Abstract
Innovation has become one of the important strategic tools to acquire and sustain competitive advantage both for firms and countries. Therefore, factors affecting national innovation ecosystems need to be investigated intensively in relevant literature. Availability of financial resources is argued to be a vital factor for fostering innovation and based on this argument the aim of this study is to explore the effects of financing opportunities on various elements of national innovation ecosystems. Financial markets and financial institutions are important elements of innovation ecosystems and the effects of them on R&D spending, university-industry collaboration and capacity for innovation are investigated by using panel data analysis in this study. Data of 115 countries between years 2010 until 2014 are used for this purpose which is obtained from World Economic Forum (WEF) Global Competitiveness Index database. According to the findings of the study there is significant positive effect of financing opportunities on R&D spending of companies and on university-industry collaboration. However, findings of the study reveal that financing opportunities have no effect on capacity of innovation.

Keywords: Innovation Ecosystem, Financing Innovation, Innovation

Öz

Anahtar Kelimeler: İnovasyon Ekosistemi, İnovasyon Finansmanı, İnovasyon
1. INTRODUCTION

Innovation is an important strategic tool for companies of today, because the ability to create and then commercialize new products and processes has become one of the necessities to acquire and sustain competitive advantage. With this necessity, all over the world firms and private sector became the ultimate engines of innovation by fostering the nations’ innovative capacity. In each country, the innovative activities of firms are strongly affected by national policy and the presence and dynamism of public institutions. Therefore a strong interaction between private sector strategies and public sector policies and institutions has become important to increase the potential of innovation in a country (Porter & Stern, 2002). These agents and their collaborations, together with the noneconomic factors such as technology, sociological interactions and the culture constitute the basic components of a nation’s innovation ecosystem (Durst & Poutanen, 2013).

According to Rabelo, Bernus, & Romero (2015) components of an innovation ecosystem include: Actors (government, universities, industry, entrepreneurs, financial system, customers and civil society); Capital (financial assets provided by some actors); Infrastructure (physical, technical conditions and general); Regulations (laws and rules that frame the innovation ecosystem); Knowledge and Ideas (intentional thoughts which spur innovation actions). Among these elements financial resources to fund innovative activities have a special role, because it is argued that well-functioning financial markets play a central role in driving economic growth through their ability to foster innovation (Kerr and Nanda, 2014). Research question of this study that arises in this context is whether financing opportunities affect the components of national innovation ecosystems or not.

Among the components of innovation ecosystems R&D expenditures, university-industry collaboration and capacity of innovation are important ones which play a vital role within this ecosystem (Griffith, Huergo, Mairesse, & Peters, 2006; Mathews & Hu, 2007; Natário, Couto, Teresa, Tiago, & Braga, 2011; Porter & Stern, 2002). Therefore these three components are selected as dependent variables in three different models and the effects of financing opportunities on them are investigated in this study. Panel data of 115 countries between years 2010 until 2014 are used for this purpose which are obtained from World Economic Forum (WEF) Global Competitiveness Index database. As a result of fixed effects regression models, we found that financing opportunities have a significant positive effect on R&D expenditures of the firms and university-industry collaboration, whereas they have no effect on capacity of innovation.

2. LITERATURE REVIEW

Recent literature points out the link between financial activities and economic development supported by innovation (Kerr and Nanda, 2014). In this literature financial markets are argued to have an important role in economic growth especially by fostering innovation. Private equity firms, venture capitalists, and banks are some of the financial intermediaries that are needed for pace of innovation (Nicholas, T. 2011).
In their research King and Levine (1993) mentioned two points of view on potential capacity of financial activities affecting economic development. According to them strong financial institutions provide effective services which explain inter-regional differences in terms of development. The source of the idea goes back to Schumpeter’s (1934) work of “creative destruction” (Kerr and Nanda, 2014). Schumpeter has made an important contribution to literature by analyzing the relationship between innovation and financial resources. Schumpeter emphasizes that well-functioning credit opportunities encourage innovation by financing entrepreneurs who aim to push over existing with new products and as a result this ensures economic growth. This process is named as creative destruction. It is argued that new companies are more capable of taking risks and are more innovative. So, according to him easy access to financial resources will foster destruction process by new companies’ entrance in the market (Fagerberg, Mowery, Nelson 2004).

Both internal finance and external finance are considered to be important for R&D and innovative activities. A significant and economically large relationship between R&D investment and internal finance has been found by Himmelberg and Petersen (1994) who used data of 179 US small firms in high-tech industry. In terms of external financing, Rajan and Zingales (1998) suggested that industries have different dependencies on external financing. Because of these differences; they argued that financial system’s effect on industry-based economies is also different. Authors have sorted 28 industry-based economies according to their dependencies and found that countries with developed financial systems in which industries are dependent on external financing are growing faster. According to their findings, there is a strong correlation between dependency on external financing and consistency of R&D activities. In other words, industries with rich R&D activities are also industries that are most dependent on external financing (Rajan & Zingales,1998).

Some researchers in the literature have dealt with the relationship between cash flows, financial constraints and R&D investment. Bond, Harhoff, and Van Reenen (1999) investigated whether financial constraints influence the decisions of the firms to engage in R&D investments by comparing the firms in United Kingdom and Germany. Their results suggested that the cash flow impacts of financial constraints on R&D are significantly different in large manufacturing firms of United Kingdom and Germany. They found that financial constraints are more significant in United Kingdom.

There are also studies which focus on cross-country comparisons regarding financial system development and innovative activities. Countries with developed financial infrastructures support economic growth by providing more external financing to innovation and R&D based companies, because these countries are better at savings, risk assessment, screening and monitoring (Aghion&Howitt, 2009). On the other hand, countries which have underdeveloped financial systems are obstructing entrepreneurs who have new ideas but no capital, by transferring financial resources to the bigger companies which have less potential for innovation. This situation is preventing R&D activities, innovation and so economic growth by disordering the effective capital allocation (Buera & Kaboski, 2011). In another study, Hsu, Tian and Xu (2010) have used a large data set from 34 emerging and developed markets.
They found that well organized financial markets’ effect on innovation is more notable in emerging countries than developed countries and in markets with better shareholder protection and less creditor protection. They also found that, countries which have stronger capital markets than money markets are more successful at increasing innovation. (Hsu&Tian&Xu,2010).

To build an effective innovation ecosystem, sophisticated financial markets are required to make capital available for private-sector investment from such sources as loans from a sound banking sector, well-regulated securities exchanges, venture capital, and other financial products. Especially venture capital has an important role in innovation finance by funding early-stage entrepreneurs. For example Samila and Sorenson (2010) found that public funding of academic research and venture capital have a complementary relationship in fostering innovation and the creation of new firms. This indicates a strong interaction between private financial intermediation and public research funding in promoting entrepreneurship and innovation (Samila & Sorensonb, 2010). However despite their critical contributions to supporting especially university-industry linkages by providing important sources of financial support and expertise, most venture capitalist may tend to be more interested in short-terms gain on investment and few may be willing to take on the risk of investing at the embryonic research stage (Bramwell, Hepburn, & Wolfe, 2012). On the other hand, venture capital as a solution for financing innovation has its own limits. For example, VC is tend to focus only a few sectors at a time and the minimum size investment might be too large for startup companies in several sectors. It can be said that more innovative companies go for venture capital for financing, but it cannot be always said that companies that are using venture capital are more innovative than others (Hall &Lerner, 2009).

3. EMPIRICAL ANALYSIS
3.1 Data and Sample Group
The aim of the research is to explore the effects of financing opportunities on innovation ecosystem. Panel data analysis is used in the study to find out the effects of the financing opportunities on various components of nations’ innovation ecosystem. Data used is obtained from the dataset of World Economic Forum’s (WEF) “The Global Competitiveness Report 2014 – 2015”.¹ This report gives comprehensive information about the key determinants of economic growth and the level of present and future prosperity in a country. Thus it uses a large dataset of 144 countries containing over 100 indicators. In the report, competitiveness is defined as the set of institutions, policies, and factors that determine the level of productivity of a country and it is measured by Global Competitiveness Index (GCI). GCI is calculated by including a weighted average of many different components, each measuring a different aspect of competitiveness. These components are grouped into 12 pillars in the report and one of those pillars is “Innovation”. Variables of the panel data analysis that will be explained in the following section are selected from the components of these 12 pillars. Pillars that are used in the analysis are (World Economic Forum, 2014):

• **8th Pillar- Financial market development**: Efficiency of financial markets (Availability of financial services, Affordability of financial services, Financing through local equity market, Ease of access to loans, Venture capital availability), Trustworthiness of financial markets (Soundness of banks, Regulation of securities exchanges, Legal rights index)

• **10th Pillar- Market size**: Domestic market size index, Foreign market size index, GDP (PPP$ billions), Exports as a percentage of GDP

• **12th Pillar- Innovation**: Capacity for innovation, Quality of scientific research institutions, Company spending on R&D, University-industry collaboration in R&D, Gov’t procurement of advanced tech products, Availability of scientists and engineers, PCT patents applications

Data representing the variables of the research model in this study are taken from the subcomponents of abovementioned pillars.

The data of WEF about global competitiveness index covers the period of 2006-2014. However some of the indicators are not used and published before 2010. Therefore the time span of the research covers the years between 2010 and 2014. Although there are 144 countries in the report several indicators are not available for some countries. As a result these countries were removed from the sample and 115 countries, for which all the relevant data exist, are included in the sample group.

### 3.2 Model and Variables

To be able to determine the effects of the financing opportunities of innovation on the components of the innovation ecosystem, the following regression model is developed

\[
IC_{it} = FINOPP_{it} + INFR_{it} + SIZE_{it} + RESQUAL_{it} + e_{it}
\]

Where,

- \(IC_{it}\) = Innovation Ecosystem Component in country i, at period t
- \(FINOPP_{it}\) = Financing Opportunities in country i, at period t
- \(INFR_{it}\) = Infrastructure in country i, at period t
- \(SIZE_{it}\) = Market Size in country i, at period t
- \(RESQUAL_{it}\) = Scientific Research Quality in country i at period t
- \(e_{it}\) = error term

The variables used in the model are as follows:

### 3.2.1 Dependent Variables in Models

The dependent variable of the main research model is the component of an innovation ecosystem. A nation’s innovation ecosystem is composed of different factors which are discussed in literature review part of the study. Three variables are selected among these factors to represent the ecosystem. As a result, three different models, each of which has different dependent variables but the same set of independent variables, are developed.

**Company R&D Spending (Model 1):**

R&D has an important role in generating innovation and at the same time in facilitating the adoption of innovations developed elsewhere through the use of a certain absorptive capacity (Archibugi, Denni, & Filippetti, 2009). Thus, R&D spending has been one of the most
commonly used measures of innovation. (Griffith, Huergo, Mairesse, & Peters, 2006). Although investment in R&D is not synonymous with innovation, the relationship between the amount of investment in R&D and product and process innovation for a broad cross-section of industries has been demonstrated in the literature (National Science Board, 2012). In this paper this variable is taken from GCI, which is measured by the answers given to the question of “In your country, to what extent do companies spend on research and development (R&D)? [1 = do not spend on r&d; 7 = spend heavily on r&d]”.

University-Industry Collaboration (Model 2)

Universities are regarded as catalysts of technological innovation and they stimulate and increase the production and flow of knowledge (Bramwell, Hepburn, & Wolfe, 2012). A nation’s university system, should provide a particularly strong and open bridge between technology and companies. (Porter & Stern, 2002). It is revealed in different studies that universities play an important role in conducting R&D and transferring new technologies across to industry (Mathews & Hu, 2007). Therefore university-industry collaboration is a vital component of a nation’s innovation ecosystem. This variable is represented by the indicator in GCI, which is measured by the answers given to the question “In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively]”.

Capacity for Innovation (Model 3)

National capacity for innovation includes the real and potential capabilities of a system to convert knowledge into innovation. It represents the institutional potential of a country to sustain innovation and is affected by many factors such as institutional efficiency, national culture, human resources, financial resources and etc (Mathews & Hu, 2007; Natário, Couto, Teresa, Tiago, & Braga, 2011). Thus it is important to explore the effect of financing opportunities on this component of innovation ecosystem, to be able to understand the role of financing on innovation. In this study “capacity for innovation” variable is represented by the innovative capacity of the companies in each country. It is measured by the answers given to the question of “In your country, to what extent do companies have the capacity to innovate? [1 = not at all; 7 = to a great extent]”

3.2.2 Independent Variables Set

Financing Opportunities

The aim of the study is to measure the effects of financing opportunities on the components of innovation ecosystem. The 8th pillar of WEF’s GCI data is “Financial market development” as mentioned in the “Data & Sample Group” part of this study. This pillar includes two subcomponents which are “Efficiency” and “Trustworthiness”. Within the Efficiency subcomponent availability of financial services, affordability of financial services, financing through local equity market, ease of access to loans, venture capital availability are quantified. Therefore this subcomponent of the 8th pillar used as an independent variable together with
the following control variables which are determined based on the literature on innovation ecosystem.

**Control Variables**

- **Infrastructure:** It is argued that innovation is becoming more dependent on a geographically defined infrastructure which can mobilize technical resources, knowledge, and other inputs of the innovation process (Feldman & Florida, 1994). To represent this variable 2nd pillar of the GCI data set is used.

- **Market Size:** Market size is one of the important factors which facilitate innovation by means of increasing competition (Klaus & Stephen, 2010). Based on this argument market size measured by domestic and foreign market size together with GDP and exports as a percentage of GDP is used as a control variable in the model (10th pillar).

- **Quality of Scientific Research Institutions:** Since the universities play an important role in innovation ecosystems especially in technology transfer process, quality of these institutions are also regarded as a factor that affects the innovation ecosystem.

All the variables used in the three models are summarized below:

**Table 1: Variables used in the models**

<table>
<thead>
<tr>
<th>Name of the Model</th>
<th>Dependent Variable</th>
<th>Independent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>Company R&amp;D Spending (R&amp;DSPEND)</td>
<td>Financing Opportunities (FINOPP) Infrastructure (INFR)</td>
</tr>
<tr>
<td>Model 2</td>
<td>University-Industry Collaboration (UNIIND)</td>
<td>Market Size (SIZE) Quality of Scientific Research Institutions (RESQUAL)</td>
</tr>
<tr>
<td>Model 3</td>
<td>Capacity for Innovation (CAPACITY)</td>
<td></td>
</tr>
</tbody>
</table>

**3.3. Methodology**

Panel data analysis is used to test the models explained above. When conducting panel data analysis three alternative models (pooled regression, fixed effects regression and random effects regression) may be used. Firstly all of the models of the study were analyzed using the three models, then F test, Breusch-Pagan Langrage test and Hausman tests were conducted to decide which model to use. The results of these tests are summarized below in Table 3. According to the test statistics Random Effects Model should be used for Model 1 and Fixed Effects Model should be used for Model 2 and Model 3. Also unit root tests were conducted for all of the variables used in the models and no variable was found to have a problem about non-stationarity.²

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² The results of unit root tests are available upon request
Table 2: Test Statistics for Model Selection

<table>
<thead>
<tr>
<th>Model</th>
<th>Test</th>
<th>Test Statistics</th>
<th>Resulting Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>F-Test</td>
<td>F(114, 456) = 35.59; Prob &gt; F = 0.00</td>
<td>Random Effects</td>
</tr>
<tr>
<td></td>
<td>Breusch-Pagan</td>
<td>chi²(1) = 874.62; Prob &gt; chi² = 0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hausman</td>
<td>chi²(4) = 2.09; Prob &gt; chi² = 0.72</td>
<td></td>
</tr>
<tr>
<td>Model 2</td>
<td>F-Test</td>
<td>F(114, 456) = 19.06; Prob &gt; F = 0.00</td>
<td>Fixed Effects</td>
</tr>
<tr>
<td></td>
<td>Breusch-Pagan</td>
<td>chi²(1) = 684.94; Prob &gt; chi² = 0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hausman</td>
<td>chi²(4) = 15.89; Prob &gt; chi² = 0.0032</td>
<td></td>
</tr>
<tr>
<td>Model 3</td>
<td>F-Test</td>
<td>F(114, 456) = 11.05; Prob &gt; F = 0.00</td>
<td>Fixed Effects</td>
</tr>
<tr>
<td></td>
<td>Breusch-Pagan</td>
<td>chi²(1) = 221.69; Prob &gt; chi² = 0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hausman</td>
<td>chi²(4) = 195.09; Prob &gt; chi² = 0.00</td>
<td></td>
</tr>
</tbody>
</table>

3.4 Findings

Model 1 (Dependent Variable : Company R&D Spending)

Table 3: Findings of Model 1

<table>
<thead>
<tr>
<th></th>
<th>Coef.</th>
<th>StdErr.</th>
<th>Pr &gt; z</th>
<th>[95% Conf.Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINOPP</td>
<td>0.199</td>
<td>0.035</td>
<td>0.000</td>
<td>0.130</td>
</tr>
<tr>
<td>INFR</td>
<td>0.027</td>
<td>0.009</td>
<td>0.002</td>
<td>0.010</td>
</tr>
<tr>
<td>SIZE</td>
<td>0.063</td>
<td>0.034</td>
<td>0.061</td>
<td>-0.0028</td>
</tr>
<tr>
<td>RESQUAL</td>
<td>0.573</td>
<td>0.030</td>
<td>0.000</td>
<td>0.513</td>
</tr>
<tr>
<td>Constant</td>
<td>0.031</td>
<td>0.161</td>
<td>0.850</td>
<td>-0.286</td>
</tr>
<tr>
<td>R-sqr (overall)</td>
<td>0.7724</td>
<td>sigma_u = 0.4045; sigma_e = 0.1512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.of Obs.</td>
<td>575</td>
<td>575</td>
<td></td>
<td>575</td>
</tr>
<tr>
<td>No.of Groups</td>
<td>115</td>
<td>115</td>
<td></td>
<td>115</td>
</tr>
</tbody>
</table>

According to the findings summarized in Table 3, financing opportunities have a significant effect on R&D spending of companies and this effect is positive. Increase in financing opportunities is affecting R&D spending positively. Our finding is parallel to the findings of other empirical research in the literature. There are studies which argue that restrictions in credit markets or access to equity cause decreases in R&D spending and vice versa (Assmuth, 2014). When firms get easy access to financial resources they invest more on R&D projects. But financing opportunities are not the only factor affecting R&D expenditure. Infrastructure and quality of the research institutions are also found to be effective factors. They have a positive effect on R&D expenditures and the effect of the quality of research institutions are more significant compared to the effect of the infrastructure. However it seems that market size is not affecting R&D spending according to our findings.
Model 2 (Dependent Variable: University-Industry Collaboration (UNIIND))

Table 4: Findings of Model 2

<table>
<thead>
<tr>
<th></th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>P&gt;t</th>
<th>[95% Conf.Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINOPP</td>
<td>0.161</td>
<td>0.034</td>
<td>0.000</td>
<td>0.094</td>
</tr>
<tr>
<td>INFR</td>
<td>0.006</td>
<td>0.007</td>
<td>0.382</td>
<td>-0.008</td>
</tr>
<tr>
<td>SIZE</td>
<td>-0.174</td>
<td>0.071</td>
<td>0.015</td>
<td>-0.313</td>
</tr>
<tr>
<td>RESQUAL</td>
<td>0.630</td>
<td>0.032</td>
<td>0.000</td>
<td>0.567</td>
</tr>
<tr>
<td>Constant</td>
<td>1.414</td>
<td>0.030</td>
<td>0.000</td>
<td>0.819</td>
</tr>
</tbody>
</table>

R-sqr (overall) | 0.858 | F(4,456) = 115.18
No. of Obs. | 575 | corr(u_i, Xb) = 0.4521 Prob > F = 0.0000
No. of Groups | 115 |

In the second model the dependent variable is university-industry collaboration and financing opportunities affect this relationship positively according to the findings above. This finding is consistent with the study of Fontana et al. (2006) which argues that the financial aspects are an important motivation for firms to collaborate with public research organizations despite the excessive bureaucracy. Our findings also reveal that together with financing opportunities both market size and quality of research institutions are significant factors which affect the collaboration positively.

Model 3 (Dependent Variable: Capacity for Innovation (CAPACITY))

Table 5: Findings of Model 3

<table>
<thead>
<tr>
<th></th>
<th>Coef.</th>
<th>StdErr.</th>
<th>P&gt;t</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINOPP</td>
<td>-0.077</td>
<td>0.071</td>
<td>0.279</td>
<td>-0.217</td>
</tr>
<tr>
<td>INFR</td>
<td>0.002</td>
<td>0.015</td>
<td>0.889</td>
<td>-0.027</td>
</tr>
<tr>
<td>SIZE</td>
<td>2.488</td>
<td>0.148</td>
<td>0.000</td>
<td>2.197</td>
</tr>
<tr>
<td>RESQUAL</td>
<td>0.790</td>
<td>0.068</td>
<td>0.000</td>
<td>0.657</td>
</tr>
<tr>
<td>Constant</td>
<td>-9.007</td>
<td>0.631</td>
<td>0.000</td>
<td>-1.024</td>
</tr>
<tr>
<td>R-sqr (overall)</td>
<td>0.4398</td>
<td>F(4,456) = 132.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
No. of Obs. | 575 | corr(u_i, Xb) = -0.9744 Prob > F = 0.0000
No. of Groups | 115 |

Table 5 reveals that financing opportunities are not affecting the capacity for innovation and neither do infrastructure. Therefore, according to our findings innovative capacity of the firms in a country is not influenced by the financial resources and financial system. However market size and quality of research institutions have statistically significant coefficients indicating that domestic and foreign market size, and quality of research institutions affect innovative capacity positively.
4. CONCLUSION
Innovation has become an important tool to foster economic growth and competitive advantage of countries. Therefore it has been one of the mostly debated topics in literature of different disciplines. The concept of innovation ecosystem is widely used in most of these studies and innovation ecosystem of each country has several components such as actors, capital, infrastructure and etc. These components have interactions with each other like the components of any ecosystem. Thus every one of them has a potential to influence innovation. Financial resources are one of these components and they are regarded as vital sources to foster innovation. This study aimed to explore the relationship between the opportunity to reach financial resources and various components of innovation ecosystems by using the dataset of World Economic Forum’s Global Competitiveness Index.

Findings of the study reveal that financing opportunities have a significant positive effect on R&D spending of companies and university-industry collaboration in a sample group of 115 countries in the period between 2010-2015. However, according to the findings, financing opportunities do not affect the capacity of innovation. Thus, we can conclude that although having access to financial resources do not influence gaining capacity for innovative activities, once the companies have enough capacity for innovation financing opportunities become important when making R&D expenditures and collaborating with universities.

Another important finding of the study is about the effects of the research institutions’ quality on the components of innovation ecosystem. It was found to have a significant positive effect on all the dependent variables such as R&D spending, university-industry collaboration and capacity for innovation. Thus we can conclude that policies for increasing the quality of research institutions are as important as the sources of finance for innovation.

REFERENCES


