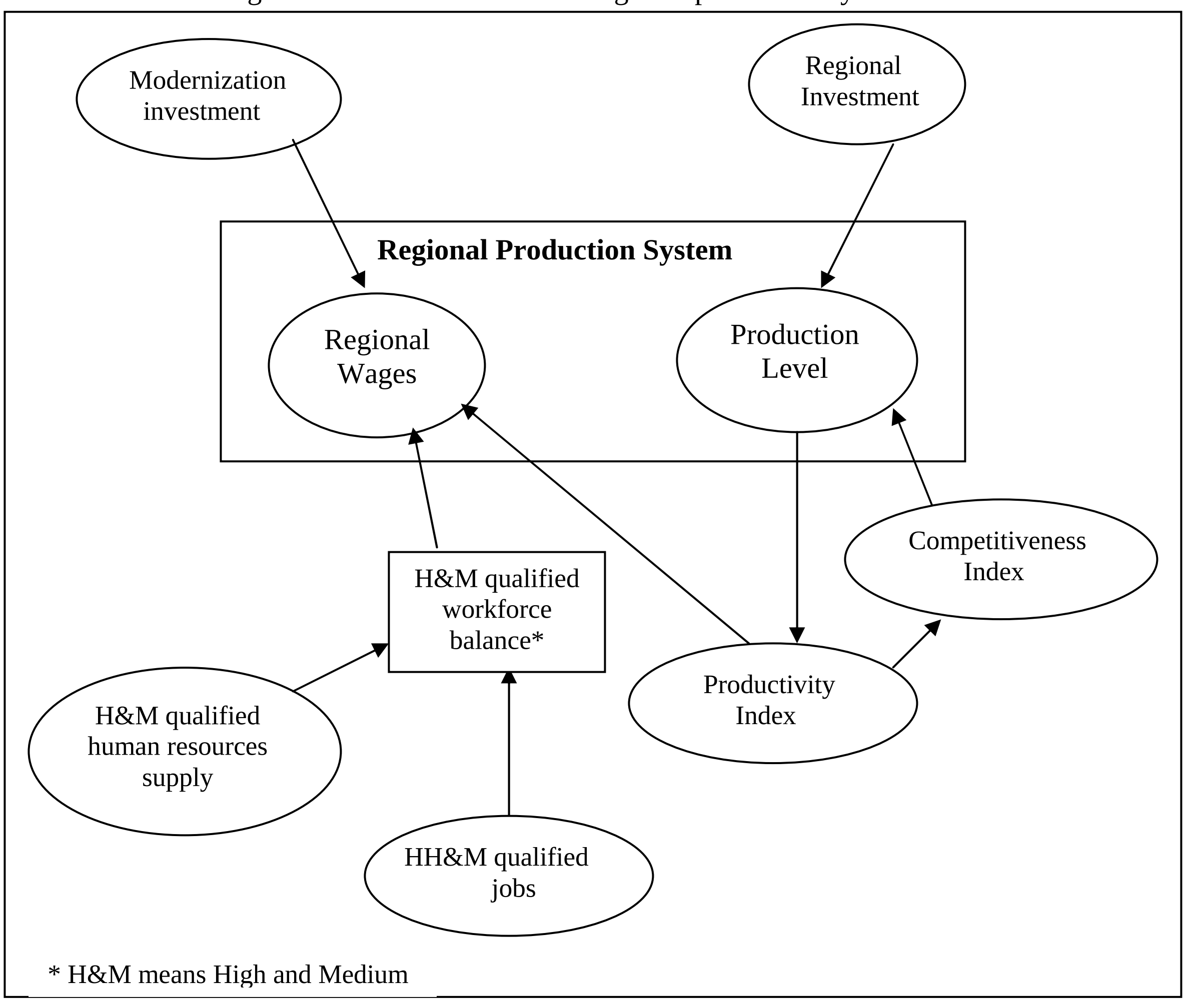


a. The production system.

The regional production system is represented by two level variables: regional production and regional wages levels. Increasing regional competitiveness requires enhancing both variables. According to competitiveness definition, there will not be competitiveness augmentation if the production level enlarges, but not the wages level.

The regional wages increasing depends on the regional investment for modernization, the productivity index and the workforce balance related to high and medium qualified jobs (see figure 2).

Figure 2. Relevant variables in regional production system.



b. The investment system.

The technological change is driven by the regional investment process. The regional investment characteristics are relevant to define the regional production future system. The regional investment process it can be divided as shown.

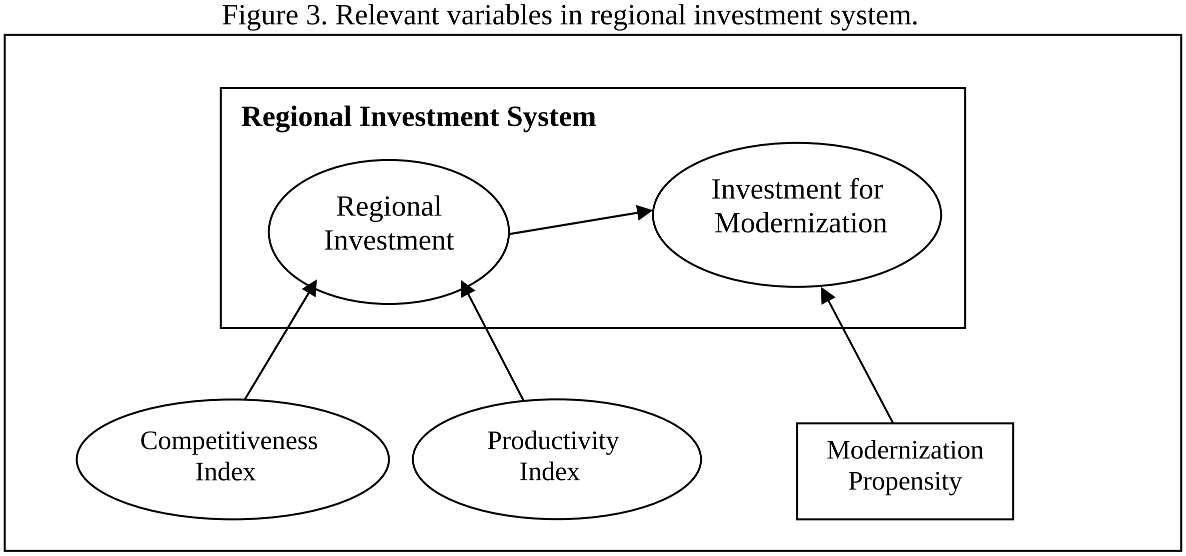
- Regional Investment
  - Work capital and maintenance
  - Capital formation
    - Infrastructure investment
    - Productive investment
      - Investment for enlargement
      - **Investment for modernization**
        - **Investment in equipment**
        - **Investment in reorganization**

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

- Applying new machinery and better equipment on technological and technical terms.
- Developing investment projects related to new products, new production process, quality and productivity improvement, reengineering, training programs, and so on.

This kind of investment is related to a reorganization of the production system.

Figure 3. Relevant variables in regional investment system.



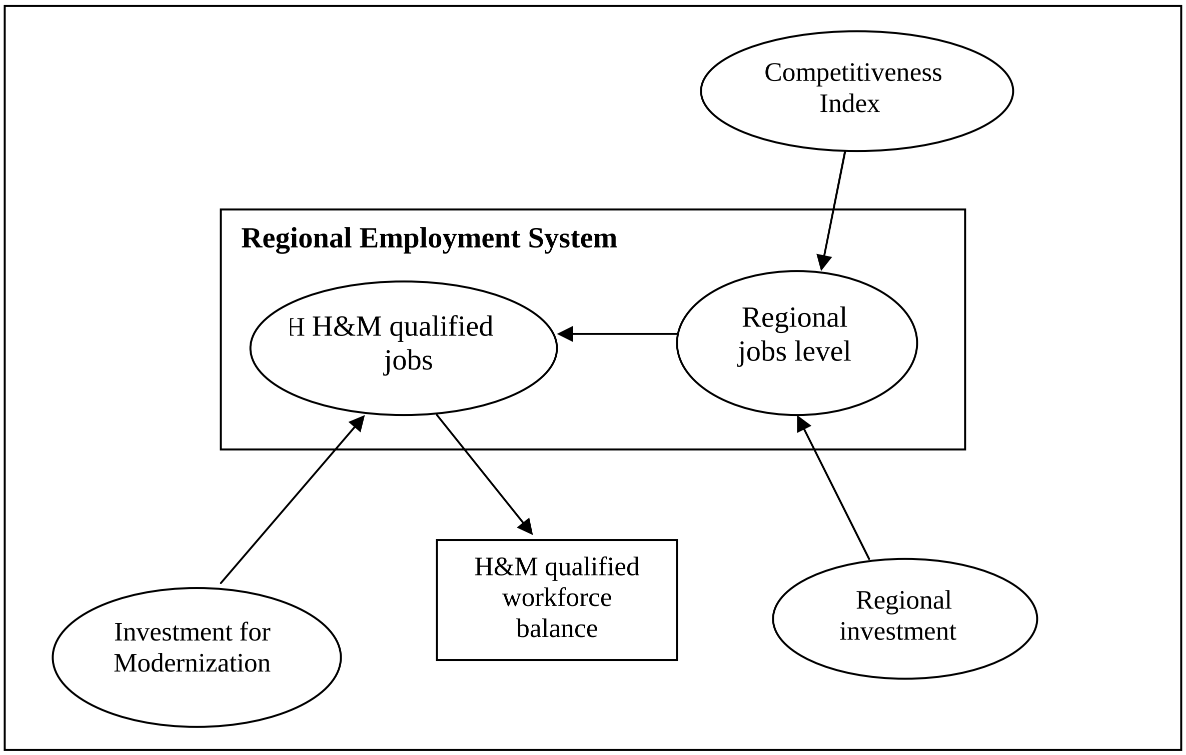
The regional investment system is represented by two level variables: the regional investment and the investment for modernization. The last one is part of the regional investment (see figure 3).

c. The employment system.

The regional employment system is represented by two level variables: total regional jobs and high and medium (H&M) qualified jobs. The last one is part of the regional jobs level (see figure 4)

The development of H&M qualified jobs depends on the importance of regional investment for modernization.

Figure 4. Relevant variables in regional employment system.



d. The human resources education system.

The investment for modernization requires the regional availability of high and medium (H&M) qualified human resources. These human resources play a double role: they serve as change agents promoting projects of modernization, and as technical support in developing these projects.

The regional employment system is represented by two level variables: total supply of H&M qualified human resources and H&M qualified human resources working in regional educational organizations. This variable represents to regional capacity to educate the new H&M resources.

The regional H&M supply is integrated by the new educated resources in region plus the resources attracted from out the region (see figure 5).

e. The regional competitiveness index.

The regional competitiveness is evaluated by the dynamic model based on four regional systems behavior (see figure 6).

Figure 5. Relevant variables in regional human resources system.

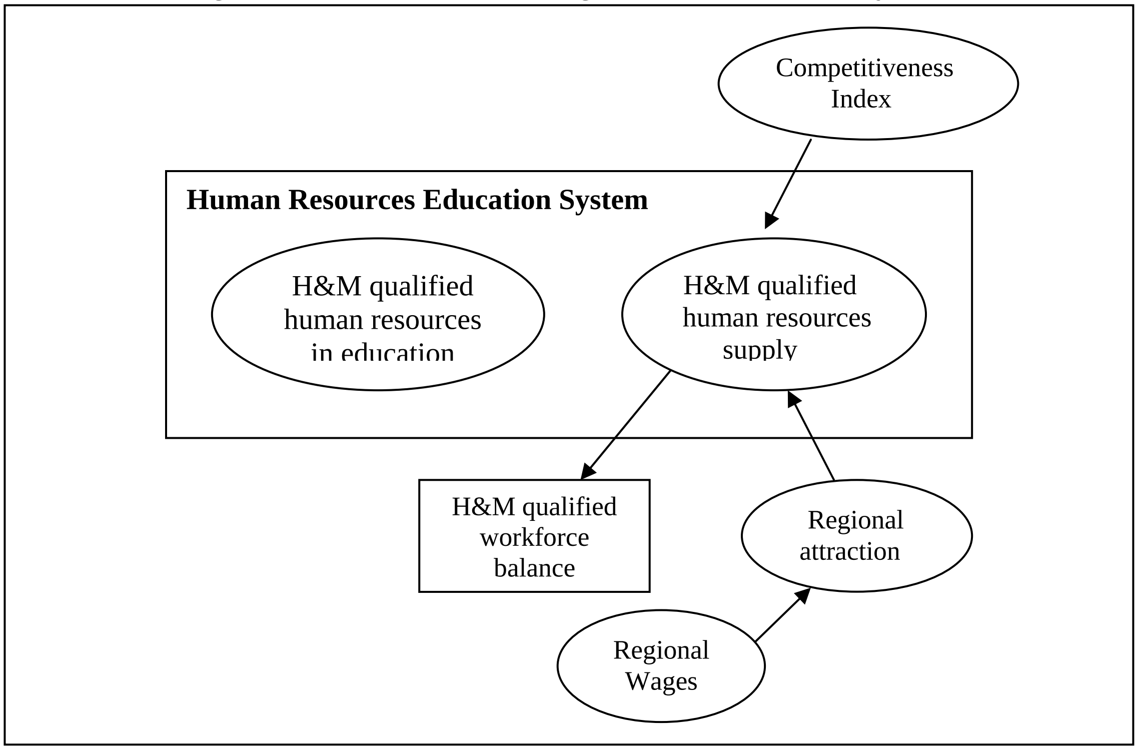
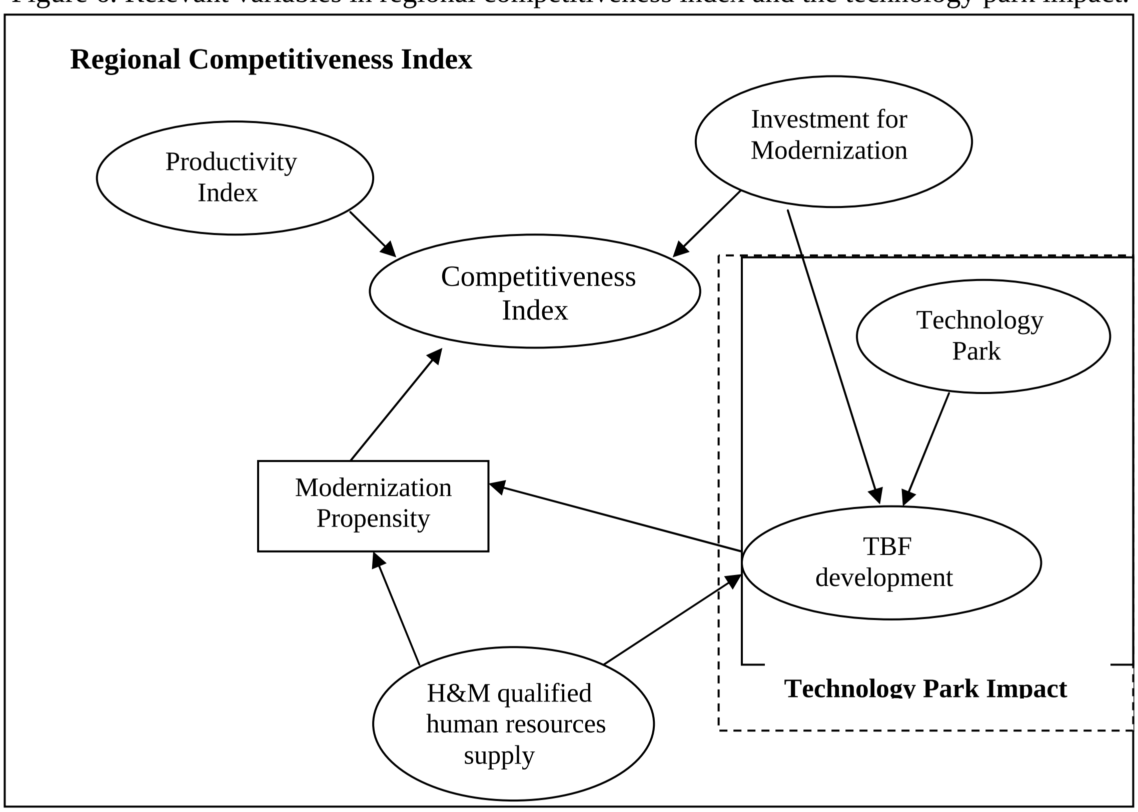


Figure 6. Relevant variables in regional competitiveness index and the technology park impact.



The dynamic model is able to relate TBF development to regional competitiveness throughout changes in the regional modernization propensity. The TBF development and an adequate H&M qualified human resources supply increase the regional willing to invest in modernization. The presence of a technology parks supports the TBF development.
The dynamic model introduces a constant defined as TBF Multiplier (TBFM). This constant represents the regional effort aimed to create and to sustain the TBF development. Technology park is an important regional effort related to TBF fostering.
If TBFM is greater than one, the number of employees working in TBF will increase faster.

6. Model application.

This model was applied to the Cuernavaca region in the central area of Mexico.
In 1989, the idea to build a technology park in Cuernavaca region was shaped. This project tried to reinforce the spontaneous regional process of creating TBF. In Cuernavaca, between 1988 and 1994 the personnel occupied in TBF had grown more than 5% annually.
In spite of this TBF development, in 1996 the technology park project was cancelled due to different reasons (López-Ortega, 1997a).
To evaluate the impact of this decision, a dynamic model was applied. This model was originally planned to study the regional competitiveness behavior (López-Ortega, 1997b). The model was adjusted in order to consider the TBF subsystem as part of the regional system of innovation. The dynamic model was developed using PowerSim software.
Two scenarios were considered: one with the technology park development aimed to promote TBF raise up and the second without it. Table 1 shows the main results obtained throughout the model application.

Table 1. Main results obtained with model application to Cuernavaca region.

Variable	Initial Level*	Scenario 1 (without TP)	Scenario 2 (with TP)
Year	1994	2004	2004
Number of TBF	42	67	74
Personnel occupied in TBF	525	800	958
Personnel/TBF	12.5	11.9	13.0
Productivity Index	1.000	1.524	1.580
Competitiveness Index	1.000	1.540	1.589
H&M qualified jobs Index	1.000	1.553	1.610
Regional Wages Index	1.000	1.530	1.605

* Considering the research results carried out in 1994 (López-Ortega, 1997a)

7. Conclusions.

The model application shows different results between the two considered scenarios. The most evident is the personnel occupied in TBF. In 2004, the scenario 2 shows more than 150 employees in TBF by comparison to scenario 1. Also, the personnel by TBF is larger in scenario 2; it could indicate a better consolidation process of TBF.
In scenario 2 it obtains also a little larger productivity and competitiveness indexes.
The regional wages index shows an interesting increase by comparison to scenario 1. This raise represents almost 5% more than scenario 1.

The dynamic model could be utilized in other regions to evaluate the technology park impact. To do this, it is necessary to carry out some adaptations in order to express the specific regional conditions.

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