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A STUDY ON THE RELATIONSHIP BETWEEN LIQUIDITY PREFERENCE AND INNOVATION IN BRAZIL

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SUMÁRIO

ABSTRACT

This paper discusses and assesses the features of the Brazilian Financial System, as well as the impacts of Liquidity Preference on Regional Development in Brazil. In the post-Keynesian literature, money is considered endogenous to the economic system, introduced in the economic activity through the credit provided by banks. Taken as non-neutral, banks are economic agents which can present lower or higher liquidity preference. Because of that, banks are also particularly important to the development process. Precisely, we tested the influence of credit and the role of banks in regional development. We estimate a panel across states in Brazil in order to test the impact of liquidity preference and other financial variables on Brazilian states' number of patents, aiming at testing the importance of the bank system to technological progress and regional development. Conclusions confirm both hypotheses.

KEY WORDS: Monetary System, National Innovation System, Credit

JEL: R10, G21,O30

1. INTRODUCTION

The majority of the studies on regional economies take into account money neutrality, assuming the financial systems and regional flows as mere reflections of the disparities in the levels of inter-regional development. By considering the neutrality of money, only real variables would affect employment, production and income. On the other hand, if money is non-neutral, monetary variables can affect the income gap among regions. Recent studies such as Dow and Rodriguez-Fuentes (1997) argue that the non-neutrality of money is apparent not only at the national level but also regionally, impacting also on regional development.

In the post-Keynesian literature, money is endogenous to the economic system, introduced in the economic activity through the credit provided by banks. Taken as non-neutral, banks are economic agents which can present lower or higher liquidity preference, and because of that, are also particularly important to the development process.

Hence, it is possible to highlight at least three distinct aspects through which banks and the financial system can appear as crucial in development: (i) in boosting investment and capital accumulation; (ii) in financing innovative activity; (iii) and in the reduction in concentration of resources and breaking the centre-periphery dynamic (Albuquerque, 2005). For Celso Furtado (1983) the two initial channels are intimately interconnected, as innovation is frequently the result of the search for applications of accumulated resources by companies. Capital accumulation is central, given that technological innovations presuppose investments in specialized professionals and well-equipped R&D laboratories, among other costs.

The way in which the financial system impacts development, however, is still controversy. Levine (1997) and Stiglitz (1989) argue that well-organized financial systems, especially those focused on the stock market, lead to gains in efficiency through the increase in agents' information, reducing transaction costs and, thus, encouraging greater investment and growth. Zysman (1983), however, points out that diversification in financial system arrangements can lead to positive results, even through different ways, according to the level of development and the particularities of each country. In this case it is necessary to build models suitable for the distinct historical background of the countries. Taking this into account, the study of the way financial institutions perform within the different arrangements can help to improve the national financial system and provide an impulse to development.

The aim of this work is to discuss the impacts of liquidity preference on innovation, emphasizing the importance of bank performance and the configuration of the financial system in development. To study this relationship, we test the impact of the liquidity preference, credit and other banking variables on the level of innovative activity by state, considering the later as a proxy for technological development.

This paper is divided into five sessions including this introduction. In session two the theoretical foundations are presented. Session three analyses the historical features of the Brazilian Financial System (BFS), as well as the relationship between innovative activity and the financial system. Session four undertakes the empirical tests, which supports our hypothesis that money is non-neutral regionally. In the last session the final conclusions are drawn.

2. FINANCIAL SYSTEM, INNOVATION AND REGIONAL DEVELOPMENT

2.1. Financial System and development

The literature on regional economies provides little emphasis on money. Monetary flows are considered the result of the differences in development among regions and not their causes. Originally the idea was to reproduce national macroeconomic models at the regional level. Such a focus, found principally in more traditional work, allows, at the most, the evaluation of the influence of money in the short term. According to Richardson (1973) and Rodrigues-Fuentes (1998), such an approach can be explained by: (i) the fact that the principal trend in economics considers money neutral in the long term, not explaining impacts in the real economy at the regional level; (ii) the absence of instruments of intra-regional monetary policy; (iii) and the fact of regional economies being extremely open.

In taking money as neutral, even if only in the long term, the principal trend in economics assumes that income and employment are determined only by real variables. Money would only facilitate exchanges and price adjustments. Banks, by exercising merely the functions of financial intermediaries, allowing contact between savers and investors, would also be considered neutral. For the New-Keynesians, on the other hand, the banking system would affect the real variables at the regional level due to market failures, the result of imperfect or asymmetrical information, or through transaction costs. For post-Keynesians, however, both money and banks are non-neutral, which makes them an integral part of the economic process.

Even without a consensus on the direction of the causality, economists agree that credit serves as a central tool in economic development. The post-Keynesian literature deals with both credit supply and demand, considering them interdependent and both affected by liquidity preference. In relation to banks, the high liquidity preference, as a result of economic uncertainty, affects negatively their willingness to offer credit. From the side of demand, liquidity preference influences the determination of the public portfolio, so that the greater it is, the greater the demand for more liquid assets, and the less the demand for credit (Keynes, 1936). In addition to this, in encouraging portfolio decisions with shorter due dates, higher public's liquidity preference ends by reinforcing credit restrictions, once banks will try to adjust their liabilities and assets, reducing the term of the credit extended (Crocco, 2006).

Dow (1982, 1987) developed models in which the financial system, together with the real side of the economy, can generate unequal levels of regional development. Even having the same monetary basis, some economies would possess higher monetary multipliers the more optimistic are the expectations of agents on the prices of assets in that region. In this way, the local markets of these assets would be more liquid, resulting in a greater degree of financial development and better trade results.

Due to the high risk of default on the periphery; to the change of the marginal efficiency of the investment (which is affected by higher interest rates and less credit supply); and to the greater uncertainty towards income among the public, the liquidity preference in the peripheral region is higher. On the other hand, through less uncertainty and less volatility, the central region would have lower liquidity preference and for this reason displaying a more dynamic economy, with more liquid assets and higher bank multiplier.

By using Myrdal's (1957) theory of circular and cumulative causation, Dow (1987) argues that one of the sectors of the central economy that enjoys gains of scale and agglomeration would be the financial sector. According to the later, economies of scale lead to spatial concentration of financial offices in the centers, hindering the granting of credit on the periphery and reducing investment in this region in favor of the center. There thus occurs a separation of the locale of investment and that of raising of funds, of the locale of control and that of decision. In a backward region, as both the supply and the demand for credit are low due to the lack of development, credit scarcity reinforces the backwardness, creating a vicious circle of cumulative causation.

Because of all these factors, it is possible that certain financial system configurations work in the sense of increasing the disparities between centre and periphery instead of mitigating them. National banks lend less to the periphery, given its economic structure and the low control over its branches. Regional or local banks, that are specific to the periphery, will prefer to maintain higher levels of reserves and restrict loans, encouraging banking concentration in the centre. On the other hand, the smaller term of the deposits on the periphery, result of the greater liquidity preference of the public, imply that banks must reduce the term of their loans to harmonize their assets and liabilities, thus making less long term resources available for the region (Dow and Rodrigues-Fuentes, 1997). Such a situation hinders innovative activity, already low in the region, hindering still more the process of its development. In relation to the multinational banks operating in the country, these frequently have little or no activity in the more backward regions. The process of banking concentration in the centre is thus reinforced.

Such a theoretical referential indicates that regions with high liquidity preference and low banking access may suffer credit restrictions on the part of the banking system, which deters its development, thus generating a vicious circle.

Economic dynamism, by increasing the possibilities of gains for producers and banks, diminishes the risk of losses and, thus, influences directly the level of liquidity preference, resulting on an increase of credit availability. Regions with greater dynamism present low liquidity preference, higher expectations for investment and lower inherent risks. Such factors result in lower banks' liquidity preference, which means more credit at lower rates and greater propensity to long term loans.

In a peripheral region, where the economy is volatile and not very dynamic, the increase of the granting of credit can have profound impacts on its economic performance. Credit increases investment and result in the increase of production, employment and income. The greater money supply and the greater optimism about economic conditions makes public's liquidity preference diminish, raising the choice for less liquid assets and reducing the hoarding money. Both the investment on innovative processes and its finance are benefited, as the demand for less liquid assets raises both by banks and public.

Increases in aggregate demand, on the other hand, boosts the optimism of the producers as regards profits and stimulates a new round of investment, increasing production, employment and income once again. Gradually, therefore, uncertainty in the region falls, dynamism increases, and the liquidity preference reduces, thus creating a virtuous circle of circular and cumulative causation of growth (Myrdal, 1957).

The increase of credit supply is crucial in this process, once it impacts on agent's expectations. If the investments financed succeed, the optimism of the economy would raise, generating a cumulative process. The *animal spirits* is the key to relate the Keynesian concept of liquidity preference to the innovative behavior of the Shumpeterian entrepreneur (Schumpeter, 1934).

2.2. The Financial System and National Systems of Innovation

The financing of innovation activity is central in economic development. Innovative activity, being a long term investment and of uncertain return, is surrounded by great uncertainty, which makes its finance difficult. In addition, information asymmetry between lenders and takers worsen the situation. Researchers generally have greater knowledge about the research undertaken than lenders, which makes risk evaluation difficult. Nevertheless, the manner of financing innovation is of great importance to the conformation of the National System of Innovation (NSI).

Gerschenkron (1962) stressed that the technological gap represent a great possibility to the developing countries. That possibility, however, is not easy to be fulfilled. First, there may be an important part f the society that will resist to change (normally those who benefits from the underdeveloped condition). Second, late starters face larger capital requirements, making its finance harder. Third, it is required the development of new institutional instruments (above all in the financial sector), which would help in the developing process.

That conception of institutional and organizational configurations that make possible to the country to absorb foreign technological innovations, and its interaction with the particular cultural environment of each country, was what Lundvall (1992) and Nelson (1993) later called National System of Innovation (NSI).

The incorporation and generation of innovations are central to economic development. When an innovation is introduced, an opportunity for extra profits is opened. As Abramovitz (1986) and Perez and Soete (1988) pointed out, the reduction of the gap of the capital stock between developed and underdeveloped countries is only possible with the internalization of the creative process and the productive incorporation of innovations in the underdeveloped countries: the so-called process of catching-up.

On the other hand, according to Abramovitz (1986) there is a lag between the innovation in central countries, capable of pushing forward the knowledge frontier, and technological diffusion in peripheral countries. The first step in catching-up is to reduce this lag. In this way, if diffusion of innovations in backward countries is simultaneous (or quasi simultaneous), then they will achieve large gains without incurring the costs linked to the creation of the innovation, thus reducing the gap between center and periphery. However, for this process to occur, it is necessary to develop "social capabilities" that permits the diffusion of technical progress, mainly related to the increase in education and the creation of a scientific infra-structure, but also to the creation of a regulatory and institutional apparatus that supports and stimulates this process.

Albuquerque (1999) created an Opportunities Taking Indicator (OTI), which is the country's share in the total of patents granted by the USPTO divided by the share in the world total of papers indexed by the ISI. Under this perspective, the numerator would be a proxy for technological innovation and the denominator a proxy for scientific production. Thus, indicators close to or above 1 would indicate that the country analyzed possesses characteristics nearer to a mature NSI, whereas low indicators would indicate countries with characteristics more similar to an immature NSI. The greater the indicator, the greater would be countries' capacity to absorb international progress, by means of new national patents creation, in relation to the knowledge nationally created (scientific papers).

Although mature NSI present an institutional structure that supported and impulse scientific and technological development, it is important to emphasize that one does not find a fixed form of mature NSI, but that each central country has developed its institutional apparatus in accordance with the historical, social and economic context in which it was inserted. In the same way, the configuration of the financial system of these countries does not appear uniform, but presents important differences. The hypothesis of this work is that money and banks have impacts on the real economy, and may provide an impulse to development or hinder it. Based on this arguments it can be inferred that different arrangements of financial systems can also have distinct influences on economic results.

According to Levine (1997), the financial system, by reducing transaction costs, and those of obtaining information, would stimulate economic performance. Financial institutions would have five primordial functions: i) to help exchange, and offer protection from and diversification of risk; ii) to allocate resources; iii) to monitor the administrators and to exercise corporate control; iv) to mobilize savings[1]; and v) to facilitate the exchange of goods and services.

Besides, once Levine's (1997) central focus is problems related to information, he considers the financial system as fundamental in the identification and financing of innovative activity. This relationship, however, can occur in different ways. Zysman (1983) argues that it is possible to differentiate three types of financial system: i) one characterized by the predominance of the stock market; ii) the other by the predominance of credit with administered prices; iii) and a last by credit with a limited number of financial institutions (big banks). According to the author, each one of these structures causes different consequences in the economy, influencing the basis of policies to be adopted by governments.

Zysman (1983) argues that the first model would be strongly connected to developed countries, such as the United States and the United Kingdom. This occurs because these countries underwent slow and gradual development of their stock market, accompanying the development of the industrial and productive structure, which allowed them to base their financing structure on this market. On the other hand, the other two systems would be more suitable for less developed countries. Having lower capital accumulation, lower productive scale, lower market incentives, and less developed stock markets, underdeveloped countries rely higher importance to the credit market. The government should act as coordinator, motivating and providing orientation for the credit, seeking

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[1] The interpretation of this item can be controversial, and for this reason demands some explanation. It is possible that this item can be interpreted as the capacity of the financial system to "motivate" savings, which would then revert to investments. The Keynesian theory, however, considers the volume of savings determined by the level of investment. The capacity to "mobilize savings", accordingly, is here interpreted as the capacity to raise the magnitude of credit (bank multiplier) with the same base of deposits.

consolidation of the industrial structure in the country. The most important countries that fit into this category are Japan, France and Germany, which had latter development.

Following a similar characterization, Christensen (1992) points out that companies in countries with a financial system of the first type would have a greater focus on the financing of investment with their own capital, whereas companies in countries with financial systems of the last two types would have a greater part of their investment financed by banks, through credit. In this way, it can be seen that in still less developed countries the predominant form of financing is bank credit, even if the manner of conciliating this financing with industrial policy and innovation is different. However, in spite of the differences in the form of investment financing, as regards innovative activity, the literature presents evidence that companies normally use primarily their own resources to finance such activity. In this way, with the expansion of credit for investment in capital goods, the need to channel own resources for this purpose is reduced, thus liberating greater amount of resources to be employed in innovative activities and in research and development (R&D).

3. FINANCIAL SYSTEM, AND REGIONAL INNOVATIVE DYNAMIC IN BRAZIL

To understand the current Brazilian Financial System (BFS) it is important to analyze the factors that shaped the way banks performed in the recent past. During the period of high inflation, the BFS established itself as solid and competitive, which would be confirmed during the 1990s. However, although it presented high efficiency as regards the agility of the systems of payments, a fundamental requirement for achieving better results with floating, the BFS continued to be inefficient in the allocation of resources for investments and in fostering productive activity. The constant attempts to revert this situation were frustrated. This phenomenon characterizes what Carvalho (2005) calls the "Brazilian paradox".

As incentives to the stock market were unable to transforming it into an important source of long term financing, the failure of most of the attempts at reform of the BFS resulted in long-term financing in the 1960s to 1980s remaining concentrated in the public sector – mainly linked to resources from the BNDES – and in foreign capital (Puga, 1999).

The beginning of the 1990s was internationally favorable for Brazil. The exchange-rate based stabilization Plan in 1994 was successful, which spurs short-run growth. However the BFS was still strongly dependent to inflationary gains. With the loss of income from inflationary gains, the earnings of banks with floating fell from 4.2% of the GDP in 1993, which was equivalent to 35% of the earnings of the financial sector, to zero in 1995 (Carvalho, 2005). At the same time, there was a process of banking concentration, as well as plans for the restructuring public banks. Nevertheless, high interest rates seen in Brazil over the last fifteen years made possible for the banking system to ensure their profitability without improving the credit, what ended up creating a repressed demand for credit.

This process also generated an increase in the concentration of bank branches and head offices. In relation to bank head offices, in 2004, 78.7% were in the South-East region and 9.3% in the Southern Region, totaling 88% of the head offices of banks in the country. The number of branches in

the South-East region represents more than double that the rest of the country, the figures presenting little variation over time. (Almeida & and Jayme Jr., 2008). Indeed, the share of the branches located in the South and South-East regions together, increased from 70.82% of the total in 1989, to 75.05% of the national total in 2004. This demonstrates how banking concentration in Brazil has been intensifying in this period.

The more significant results observed with the increase of financial concentration in Brazil are: i) the fall by half in the number of public banks, mainly because of the reduction in the number of regional public banks; ii) the increase in the number of international banks, diminishing a little at the end of the period, because of the strong competition with the already consolidated local banks; iii) the reduction in the number of private local banks, mostly due to the increase in the demand for minimum capital and M&As, with a recovery at the end of the period, however, being noticed. It is interesting to emphasize also that in 2004 one observes a share of 75.2% of the banks considered large in the total assets of the banking segment (Almeida & Jayme Jr., 2008).

As regards the relationship between the financial system, credit and innovative activity in Brazil, the starting point is the Industrial Survey of Technological Innovation (PINTEC) 2003, which researched 84,262 industrial companies with ten or more employees in the whole Brazil. The research shows that 28,036 companies (33.3% of the total) implemented innovations between 2001 and 2003. Of these, however, only 4,941 (5.9% of the companies, or 17.6% of the companies that carried out innovations) declare having had disbursements with R&D, with only 2,432 companies (2.9% of the total of companies, 8.7% of the companies that carried out innovations) possessing continued disbursements with R&D. The reduced number of companies that invest in R&D highlights the fragility of the Brazilian NSI, which leads to missing many windows of opportunity (Henriques, 2007). Furthermore, this lack of constant R&D investment makes difficult to use that variable as a determinant of the innovation.

In addition, it is further established that 86.79% of the disbursements in innovative activity were made in the South and South-East regions, which demonstrates the great concentration of this activity. In the same way, of the companies that declare having had disbursements with such activities, 83.06% of them are located in these two regions.

In relation to the source of financing of innovation, Henriques (2007) found that the utilization of own capital prevails in Brazil in R&D activities. In this way, evaluating credit availability in the country is considered of great importance, as with an increase of credit the possibility of reverting part of their capital into R&D exists. PINTEC considers further the acquisition of machinery and equipment as innovative activity, this being in fact the activity of greater relevance among Brazilian companies. Thus, as has already been stressed, capital accumulation itself represents a positive impact for development. In evaluating the credit made available by region, however, it was already stressed its strong concentration in the south-east region, which makes the development of the less developed regions difficult.

3.1. Opportunity Taking Indicator and Liquidity Preference

In this item the relationship between the liquidity preference and the creation of innovations is discussed. It is possible to highlight two ways in which the liquidity preference influences innovation. Firstly, the lower the first, the greater will be the preference for less liquid assets, encouraging investment in innovative activities, that are highly uncertain and have a greater period of maturation. Secondly, in being related to expectations, low liquidity preference implies greater optimism of agents, which represents stronger motivation for innovation.

Table 1 presents the numbers of the OTI developed by Albuquerque (1999). As already mentioned, the index seeks to evaluate to what point a country is in a stage of development characterized by an immature or mature NSI, reflecting thus its degree of development and capacity for the generation and assimilation of new technologies. In this study, however, this index is used to measure the greater or lesser maturity of the system of innovation of each Brazilian state and region. The index represents the share of patents registered in each state in relation to Brazil, divided by the share of scientific papers published in the same state in relation to the country. According to Albuquerque (1999), if the result is greater than 1, we can infer that the state possesses a dynamic innovative mature, being capable of incorporating the innovations created by the scientific frontier and also creating new ones (larger proportion of patents than scientific papers in the world total). If the index is below 1, then the state creates more knowledge than it can incorporate productively, thus having a still immature innovative dynamic, where one can presume a low interaction between the channels of creation, diffusion and assimilation of new technologies.

In analyzing Table 1, however, it is necessary firstly to stress that, as they are Brazilian states, some of them not very developed, some of the indexes calculated lose their explanatory power. As the numbers of patents and scientific papers are very low, small changes lead to a large impact in the index, which does not mean that the state in question really underwent a leap in its development. These are the cases of Ceará, Amazonas, Rondônia and Tocantins. In these four states one observes a greater number of patents than sciencficic papers, indicating a relatively low presence of research centers, which produces such distortion, given that both the values are very low.

Regarding the remaining indexes, they correspond to the theoretical underpinning pointed out by Albuquerque (1999). The less developed states in Brazil present indexes less than 1, while the more developed (Espírito Santo, Paraná, Rio de Janeiro, Santa Catarina and São Paulo) present indexes greater than 1. There are also a group of states that are at an intermediary level, with indexes quite close to 1, as is the case of Goiás, Mato Grosso[2] and Rio Grande do Sul. Finally, the insignificant result of Minas Gerais is worthy of note, which was the sole state of the south-east region to present an index below 1. This demonstrates its low capacity to connect the large scientific production found there with the production of patents, characterizing it more as a state with a still immature innovative dynamic.

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[2] Mato Grosso was the sole state that presented more varied behavior, beginning with an index above 1, and afterwards falling. Such a fact was due to the increase in scientific production in this state, while the number of patents was maintained with little variation. Due to this it was classified in the group of intermediary states.

TABLE 1

Oportunity Taking Indicator (OTI) of Brasilian States and Regions

State/Region	1997	1998	1999	2000	2001	2002	2003	2004
Acre	0,00	0,95	0,00	0,00	0,32	0,41	0,57	0,57
Alagoas	0,26	0,11	0,43	0,25	0,33	0,21	0,52	0,17
Amazonas	0,00	21,80	0,00	0,00	0,00	19,68	79,02	36,01
Amapá	0,00	0,00	0,00	0,00	0,96	0,00	0,51	0,00
Bahia	0,56	0,70	0,45	0,47	0,31	0,34	0,59	0,35
Ceará	30,63	14,85	15,00	39,30	64,07	29,27	47,21	35,25
Distrito Federal	0,26	0,23	0,31	0,20	0,24	0,33	0,19	0,20
Espírito Santo	1,80	1,52	1,39	1,32	1,35	1,94	1,76	1,16
Goiás	0,85	0,58	0,74	0,82	0,70	0,79	0,83	0,80
Maranhão	0,15	0,05	0,11	0,11	0,05	0,05	0,05	0,06
Minas Gerais	0,62	0,51	0,51	0,51	0,52	0,58	0,59	0,65
Mato Grosso do Sul	0,66	0,25	0,36	0,24	0,30	0,25	0,22	0,30
Mato Grosso	1,76	2,53	3,09	1,85	1,99	0,81	0,80	0,66
Pará	0,24	0,31	0,18	0,10	0,29	0,35	0,17	0,25
Paraíba	0,84	0,77	0,62	0,51	1,20	0,68	0,44	0,51
Pernambuco	0,20	0,33	0,28	0,24	0,24	0,25	0,20	0,18
Piauí	0,73	0,27	0,33	0,86	0,30	0,23	0,13	0,29
Paraná	5,72	5,42	7,06	5,28	5,45	5,36	5,24	4,79
Rio de Janeiro	1,18	1,38	1,68	1,43	1,42	1,19	0,98	1,00
Rio Grande do Norte	0,24	0,34	0,15	0,22	0,14	0,08	0,22	0,17
Rondônia	1,94	0,95	3,22	2,37	1,69	5,87	0,62	0,71
Roraima	0,00	0,00	0,00	0,36	0,00	0,44	1,32	0,00
Rio Grande do Sul	0,86	0,90	0,81	0,90	0,84	0,98	0,95	0,89
Santa Catarina	1,46	1,06	1,26	1,39	1,61	1,57	1,67	1,59
Sergipe	0,66	0,57	0,23	0,68	0,53	0,33	0,49	0,50
São Paulo	1,20	1,31	1,27	1,25	1,24	1,18	1,20	1,25
Tocantins	4,38	0,47	4,60	3,79	1,28	4,14	2,05	0,83
Brazil	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
North	0,55	0,60	0,54	0,37	0,56	0,74	0,78	0,68
South	1,41	1,32	1,37	1,47	1,43	1,53	1,52	1,48
Center-West	0,42	0,36	0,45	0,35	0,37	0,41	0,33	0,33
North-east	0,41	0,46	0,39	0,44	0,36	0,33	0,43	0,36
South-east	1,08	1,11	1,11	1,09	1,09	1,05	1,04	1,09

Source: Own elaboration based on INPI and ISI data.

Regionally, the index becomes more homogeneous. Less developed regions (North, North-East and Center-West) have OTI less than 1, whereas more developed regions (South and South-East) present OTI above 1. It is interesting to stress the more significant result of the Southern Region, which demonstrates its greater development during the period, in relation to the other regions. Such a performance indicates that this region is catching up in relation to the South-East, which is the most developed in Brazil. This also demonstrates the importance of the institutional pattern and of the productive structure, as even with a less significant scientific production, the Southern Region, because of its peculiar historical development in relation to the rest of the country, ends by presenting a large number of patents.

Regarding liquidity preference, we estimate for each Brazilian state an index, namely banks' liquidity preference (BLP), as proposed by Crocco et al. (2005). The aim is to analyze how it impacts the supply of credit, taking as given that in Brazil there is a repressed demand, caused by the long period of high interest rates.

In order to accomplish this objective, we used data on the financial institutions that operate in Brazil through the Brazilian Central Bank.[3] Among the accounts available, "credit operations" reflects the part of the banks' assets which possesses less liquidity, while "short-term deposits" and "long-term deposits", which belong to the liabilities, allow us to analyze the public's choices of portfolio, having the banks as intermediaries. Such accounts allow some inferences regarding the behavior of the banks, especially as regards the decision to supply credit or not according to their basis of regional deposits.

According to Crocco et al. (2005), in order to get the BLP, short-term deposits represent the most liquid resources that the banks have available, while Credit represents their less liquid allocation of resources, precisely their willingness to provide loans. In this way, the less the Bank is willing to lend, in view of its available resources, the greater will be its liquidity preference. The aim is gather how the banking system allocates its resources between assets of greater or lesser liquidity taking into account the characteristics of the region in which it is located and its available resources. What is expected is that in regions with greater economic uncertainty the level of loans will be less due to a greater liquidity preference of the banks faced with this uncertainty. In the same way, the level of development and of generation of innovation will be low, due to the greater uncertainty and the lower level of optimism of the investors.

$$BLP = \frac{Cash\ Deposits}{Credit\ Operations}$$

Table 2 shows the index of banks' liquidity preference computed according to such specifications for the Brazilian states, during the period from 1997 to 2004. Through the index it is possible to observe a number that separates developed and undeveloped states. The data are clearer from 1999. In this year Brazil suffered a heavy loss of capital, which forced a devaluation of the exchange rate and a large rise in the domestic interest rate. The result was the increase of the liquidity preference of the banks, which transferred credit resources to applications in public bonds, which are more liquid assets and subject to less risk. From this year on it can be perceived clearly that in the states of the South-East and South regions the indices are lower, while in the North-East and North the indices are higher. The Center-West, however, has indexes more like those of the South-East and South. This is explained by the presence of the Federal District in this region, which has very low indexes, and which affects negatively the average of the four states of the region.

It can be seen that both indexes, OTI and BLP, have a similar regional distribution, both being consonant with their theoretical references. Evidence exists, therefore, of the influence of financial variables on development, indicating the relevance of the relationship highlighted at the beginning of this section.

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[3] Source: Laboratory of Studies on Currency and Territory (LEMTe) of CEDEPLAR/UFMG.

TABLE 2

Bank Liquidity Preference of Brazilian States and Region

State/Region	1997	1998	1999	2000	2001	2002	2003	2004
Acre	0,32	0,41	0,60	0,61	0,41	0,54	0,40	0,44
Alagoas	0,11	0,12	0,12	0,15	0,20	0,31	0,31	0,28
Amazonas	0,24	0,06	0,23	0,32	0,41	0,59	0,57	0,54
Amapá	0,41	0,45	0,43	0,45	0,49	0,47	0,38	0,34
Bahia	0,12	0,15	0,14	0,14	0,17	0,27	0,26	0,29
Ceará	0,13	0,17	0,17	0,21	0,20	0,32	0,25	0,24
Distrito Federal	0,11	0,08	0,06	0,08	0,09	0,18	0,17	0,22
Espírito Santo	0,17	0,19	0,18	0,20	0,22	0,29	0,33	0,33
Goiás	0,05	0,14	0,17	0,19	0,22	0,27	0,24	0,22
Maranhão	0,08	0,20	0,18	0,21	0,24	0,36	0,36	0,31
Minas Gerais	0,14	0,17	0,15	0,17	0,20	0,22	0,21	0,21
Mato Grosso do Sul	0,08	0,11	0,12	0,14	0,19	0,22	0,19	0,19
Mato Grosso	0,06	0,09	0,11	0,15	0,20	0,25	0,21	0,20
Pará	0,07	0,22	0,23	0,28	0,34	0,48	0,48	0,42
Paraíba	0,25	0,31	0,19	0,21	0,26	0,29	0,26	0,25
Pernambuco	0,11	0,15	0,12	0,16	0,23	0,31	0,30	0,29
Piauí	0,16	0,18	0,15	0,16	0,17	0,23	0,25	0,25
Paraná	0,09	0,10	0,10	0,13	0,15	0,19	0,18	0,18
Rio de Janeiro	0,15	0,14	0,13	0,13	0,19	0,22	0,23	0,27
Rio Grande do Norte	0,13	0,22	0,15	0,17	0,24	0,32	0,31	0,34
Rondônia	0,15	0,26	0,33	0,43	0,41	0,46	0,41	0,37
Roraima	0,19	0,48	0,50	0,61	0,54	0,47	0,20	0,56
Rio Grande do Sul	0,10	0,10	0,11	0,12	0,15	0,18	0,17	0,16
Santa Catarina	0,16	0,15	0,17	0,21	0,24	0,28	0,27	0,28
Sergipe	0,05	0,23	0,15	0,18	0,27	0,39	0,39	0,38
São Paulo	0,07	0,08	0,08	0,09	0,09	0,09	0,10	0,11
Tocantins	0,13	0,16	0,17	0,21	0,32	0,39	0,32	0,33
Brazil	0,09	0,10	0,10	0,12	0,13	0,15	0,15	0,16
North	0,11	0,14	0,25	0,31	0,37	0,49	0,44	0,43
South	0,11	0,11	0,11	0,14	0,17	0,20	0,19	0,19
Center-West	0,08	0,09	0,08	0,10	0,12	0,21	0,19	0,21
North-east	0,11	0,17	0,14	0,17	0,21	0,30	0,28	0,28
South-east	0,08	0,09	0,09	0,11	0,11	0,12	0,12	0,14

Source: Own elaboration based on INPI and ISI data.

3.2. Brazilian Financial System and Innovation

In this session the share of the states and regions in the total growth of the variables are analyzed separately. Table 3 shows the amount of credit, number of bank branches, number of Patents and Industrial Designs in the National Institute of Industrial Property (INPI), and the number of Scientific Papers registered with the Institute for Scientific Information (ISI).

It can be seen that nearly all the regions lost branches, except the south-east, where the increase in the number of branches represents almost 200% of the country, Rio de Janeiro, the Federal District and São Paulo concentrating almost the whole national change (57.56; 13.9 and 143.9% respectively). We should especially draw attention to the large loss of share of the states of Bahia, Mato Grosso do Sul and Pernambuco (-20.49; -15.12 and -11.95% respectively).

With regard to credit, in spite of appearing at first sight a deconcentration, in fact what happens is the opposite. As the national variation of credit between 1997 and 2004 was negative (from approximately US$250 billion to US$230 billion), then one should interpret the data of table 3 with the sign inverted. What happened was a concentration of credit. The South and South-East regions present an increase, as the negative participation in the national reduction of credit indicates an increase in their case (19.99 and 14.84% respectively). The reduction of credit in Brazil during the period is attributed to the Center-West and North-East regions, and to a lesser degree to the northern region (57.03%, 54.68%, and 23.12% respectively).

TABLE 3
Variation of key variables

State/Region	1997 - 2004		1997 - 2004	
	Branches	Credit	Patents	Scientific prod.
Acre	-2,20	-0,13	0,23	0,08
Alagoas	-8,54	3,95	0,19	0,58
Amazonas	1,46	1,42	1,23	0,05
Amapá	0,24	-0,17	0,00	0,02
Bahia	-20,49	11,49	1,23	4,41
Ceará	-5,37	4,16	2,77	0,11
Distrito Federal	13,90	9,44	0,69	5,77
Espírito Santo	2,20	1,53	0,77	0,70
Goiás	-3,90	36,50	2,08	1,90
Maranhão	-5,37	10,48	-0,42	2,67
Minas Gerais	-4,15	-6,99	9,42	15,06
Mato Grosso do Sul	-15,12	3,03	-0,31	1,46
Mato Grosso	-7,07	8,06	0,69	0,56
Pará	-3,41	20,49	0,19	0,96
Paraíba	-6,10	-1,36	0,77	0,61
Pernambuco	-11,95	13,28	0,88	3,50
Piauí	-0,49	0,91	0,12	0,30
Paraná	-5,85	-4,90	14,50	2,35
Rio de Janeiro	57,56	1,65	1,69	4,54
Rio Grande do Norte	0,00	1,34	0,31	1,94
Rondônia	-4,88	0,06	0,04	0,09
Roraima	-1,22	0,46	0,12	0,11
Rio Grande do Sul	-9,27	-11,78	13,08	14,86
Santa Catarina	3,66	-3,31	15,88	6,32
Sergipe	-0,98	10,42	0,42	0,40
São Paulo	143,90	-11,04	33,38	30,38
Tocantins	-6,59	0,58	0,04	0,27
Brazil	100,00	100,00	100,00	100,00
North	-16,59	23,12	1,85	1,58
South	-11,46	-19,99	43,46	23,54
Center-West	-12,20	57,03	3,15	9,68
North-east	-59,27	54,68	6,27	14,52
South-east	199,51	-14,84	45,27	50,69

Source: Own elaboration based on INPI and ISI data, and LEMTe's database.

Analyzing the credit by state, the states of the center-west presented a reduction in their share in the national credit, singling out Goiás and the Federal District. In the states of the North we find an insignificant share in the reduction of the national credit. In the South-East, Minas Gerais and São Paulo presented increases in the share in the national credit, while Espírito Santo and Rio de Janeiro had a small fall (6.99; 11.04; -1.53 and -1.65 respectively). Among the states of the North-East, however, what is seen in general is a fall in their share. Among them, the states that presented the largest falls in the participation in national credit were Bahia, Pará and Pernambuco (-11.49; -20.49 and -13.28% respectively), while the highlight of the region was Paraíba, where there was a slight increase (1.36%). Piauí and Rio Grande do Norte had practically null participation in this reduction.

Regionally the results of patents are similar to those of credit, the figures for the South and South-East being more balanced. The states of the South stand out, with a high and homogeneous participation in all the three states. In the South-East, the highlight was Rio de Janeiro, which had very low participation in comparison with Minas Gerais and São Paulo (only 1.69% of the total growth of patents recorded between 1997 and 2004). Among the states of the North and North-East, practically all had insignificant participation in the national increase in the number of patents, only Ceará standing out, with participation of 2.77%, and to a lesser degree, Bahia, with 1.23%.

Regarding scientific papers, unlike the tendency observed in the other variables is the more relevant contribution of the Federal District, Bahia, and Pernambuco in the national increase of scientific papers produced (respectively 5.77%, 4.41% and 3.5% of the total increase of scientific papers in the country). On the other hand, Paraná, Santa Catarina and Rio de Janeiro present a moderate participation in the national rise (respectively 2.35%, 6.32% and 4.54%). It should be emphasized also that this variable represents a proxy for research centers, showing that scientific production can be high but not be reflected in the production of patents, indicating low interaction between the sectors of knowledge production and its productive appropriation. Nevertheless, scientific papers are interpreted as crucially important for technological progress, representing a strong input for patents creation (Crocco et al. 2007).

4. EMPIRICAL STUDY

In accordance with the theoretical foundations previously highlighted, in this empirical study we evaluate the impacts of credit and bank's liquidity preference on the number of patents generated by state, as a proxy for the level of development. Cavalcante, Crocco and Jayme Jr. (2006) estimate an equation in pooling by Ordinary Least Squares (OLS) testing the influence of liquidity preference on the credit offer for the period 1988 to 1999. Here, we estimate a panel data across states, taking the number of patents (Pat) plus industrial designs deposited in the National Institute of Industrial Property (INPI), for each Brazilian state.

In accordance with Wooldridge (2003), the panel data model presents some advantages over the cross-section or temporal series models. Working with multiple observations of the same unit permits the control of certain characteristics not observed of agents studied.

The estimated equations are the following:

$$Pat_{it} = \beta_1 + \beta_2 Credit_{it} + \beta_3 Papers_{it} + \beta_4 GDP_{it} + \beta_5 BA_{it} + \beta_6 lagPat_{it} + \varepsilon_{it}$$

$$Pat_{it} = \beta_1 + \beta_2 trend_{it} + \beta_3 GDP_{it} + \beta_4 BLP_{it} + \beta_5 lagBLP_{it} + \beta_6 BA_{it} + \beta_7 lagPat_{it} + \beta_8 Papers_{it} + \varepsilon_{it}$$

In the first model, the number of patents is a function of credit – variable of interest –, state GDP, population divided by the number of bank branches, the number of scientific papers for each state registered with the Institute for Scientific Information (ISI), and lagged patents – control variables.

The variables used are in logarithms for the set of the 27 Brazilian states for the period 1997 to 2004. The Consumer Price Index (IPCA) is the deflator, based on January 2006[4]. In this equation, population divided by bank branches for each state (variable BA, for bank access) represents the bank access of its population, thus trying to measure the level of financial exclusion. The variable scientific papers seeks to measure the capacity for knowledge creation of each state, and serve further as proxy for the presence of research and development centres within each state. What is expected is that the greater their number, the greater will be the development of the state. This variable can also be considered a proxy for centrality. The concept of centrality refers to the greater or lesser supply of sophisticated services (Christaller, 1966). The greater the supply of specialized services, the greater will be the degree of centrality of the determined locality. This is the case of research centers. It is expected that regions with greater centrality possess a greater number of research centers due to the presence of more specialized services and greater economic dynamism.

The lagged number of patents represents a proxy for a sort of learn-by-doing, related to the benefits of past innovations. However, it is not plausible to expect that an innovation will create a learn-by-doing process that will lead to other ones, once the innovative process is extremely uncertain. The creation of an innovation, nevertheless, can impulse other innovations related to the first one, or even create greater optimism towards the possible success of R&D investments. Having this in mind, it would be more appropriate to call the lagged patents an *innovative spirits* component. An innovation would push stronger *innovative spirits* in the firm, increasing their motivation to seek other innovations.

In the second model, the relationship we expect to find is that, the lower the liquidity preference, the greater the credit term, and the greater the financing of innovative activity, that is, that the fall in the liquidity preference has an impact on regional development. On the other hand, even if not directed specifically to the innovation process, credit would encourage innovation through opening the possibility of investments in R&D with accumulated resources. Also, capital accumulation itself and the incorporation of new machinery are important for development, from which one can expect that greater learning can be generated: advantages of learning-by-doing, more training, technical courses, etc. Because of that the acquisition of capital is considered as innovation by the PINTEC. In addition, as already argued, it is expected that the optimism of agents in a context of low liquidity preference stimulates as much innovative activity as it does the granting of credit. Finally, from better economic performance and the greater income deriving there from, greater spending on education and training is to be hoped, influencing positively the composition of the NSI and encouraging development. In the second model is also incorporated a lagged bank liquidity preference variable.

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[4] The data supplied by the LEMTe were already deflated on this basis, so the same deflator for the State GDP was used.

Panel data present multiple observations on the same economic units, having the characteristics of cross-sections and temporal series. Because of this, in a sample of panel data, each element possesses the group identifier i, and the time indicator t.

In addition to the advantages already pointed out, the tests with panel data also allow the consideration of individual heterogeneity, which is not possible with cross-sections or time series. Therefore, panel model presents more informative results, with greater variability, less collinearity among variables, greater degree of freedom, and more efficiency in estimation. The difference between the fixed effects model and that of random effects is that, while the first considers the non-observed effects as correlated with the variables within each unit – as in the case of socio-cultural factors of a particular region –, the random effects model specifies the individual effect as random – such as the effect of public policies decided at the national level –, accordingly not correlated with the explanatory variables nor with the error term.

To define which is the best model to be adopted it is necessary, however, to carry out some tests: (i) the F test tests the hypothesis of heterogeneity between the information; (ii) Breusch and Pagan's LM test also seeks to validate the hypothesis of heterogeneity between the information, individual variance now being tested (σ^2_i); (iii) while the tests above are utilized to validate the use of the econometric technique of panel data, once the hypothesis that estimation by panel is more suitable has been accepted, it is necessary then to define which is the appropriate technique for the estimation. The Hausman Test allows confrontation of the results of the models of fixed effects and random effects.

4.1. Results

Before analyzing the results of the tests it is important to make some remarks on the estimated models. Firstly it is important to stress that we chose to regress more than one equation in order to avoid problems of multicollinearity between the variables credit and BLP. Another aspect to be stressed is the specification of the dependent variable. In both models, the number of patents is not in logarithm. Although not altering the estimation process, it results in differences in the magnitudes of the estimated parameters and in the relationships established.

The regression results compare the estimates of OLS, Fixed Effects (FE), and Random Effects (RE). We intend to make evident the advantages of the utilization of the panel data model. Analysis of the results, however, gives attention only to the model indicated as more suitable by the Hausman test. In all the estimations the F and LM tests reject the hypothesis that there is no variability in the term of intercept, that is, rejecting that the OLS model is the most suitable. According to this, it was accepted in both the cases that the panel model is the most suitable. On the other hand, the Hausman test also in both cases indicated that the null hypothesis should be accepted, that the Fixed Effects model produces more consistent and efficient estimators. Such a result indicates the existence of non-observable factors linked to specific conditions of the state such as historical, cultural and social aspects, which do not vary over time and are correlated with the explanatory variables, resulting in the information not being independently distributed. In this way, the analysis of all the results will be focused on the numbers of the models of Fixed Effects (FE).

TABLE 4

Test 1: Analisis of patents determinants

Patentes	OLS		FE		RE	
	Coef.	p>|t|	Coef.	p>|t|	Coef.	p>|t|
Log Credit	-22,1507	0,398	40,13675	0,030	56,59646	0,003
Scientific Papers	1,0327	0,000	0,689999	0,000	0,749283	0,000
Log GDP_state	16,3768	0,504	-11,7748	0,506	2,169142	0,908
Log Pop/Branches	-49,7961	0,084	181,1665	0,014	-43,6332	0,270
Lagged Patents	1,002062	0,255	0,429917	0,000	0,42108	0,029
constant	775,5772	0,186	-2415,56	0,009	-775,603	0,203
Number of obs:	189		189		189	
R2	0,9136		0,6918		0,8974	
LM	394,83	Prob > X2	0,0000			
Hausman	29,68	Prob > X2	0,0984			
F test (5, 157)	160,42	Prob > F	0,0000			

Source: Own elaboration based on LEMTe's database, INPI and ISI.

Table 4 shows the numbers of the first test. In this model, in spite of the variables being found with the expected signs, the GDP is not significant to 5%. This can be explained because a considerable part of the patents registered in Brazil are obtained by Public Universities (federal and state universities), which decrease the effect of GDP on patents. Besides, PINTEC 2003 asserts that few firms have permanent R&D activities. Taking GDP as reference variable for the level of economic activity, we can see that its acceleration has low impact on innovation, which reflects the low orientation of firms to seek innovations.

The variable Bank Access (BA) is significant, showing that the access to the financial system has a positive impact over the innovation process. The number of papers and the lagged number of patents have also a positive impact, which demonstrates that both the knowledge input and the *innovative spirits* component, respectively, result in greater volume of innovations. As expected, the credit has also a positive influence, confirming the hypothesis that although it does not directly finance innovation, it opens the possibility for the firm to redirect resources to the seek of innovations.

TABLE 5

Test 2: Influence of BLP on the number of patents

Patents	OLS		FE		RE	
	Coef.	p>|t|	Coef.	p>|t|	Coef.	p>|t|
Trend	-20,5071	0,154	-13,3834	0,111	-3,99262	0,328
Log lagged BLP	-42,5703	0,343	13,26769	0,133	-2,2888	0,814
Log BLP	31,0257	0,570	-28,8189	0,020	-16,9526	0,214
Scientific Papers	1,0277	0,000	0,696043	0,000	0,758096	0,000
Log GDP_state	11,1315	0,471	92,72393	0,155	30,82249	0,236
Log Pop/Branches	-35,6980	0,086	222,1067	0,003	-88,0768	0,032
Lagged Patents	1,021973	0,227	0,436953	0,000	0,421631	0,035
constant	356,8544	0,086	-2934,33	0,005	613,2394	0,153
Number of obs:	189		189		189	
R2	0,9147		0,3441		0,905	
LM	414,58	Prob > X2	0,0000			
Hausman	12,07	Prob > X2	0,0984			
F test (7, 155)	117,44	Prob > F	0,0000			

Source: Own elaboration based on LEMTe's database, INPI and ISI.

Table 5 presents the results of the second test. The variable BLP is now included, representing the portfolio decisions of the banks. Once more, State GDP is not significant to 5%, as well as the lagged BLP. It shows that the actual liquidity preference is important, not the past. BLP is also significant and with the expected signal. The number of papers, Bank Access, and the number of lagged patents are also significant to 5%, and have positive signs, highlighting its importance for development. The trend is not significant to 5%, which supports the fact that there is weak long-run pattern of patents registered in Brazil, which once again stresses the fragility of the Brazilian NSI. Finally, regarding the size of the parameters, the observed difference relates to the use of logarithms of the remaining variables.

It is important to emphasize that it is supposed that the BLP would be not only directly related to the financing of innovative activity, as it represents bank's decision in lending or not, and how long would be the term of these loans, but also to the degree of optimism of agents. In indicating the level of expectation of banks in relation to the future[5], the relevance of these variables corroborates the initial supposition that the greater the optimism (the less the BLP index), the greater the development proportioned within each state. Those relations were confirmed by the test here developed.

Finally, accordingly to the PINTEC 2003, once few companies invest in R&D in Brazil, and once these companies generally make these investments with their own resources, it is of great importance to stimulate an increase in the number of firms that make such investments, as well as to increase the number of firms that maintain permanent R&D activities. Optimistic expectations on the part of the agents are central to achieve those objectives.

5. CONCLUSIONS

Throughout this work we emphasized the close relationship between the financial system and development. As stressed theoretically, the way in which the first is organized, given the historical and cultural particularities, impacts directly not only on the form of financing of investments, but also on innovative activity. Financial systems in developing countries such as Brazil, possessing stock markets with little organization and still immature innovative structure, generally tend to focus on bank credit as a means of leveraging capital accumulation (Zysman, 1983). On the other hand, PINTEC 2003 reveals that R&D is mainly financing by own capital of the firms.

It was also stressed that, the greater the level of economic activity and dynamism of a determined region, the greater the optimism of agents. However, more than influencing directly the financing of capital and innovation, the financial system has also another impact on economic activity and development. By being related to the money supply, it would have strong impact on the expectations of agents. In improving expectations, an impulse is provided for greater investment and greater innovative force among businessmen, thus encouraging greater development. In this way, stimulating better interaction of the financial system with the productive and innovation sector is shown to be the fundamental form not only of stimulating greater development, but also of promoting its maintenance, thus warranting the continuity of the circular cumulative causation circuit consisting of credit, investment and innovation.

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[5] Expectation of growth of income/product, as this expectation would be related to the expectation of payment of the loans granted by the banks.

On the other hand, it was also argued that in Brazil, given the excessive concentration of the BFS, a regional concentration of credit is observed as well as innovation, forming a centre/periphery dynamic where the centre concentrates all the dynamism, maintaining itself in a virtuous circle of growth. The periphery, on the other hand, presents greater risk, less credit, greater liquidity preference and lower returns, ending at a vicious circle trap. The BLP and OTI indexes, as also the credit and patents data, in presenting similar regional distribution, show the existence of correlation between the financial system and innovation, and also confirm the argument related to the centre/periphery dynamic.

The tests carried out here support the theoretical referential of this work, reinforcing the argument developed and stressing the importance of deeper studies on the theme.

In this study we made an empirical advance on the interaction between the Financial System and the National Systems of Innovation, especially emphasizing the influence of liquidity preference over capital accumulation and innovation. We intend to motivate new plans of research on the subject, such as the study of the factors that impact the decision for R&D investment, or even the estimation of improved models that include new variables and information. Intensifying those studies is of core importance for deepening the comprehension of the relations of money and technological progress.

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