



Leandro, C.R.; Amato Neto, J., Productive cooperation networks, knowledge and innovation: The case of Sorocaba Metropolitan Region”, *Proceedings of the 18<sup>th</sup>. Annual Production and Operations Management Society (POMS) Conference*. POMS, Dallas, Texas, USA.

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**Productive cooperation networks, knowledge and innovation: The case of  
Sorocaba Metropolitan Region**

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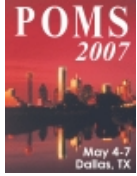
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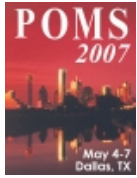
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## **Productive Cooperation Networks, Knowledge, and Innovation: the Case of Sorocaba Metropolitan Region.**

### **Abstract**

This study aims at analyzing the process of building competences to innovate through cooperation networks among private and public actors (companies, local government, universities, and non-governmental organizations) focusing a project of Sorocaba Metropolitan Region (SMR). The methodological approach of this paper is the case study, which is structured in the following steps: mapping the homogeneous characteristics (regional industrial identity) among firms; the second step explores the competences for innovation required within the production chain; the third step explores the design of system knowledge within the inter-firm network , it means how firms acquire, codify and transfer knowledge among them to coordinate innovation activities; the fourth step refers to the design and alignment of resources structure required within the network and how the public government, non-governmental organizations and universities can act together to work on the structure of distinctive resources.

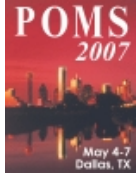
**Keywords:** co-operation networks, innovation systems, resource-based view, regional development.



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## 1. Introduction

Innovation is widely accepted by academics, politicians and entrepreneurs as an important part of the capitalism evolution (Schumpeter, 1934; Metcalfe, 2006; Belussi&Samarra, 2005). From economics to business strategy theories, innovation has been correlated to economic growth, equity and returns above the average (Penrose, 1959; Nelson and Winter, 2005 ). From a macroeconomic perspective politicians have already noticed that policies to control interest and exchange rates and keep inflation low are not enough to develop a nation’s economy. Nowadays, the national innovation system (NIS) is part of countries’ government policies whose goal is to stimulate the production of innovative products and services. NIS, very often, shows restrictions because it determines generic guidelines for the whole economic society while regions and industrial sectors are different in many aspects: available resources, culture and current level of development. Although NIS represents a good initiative of central governments, it is very difficult do discuss, in a macro level, what specific resources are required for each region or sector and sometimes the combination of both. Although innovation system is a result of the interaction of the whole society, it comes true in a microeconomic level, meaning products and services developed within an innovative concept by microeconomic agents. Firms, responsible for these products and services, frequently seek for innovation, but the difficulty to obtain all tangible and intangible resources to innovate, make their individual strategy impossible to practice.

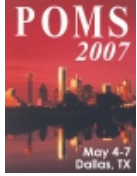


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Within this context, some authors believe that the innovation system and economic development are dependent on mesoeconomic studies. Mesoeconomic could be understood as an intermediate level between macro and microeconomics; a branch of the economic theory to study endogenous growth factors. Dopfer et al (2004) complements that an economic system can be viewed as a complex structure of rules. When new rules are originated, adopted and diffused, new driving forces determine the evolution of an economic system. Knowledge has been the driving force in current economy. While policies at macro and microeconomics level stimulate the innovation system, the mesoeconomic level tries to answer how to align these policies within an efficient system of knowledge and resources management.(Metcalf, 2006; Bellusi&Gottardi, 2003; Bellusi&Samarra, 2005; Amato Neto, 2005).

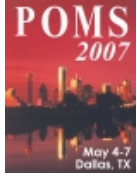
## **1.2 The Missing Link between Macro and Microeconomics.**

Mankiw (2004) defines microeconomics as the study of how households and firms take decisions and interact with market while macroeconomics studies the aggregated consequences of the microeconomic dynamics. This classical theory defends the Adam Smith’s invisible hand concept where market reaches desirable outcomes by the interaction between consumers and producers. The central role of the government, in this theory, is to protect the invisible hand when market fails. For Belussi&Gottardi (2003) and Nelson and Winter (1982) this classical theory does not explain the dynamics of the current knowledge-based economy. Empirical studies explored by these authors reveal that regions and industrial sectors in developed countries have produced



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economic returns above the average. Complementing these studies, Amato Neto (2000) evidenced in some Brazilian industrial districts endogenous growth stimulated by the capacity of firms to create and explore knowledge over specific resources. These studies contribute to show that firms are quite responsible for creating their own technology as a result of productive knowledge. Following Schumpeter’s theory of business cycle, the classical economics theory cannot explain why firms, regions and industries, grow above the average. This process is well understood by both, public power and the whole society, but one question remains open: Why is it so difficult to design an effective innovation system? This paper works on a proposition that only NIS (at a macro-perspective level) and companies’ business strategies (at a micro-perspective level) are not enough for creating innovation system. Innovation goes beyond both levels. It depends on market and non-market actors relationships (Metcalf, 2006; Amato Neto, 2000). Chung (2002), complements that NIS has lost relevance to Regional Innovation Systems (RIS) and Sectoral Innovation System (SIS). The main reasons are that regions are able to identify all resources for an innovation process aiming at stimulating specific sectoral development. Regions do not have the power of creating economic policies or determine how companies’ business strategy should be. Regions can influence on a mesoeconomic level where they are responsible for promoting interactions among regional and sectoral market and non market actors as an attempt to align macro and micro perspectives of innovation systems.

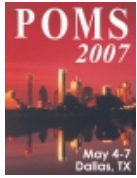


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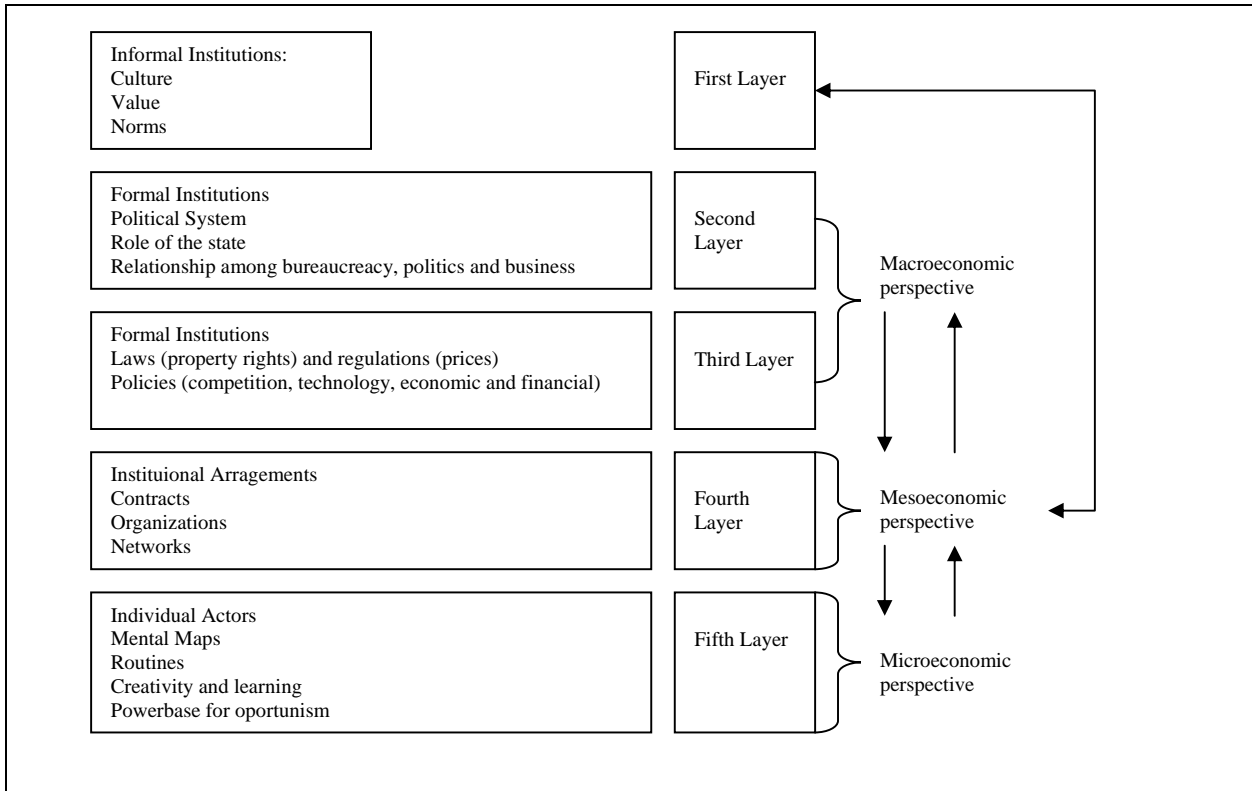
Ohmae (2006) evidenced this process by analyzing the international capital flow to regions instead of nations. For this author, global investors believe that regions are becoming more important than ever due the specialization and innovation capabilities.

### **1.3 The role of Meso-economic studies within Innovation Systems.**

According to Schumpeterian school, innovation is an economic act and does not only depend on new technological inventions but mainly on new perceptions of market opportunity (Metcalf 2006; Edquist, 2004). This understanding creates a challenge for the innovation process and some questions must be asked (Metcalf, 2006; Belussi & Gottardi, 2003, Amato Neto, 2000): ( I )What information is necessary to be obtained from the market and how to convert this information into market knowledge? (II) How can market knowledge be converted into information and transmitted to the innovation system (NIS, RIS and SIS)? (III) How can this information be absorbed by regional actors and transformed into industrial productive knowledge? These questions, frequently, remain open because each nation, each region and each sector has its own dynamics. The proposal of discussing innovation systems at a mesoeconomic level is the potential power of aligning institutions (from a macro to a microeconomic perspective) in an evolutionary path. It is possible to draw multiple layers of interconnections among institutions within an innovation environment (Groenewegen & Van der Steen, 2006, Pelikan, 2003):

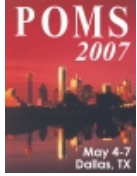


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**Figure 1. Hierarchical Layers of institutions (adapted from Groenewegen and Van der Steen, 2006).**

The first layer, in figure 1, shows that local culture and values has interference on the innovation system. The informal institutions are very important to the innovation process because they reveal how society acts and reacts to the environment. The second and third layer represents the formal institutions at a macroeconomic perspective. These institutions are represented by central government and they are responsible for coordinating economic activity through regulatory frameworks. The fourth layer, at a mesoeconomic level, represents the mechanism of governance to coordinate the innovation activity within a regional and sectoral perspective. Institutions at a



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mesoeconomic level understand the goal of formal institutions and help them to be more effective on polices and law constructions. The first layer and its impacts on the innovation system are also dealt at the mesoeconomic level. Institutions, at a meso level, are organized to determine how regions and sectors must function and which resources are required for innovative acitivities. The last layer, the fifth one, represents all microeconomic actors responsible for translating the whole innovation system into products and services.

#### **1.4 How Cooperation Networks Play a Mesoeconomic Role and Promote Competence to Innovate.**

Cooperation Networks, according to Amato Neto (2000), represent strategic alliance among several actors (market and non market actors). Several reasons stimulate network building: to build competences, to share risks, to get scale and scope economy, to get competition power and to share resources. Recently due to knowledge production and diffusion among actors, networks are also recognized as a form to stimulate innovation (Amato Neto, 2005; Lastres e Cassiolato, 2005; Belussi & Gottardi, 2003). Endogenous growth factors have been provided by the productive knowledge generated in cooperation networks. It occurs due the capacity of accumulating stock of tacit knowledge promoted by exchange of ideas, formal and informal relationships, techniques and routines. The knowledge accumulated leads to an incremental process of innovation as result of continuous learning process (Belussi & Gottardi, 2003).





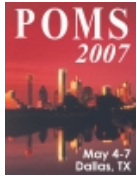
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Knowledge is considered as a key resource and it is responsible for creating and exploring new resources for promoting innovative activities. Researchers from business management believe that resource-based theory provides a valuable perspective to understand the process and pace of entrepreneurial economic development (West&Bamford, 2005). Penrose (1959) through an important research evidenced that companies’ economic returns were determined by resources available. Later, Wernerfelt, (1984); Dierickx&Cool, (1989); Barney (1991); Dyer (1997), state that firms resources are categorized as follows:

1. Human: skilled people oriented to the firms strategy.
2. Technological: the level of technological knowledge available.
3. Organizational: how the internal processes are oriented to the market.
4. Financial: access to low interest rates to invest in R&D.
5. Reputational: how consistent is the firm performance.
6. Regulatory (legal restrictions): how sensitive is the firm to local or international law.
7. Positional: who determines the governance of the productive chain.
8. Cultural: the behavior of the firm.

These authors complement that the resources must have four attributes:

1. Resources must be valuable: in the sense of exploiting opportunities.
2. Resources must be rare: the ability of managing resources combination leads companies to reach better market position.



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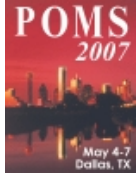
3. Resources must be imperfectly imitable: the capacity of the firms to go on innovating, it means, through resources, firms must be the first movers.
4. Resources must not have equivalent substitutes: if a resource can be obtained by any other firm, it is not a source of competitive advantage.

The categories and attributes of resources mentioned above can be stimulated, explored and aligned if regional actors cooperate within a strategic alliance. It means that cooperation networks can promote competences to innovate through resources management (KANTER, 2000).

Fleury & Fleury (2004) argue that competence can be understood as the way a company or a person mobilizes, integrates, and transfers knowledge, resources and skills in a responsible behavior producing economic value for organizations and social value for the individuals. It is also very important to emphasize that, competence for innovating is supported by several sub-competences. Resources must be allocated within a complex structure.

## **2. The project for Sorocaba Metropolitan Region**

Brazil has one of the biggest economies in the world. In the last decade the country has fallen from the 8<sup>th</sup> position to the 14<sup>th</sup> due to low growth rate. The country’s poor growth performance occurs because the national productivity and innovation capacity of the internal industry is still weak. Regarding our discussions on macro-meso-micro analysis above, it is very important to mention that, historically, Brazilian society has been extremely dependent on central (federal) government policies and decisions. This behavior has led to a high industrial stagnation. In 2006,

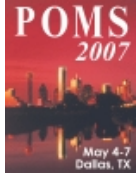


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Brazil’s economy grew by 2.5%. This scenario motivates new economic studies as an attempt of aligning macro and micro perspective through mesoeconomic lenses aiming at promoting the regional development of a São Paulo countryside region.

Brazil has already realized how important it is to develop internal industry so as to promote sustainable growth. In November, 2003 central (federal) government created a new industrial policy called PITCE (*Industrial, Technological and International Trade Policy*) which aims at driving efforts to stimulate innovation among several sectors (capital goods, software, semiconductors, nanotechnology, biotechnology and renewable energy). PITCE contemplates financial incentives for research and development (R&D), support for international market access and creation of a new institutional environment to facilitate the relationship between firms and government. In our opinion, this policy can only promote innovation if it is aligned with the firms’ business strategy due to the following reasons:

- 1) Innovation is dependent on the way knowledge is generated and diffused. Following Belussi&Gottardi (2003) studies, we also believe that productive knowledge does not come only from R&D activities, but also from the interactions among market and non market actors.
- 2) Innovation can only be reached if the knowledge system is able to explore current and new resources in a creative way.



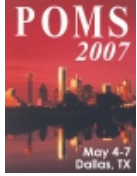
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- 3) Knowledge and specific resources cannot be defined by PITCE. Both points must be discussed at a mesoeconomic level (regional/sectoral). This occurs due the specific characteristics of regions.

We analyze one of the most important regions of São Paulo state and we propose a process of alignment of macro and microeconomic perspectives. São Paulo is the richest state in Brazil and maintains important regions such as ABCD (region where automobile industry is placed), Campinas (telecommunications industry), São José dos Campos (aero-spatial industry) among others. Sorocaba coordinates another important region of São Paulo, but is not recognized by any industry specialization. Officially Sorocaba and 15 boundary cities are not recognized as a metropolitan region by São Paulo state government although these cities (within 45 km of max. distance), maintain a closed economic and social relationship. This region shows good social and economic indicators. From a social perspective, Sorocaba Metropolitan Region (SMR) has 3,5% of the whole state population and performs a human development index above 0,8 (considered high). From an economic point of view, this region is responsible for (I) 3,5% of the whole production of the state, (II) 3,5% of industry added value and (III) 4,4% of the whole state labor force.

Although Sorocaba Metropolitan Region can be recognized as one important region of São Paulo, some points evidence the weakness of current level of innovation:

- 1) The industry production is distributed among: automobile parts, fabric and clothes, food processing, machinery and equipments, and chemical industries. The business strategy of all companies, in general terms, is constructed individually. The industrial data base of the

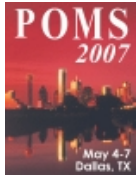


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- 2) local government recognizes these companies by the process common features, such as metal-mechanical based companies.
- 3) The regional public power maintains a new investment attraction policy oriented to fiscal incentives (tax reduction). New companies do not have incentives for investing in SMR for the specific stock of knowledge available.
- 4) Innovation strategies are only found in those firms that keep close strategic relationship with international companies.
- 5) The universities are not focused on R&D activities and the relationship maintained with firms is restricted to labor specialization (technicians, engineers and business management).
- 6) Non-governmental actors, such as unions, work as monitor agents of the regional unemployment and income level.

As SMR is an important region with good potential growth, our study aims at modeling a framework to stimulate endogenous factors for the innovation system. Before discussing the process of alignment between macro-micro level, the study was based on the following points:

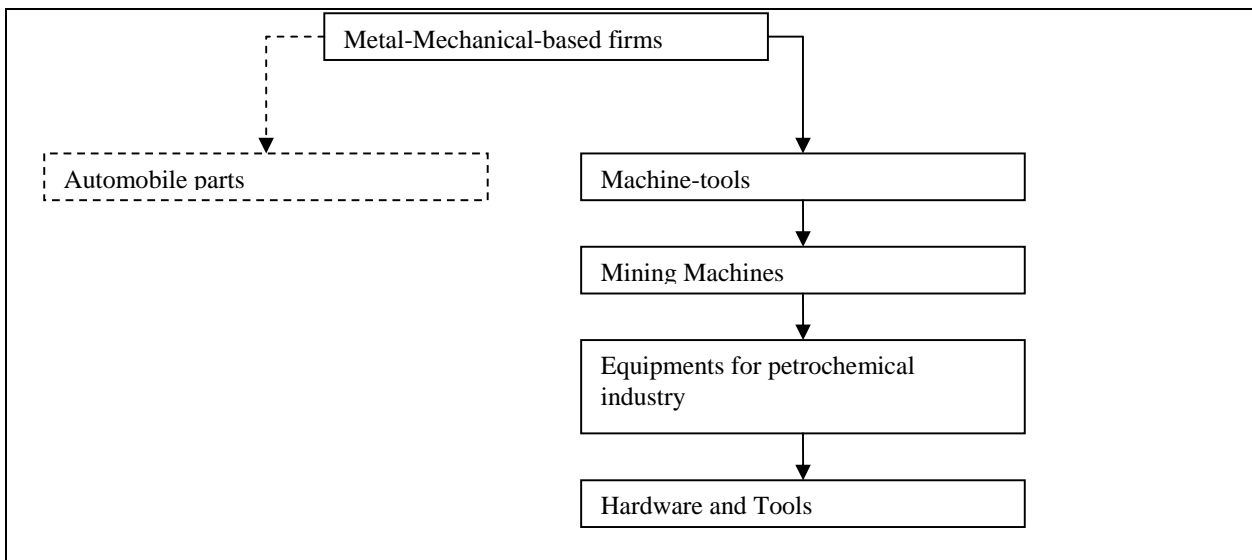
- 1) Is there a group of firms that could stimulate regional development through a sector sponsored by PITCE?
- 2) Can this sector integrate an entire region?
- 3) From a mesoeconomic perspective, how can cooperation networks coordinate the knowledge system and design resources to promote innovation?



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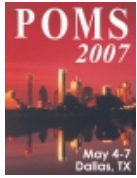
- 4) How can cooperation networks align institutions within a macro-meso-micro perspective?
- 5) Which are the market and non-market actors involved in this process?

The first step of this study was to identify the main feature of SMR industries. According to data available, metal-mechanical-based companies compound the majority of companies. Breaking down this information, we notice that all metal-mechanical companies are oriented, basically, to automobile parts and, machinery and equipments. Figure 2 illustrates this composition:

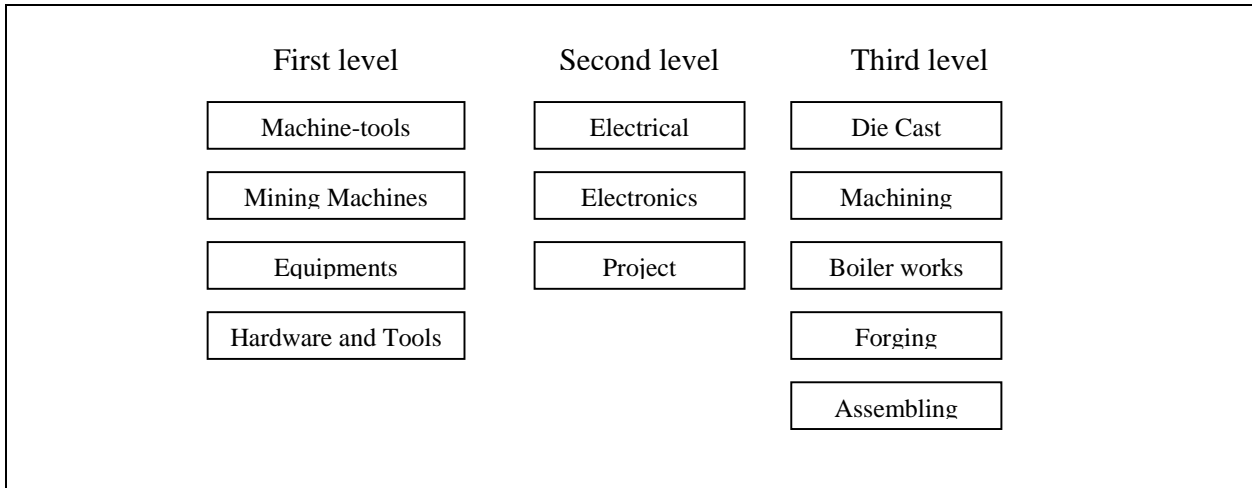


**Figure 2. Detailing SMR Metal-Mechanical-Based Firms (source: authors)**

PITCE sponsors machinery and equipments industry due to the importance of this industry for the nation’s economic productivity. Although this industry is fragmented, it is possible to find three structure levels, for this industry, in SMR:

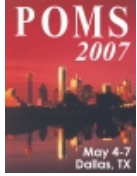


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**Figure 3 – Levels of the firms in the machine and equipments sector of SMR**

The first level refers to those firms responsible for projecting and determining how the end product must be constructed. These firms have power to translate domestic and international market needs into products and services. Among these firms are machine-tools manufacturers (CNC lathes and machining centers), mining machines, tools and hardware manufacturers and tailor made manufacturing for petrochemical industry. We understand that, companies in this level shall have an intense power of innovation due the knowledge accumulated. Firms on the second level are those that support companies at the first level. They are responsible for developing and producing motors, electrical materials, sensors, numeric control, logic control and projects. The third level is composed by firms which innovation capacity is dependent on the first level firms. Their manufacturing process is focused on machining, soldering, painting, bending and assembling parts. The interaction among all levels is restricted to buy and sell parts. Low flow of knowledge has been found and the architecture of resources differs among actors.



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The next step of our study is an attempt to convert the current dynamic into the innovation system through institutions alignment.

## **2.1 The Process of Competences Building and Resources Architecture for the Innovation System.**

The innovation system is recognized as the way how knowledge is generated, diffused and how it is used to explore all specific resources resulting in innovative products and services. We propose, in this study, a network cooperation to build competences and sub competences through an alignment of institutions. Knowledge is considered here as the key element to promote interactions in this structure. The main competences required are:

1) **Competence in knowledge management:** knowledge management is the main competence to be developed by the network. Customers willing to pay for innovative products and services are the main challenge for the innovation system. From this point, the knowledge system begins extracting information from the international and domestic market and converting it into market knowledge through cognitive models. For example, information about the future of new materials to be machined, accuracy, human safety, environment protection and productivity must be converted into a new concept of machineries and equipments. The knowledge constructed from market information orientates other sub-competences and the interactions among them. It means, market knowledge is transformed into information and transmitted to a new cognitive model to define technical possibilities. For example, the production of ultra-precision lathes involves the use of materials with low heat transfer coefficient, high level of





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vibration absorption, special linear motors and special electronic devices. This point is very important to integrate multiple areas of technological knowledge.

2) **(Sub)Competence in Projects:** As a metal-mechanical based industry, machinery and equipments industry requires a high competence in projects. This competence demands several resources: (I) access to engineering softwares (CAD/CAE) and (II) high skilled people. Although this definition can be simple, this competence refers to mechatronics projects, it means, alignment of mechanical, electrical and electronics specialists. This alignment also contemplates new areas of science, such as nanotechnology.

3) **(Sub) Competence in Mechatronics:** this competence refers to the capacity of mechanical, electrical and electronics engineering in developing solutions within systemic way. For example, faster power engines can increase friction, heat generation and vibration. The mechanical engineering must answer to this problem by researching appropriate materials and lubricants (ex. tribology). This competence also includes the firms’ capacity of processing parts with high precision: machining, bending, soldering, heat treating, assembling, casting, forging etc.

The competences, sub-competences and a brief discussion about generic resources supported by the alignment of macro-meso-micro perspectives are shown on figure 4.

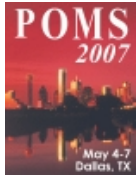
Although figure 4 shows briefly the main elements to promote innovation in machinery and equipments industry in the SMR, it evidences that the innovation process goes beyond a national innovation system policy and firms’ individual business strategy.



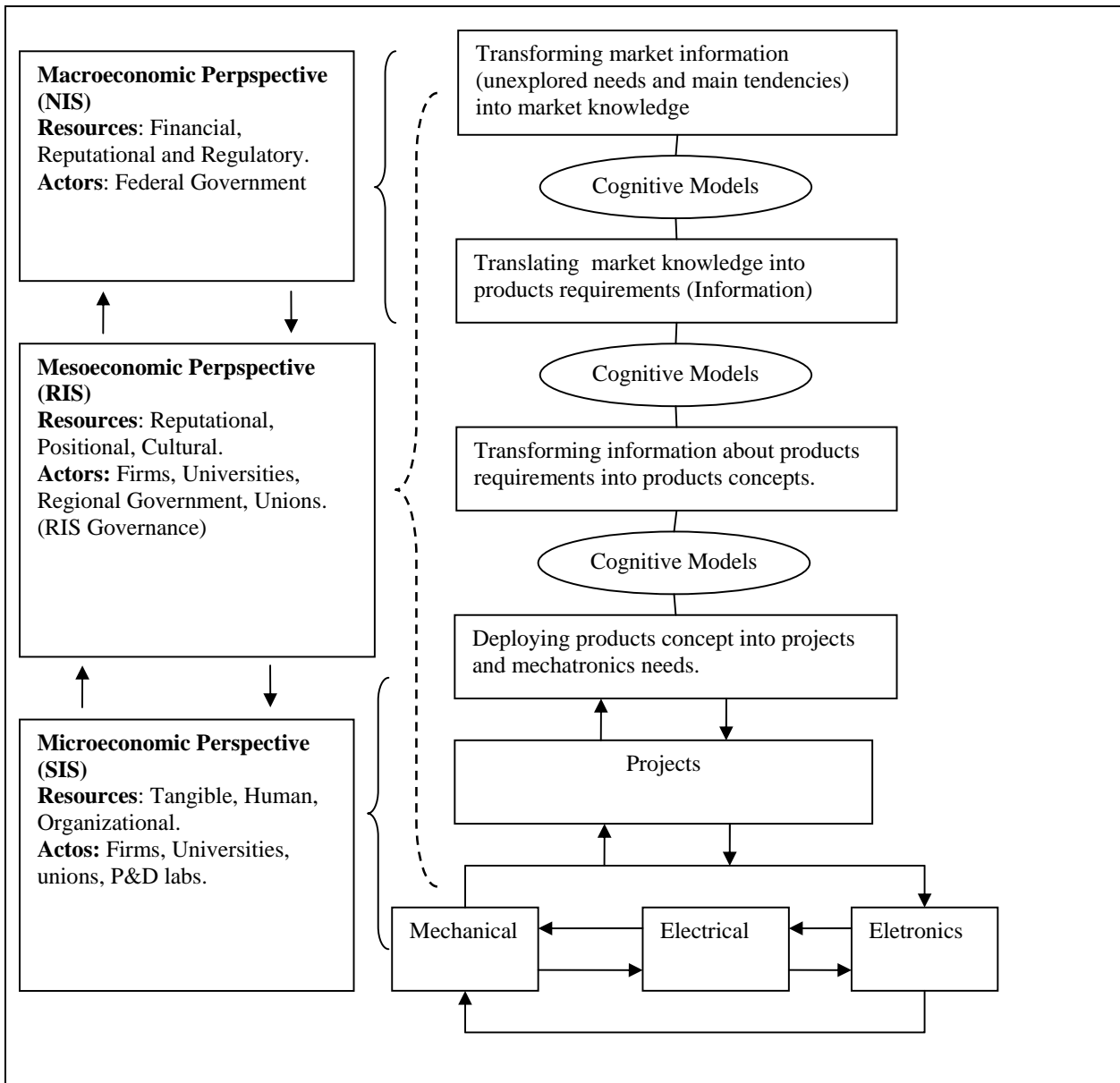
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From a macroeconomic perspective, the federal government plays an important role. First, NIS, here called PITCE, must facilitate the access of the Brazilian industries to the international market, helping the process of obtaining comparative and competitive advantage. Financial resources are also very important to promote R&D in universities and private laboratories. PITCE also maintains institutions responsible for helping transactions cost reduction, updating laws and creating new procedures to stimulate innovation. The next level, the mesoeconomic level, is very important to adapt NIS to regional/sectoral needs. In this case metal-mechanical based firms could be transformed into a machinery and equipments potential sector of innovation (from a regional perspective).

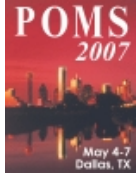
The power of mesoeconomic institutions is to develop regions according to the local features. At this level the network among market and non-market institutions need to promote specific resources such as (I) cultural change, where firms and people have to recognize the meaning and importance of creative destruction process; (II) knowledge is the main resource inside the network and it must be seen as the key element in the innovation system. All the time information must be processed into cognitive models and new knowledge must be generated and diffused. Before knowledge accumulation, the network must cooperate within an interactive learning process in a twofold way. Functional resources represent how actors can take place (as shown in figure 3) in the innovation chain. Firms positioned at the first level are responsible to coordinate firms at the second level (responsible for sub-competences) and at the third level (responsible for routines).



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**Figure 4. Macro-meso-microeconomics alignment of the machinery and equipments sector in Sorocaba Metropolitan Region - general overview (source:authors).**



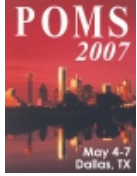
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Breaking down the network into a microeconomic perspective, firms are responsible for designing their organizational structures oriented to cooperative work, developing their workers skills and recognizing their role of offering tangible and intangible resources to other actors. Unions have an important role to help other institutions to change cultural behavior. Universities, not less important, assume (I) R&D activities, (II) coordinate the interactions among multiple areas of knowledge and (III) keep the regions aligned with the future of science and technology, for example, the expected impact on machinery and equipments from the nanotechnology.

As figure 4 shows, the innovation system for SMR is dependent on the alignment of institutions at macro, meso and micro levels. The evolution of knowledge system within this region is responsible to explore all resources promoting innovative activities for machinery and equipments sector. Beyond common resources for this type of industry, we expect this model can produce tradition, intense social relationship and a culture oriented to continuous innovation, because the most important point is the result of using all resources. The competence to explore resources could be understood as a resource itself: valuable, rare, imperfect imitable and impossible to be substituted.

## **Conclusions**

This paper began discussing the importance of mesoeconomics studies to promote innovation systems. In Brazil, this is very important due to the whole society’s high dependence on the central government. From this point two problems emerge in our opinion. First, from the

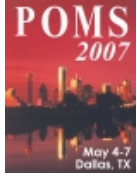


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government perspective, economic development policies have been a tradeoff between efficiency and equity, since the government cannot control endogenous factors homogeneously among regions. This happens because policies are oriented to the nation as a whole and regions grow according to their capacity of accumulating knowledge and resources. From the society perspective, these policies are always unfair and force the government to creating short-run social policies. NIS in Brazil requires a lot of effort from the whole society, but it must be oriented to regional/sectoral perspectives. It explains why decisions in a mesoeconomic level can effectively promote economic growth through innovation systems. Studies in this level reduce the usual question: who is responsible for sustainable economic growth? In our previous pages, we discussed that economic growth is dependent on innovation systems. Innovation begins from market information going down from macroeconomic to microeconomic actors, where the knowledge is accumulated as a result from the learning process. As it is a complex structure, we propose an alignment among institutions within hierarchical layers, what we call macro-meso-micro to reach from one side what NIS expects (economic growth and equity) and on the other side what entrepreneurs expect (economic value added).

The metal mechanical-based industry has been the driver of this study where a machinery and equipments innovation competence is desired. Future studies should be oriented to explore the operational feature of regional industry as a driver for a system innovation.

The contribution of this paper for a conference of operations management is the identification of production engineering studies within regional development. The innovation system must be seen



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as a result of alignment among several institutions, especially in developing countries whose culture is still being modeled to the new economic environment.

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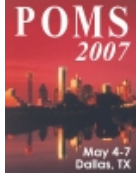
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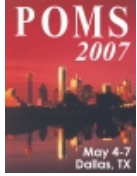
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