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Vietnamese – German University
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THESIS

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**THE DETERMINANTS OF OPEN INNOVATION: THE
CASE OF TRANSITION ECONOMIES FROM 2012 TO
2016**



Vietnamese - German University

Submitted by

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Vietnamese - German University

Abstract

Acknowledging that innovation and open innovation is now one of the most interesting topic by researchers, I have chosen this would be my idea for the bachelor thesis. The models are built to illustrate the correlation of innovation and open innovation with independent variables in economies of transition countries from 2012 to 2016 (both inside and outside factors), in addition, some econometrics testing methods have been applied into models with the aim at maximize the accuracy of models: Heckman correction and Robustness checking method. The tests find out that innovation are positively correlated with some elements such as Exporting, Managers experience working, ect. And it receives negative impacts from Formal training programs for permanent workers and so on. However, these impacts of each element might be different throughout years.

Using the same dataset, open innovation gives out many results that might be similar to impact of that element on innovation as well as different effects comparing to innovation. Although these models for OI testing are not really good at demonstrating the correlation of the independent variables and OI decision making, it could be considered as referring information about the trend of OI in transition economies.



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List of Abbreviation

BEEPS	Business Environment and Enterprise Performance Survey
EB	Europe Bank
EU	Europe Union
GDP	Gross Domestic Product
LLC	Limited Liability Company
NBER	National Bureau of Economic Research
OECD	Organization for Economic Cooperation and Development
OI	Open Innovation
R&D	Research & Development
SME	Small and Medium Enterprises
WB	World Bank

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1. Introduction

In 1934, after Schumpeter proclaimed his theory of innovation, not only researchers or economists but also entrepreneurs and policymakers were all lured about this new definition. A huge wave of innovation research and adoption appeared and flourished throughout the world during late 1980s (Caliss & Eric, 2009) and several new concepts relating to innovation were also released.

One of the most noticed topic relevant to the original idea of Schumpeter is the concept of open innovation developed by Henry Chesbrough in 2003. The definition deeply explored a new aspect of innovation by adopting outside resources for innovation over many aspects in business activities. Following idea of Chesbrough, several studies have been published with the aim of exploiting open innovation activities under different aspects. For example, René Rohrbeck, Katharina Hölzle, Hans Georg Gemünden tried to explore the competitive advantage of Deutsche Telekom in open innovation ecosystem (2009) or how to managing open innovation in a large firms by Chresbrough and Sabine (2013), etc.

The core aim of all researchers is to find the answer to these questions: Where is open innovation applied? How we can apply it? What can we use open innovation for? The open innovation is related to whom? Being aware of these questions, I have studied and wrote this paper for exploring the level of open innovation as well as innovation in business activities in economies of transition countries. Countries in transition area are specific due to their history and geographic location and research focusing on this place is quite meaningful since it could investigate the open innovative adoption in these countries to comparing with the speed of OI adoption in other area around the world. Furthermore, through this study, this might, to some extent, express the situation on OI adoption and the correlation of this with both outside and inside factors which could effect on OI decision making of enterprise in these countries. Hence, the analyzation of the assistance as well as barriers could partially dedicate to the development of OI adoption in this area.

2. Innovation definition

Innovation is widely agreed by many economists and researchers as one of key factors for the advancement of the economics (Rose et al., 2009) as well as the leverage for development of firms (Baldwin, 1995; Yamin, Gunasekaran and Mavondo, 1999; Marques and Ferreira, 2009). This is defined in many ways. Particularly, according to Zaltman, Duncan, Holbek (1973, p.7), innovation is featured as “a creative process whereby two or more existing concepts or entities are combined in some novel way to produce a configuration not previously known by the person involved”. This definition mainly refers innovation as a product by linking new ideas together for a result that is different and no similarity with existing products for a specific industry. And to the point of view of Drucker (1985, p.19), he considered “innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or service”. The definition of Drucker has shown an unaccustomed way that innovation considered as a tool to that based on the availability but with some update to gain a larger market segment. Or with Rogers (2003, p.12), he described that innovation is “an idea, practice, or object that is perceived as new by an individual or other unit of adoption”. And surrounded by those definitions, the most suitable one that could be the background to develop the model in this paper is the definition of innovation by Joseph Schumpeter. His idea about innovation seems to be the most influential from the late 1980s. It could be considered as a summary of others and was depicted under five apparent categories of innovation as below: Vietnamese - German University

1. Launch of a new product or a new species of already known product;
2. Application of new methods of production or sales of a product (not yet proven in the industry);
3. Opening of a new market (the market for which a branch of the industry was not yet represented);
4. Acquiring of new sources of supply of raw material or semi-finished goods;
5. New industry structure such as the creation or destruction of a monopoly position.

In this paper, the first two categories of innovation will be considered as the main concepts of innovation that helps to clarify the model to answer for the topic question about the influential factors of innovation and open innovation in transition economies.

3. Open innovation definition

Before 2003, when searching for phrase ‘open innovation’, people could not gain any knowledge about this. It seemed to be meaningless, there were thousands of outcomes but there was no appropriate result that can exactly or even partially explain for this phrase. However, in 2003, ‘Open Innovation’ by author Henry Chesbrough was released and then becoming the pioneer for defining open innovation around the world that sets a milestone for widespread scrutinizing and deepening by various researchers. The

popularity of open innovation is worldwide increasing, many academic articles by scientists and economists concerning about open innovation are public with this new model of innovation.

Initially, open innovation was defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively” (Chesbrough, 2006b, p. 1). However, after receiving some criticisms ‘about the lack of a proper definition of open innovation (e.g. Knudsen & Mortensen, 2011; Ozman, 2008; Trott & Hartmann, 2009) and after applying recent conceptualizations (Gassmann and Enkel, 2004; Dahlander and Gann, 2010; West and Bogers, 2014), the definition of open innovation was re-built that open innovation is a “distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and nonpecuniary mechanisms in line with the organization’s business model” (Chesbrough and Bogers, 2014, p. 17).

As the interestedness about open innovation arose in academia, the enquiry about the explanation and classification of this concept branched from innovation and many researches emerged. One of the outstanding about the classification is the work of Gassmann and Enkel (2004), which “classified the open innovation process as the outside-in, the inside-out, and the coupled process”. Or from the development basing his own definition about this new concept, Chesbrough et al. (2006) “distinguished the purposive inflows and outflows of knowledge into inbound and outbound open innovation”. As can be seen that inbound open innovation represents for the outside-in process, and outbound open innovation is considered as the inside-out process. Later, from the research published by Dahlander and Gann (2010) emphasizing “the monetary directions of the knowledge flows by adding the pecuniary and non-pecuniary dimensions to this classification”. As a result, they distinguished two forms of inbound innovation – acquiring and sourcing, and two forms of outbound open innovation – selling and revealing. Following the classifications by Gassmann and Enkel (2004) and Dahlander and Gann (2010), in their latest work Chesbrough and Bogers (2014) defined the mechanisms to help in managing the knowledge flows in open innovation. For the purpose of this study, we will apply the classification of open innovation (inbound, outbound and coupled) and supporting mechanisms described by Chesbrough and Bogers (2014).

4. Imperical studies:

It can be said that the new branch of innovation has inspired the curiosity of researchers about the concept as well as the development path of this idea in the future and also the application to the enhancement of economy. There are hundreds of papers that display the situation of OI application in the economy. And in the study of Marcus Matthias Keupp and Oliver Gassman, innovation is considered as a result from the firm-internal weakness. In the masterpiece of two researchers, they tried to explain the two critical questions about OI. They are all attracted by the way that some firms conduct OI in a larger scale

comparing to others and also have a huge curiosity with the differences in the application of OI within each entities. Unlike other previous researchers looking for the discrepancy of external factors, they attempt to explain the difference with firm-internal factors, specifically, impediments to innovation.

Based on a research that could support them to define the level of applying OI from Laursen and Salter's (2006), they choose to test the extent of OI application from their data. The level of OI on samples will be displayed by 2 dimensions, 'breadth' and 'depth'. 'Breadth' represents the number of knowledge sources the firms 'integrates in its innovation processes and 'Depth' illustrates the deeply integrated of those in innovation processes.

In their masterpiece, regarding the control variables, they have shown 'positive and significant effects of firm size and R&D intensity on both the breadth and the depth of 'OI', otherwise these 2 variables are irrelevant to regional structure and firm age. Moreover, the research also shows that industry could be seen as a factor that sensitizes to OI. In details, firms from high-tech industries (such as machinery; electric/electronic; medical devices, precision and optical instruments, watches) 'tend to have a higher 'breadth' of OI – as can be expected in such user-driven industries – whereas firms from the chemical and rubber and plastics industry are characterized by a significantly higher 'depth' of OI'.

Basing on the extent of application those knowledge resources to the processes of innovation of those firms, Keupp and Gassman divided them into groups and labeled with appropriate titles. 'Professionals' stands for group of companies which get the high scores in both categories. These firms are considered as ones that quisle both 'diversely' (acquiring a huge number of external knowledge sources) and 'deeply' (the intensity of each source to innovation processes is high). The second category also well mentioned in the paper is 'Explorers' which represented for those with medium-high level of 'breadth' but the scale of 'depth' is not as deep as those samples in 'Professionals' group. Meaning that firms in this group could have chances to approach a large number of external resources but do not apply deeply those into the innovation processes. Another group that is quite similar to 'Explorers' in the level of 'breadth' but its intensity of 'depth' level is quite moderate: 'Scouts'. Both researchers has declared that firms in above listed group are scanning the environment to figure out the most appropriate resources of outdoor knowledge for the innovation processes but they have not sorted and involved the most elite ideas into their work. Last but not least, beside the ones that could approach the wide variety of choices from environment, some of them are labeled as 'Isolationists' with low scores on both scales. These firms denied accessing the open innovation concept for their innovation activities. The writers said that those firms had better accept to OI due to benefits from taking advantage of outside knowledge on their innovation activities to reduce cost as well as to swiftly heritage new knowledge from outsiders.

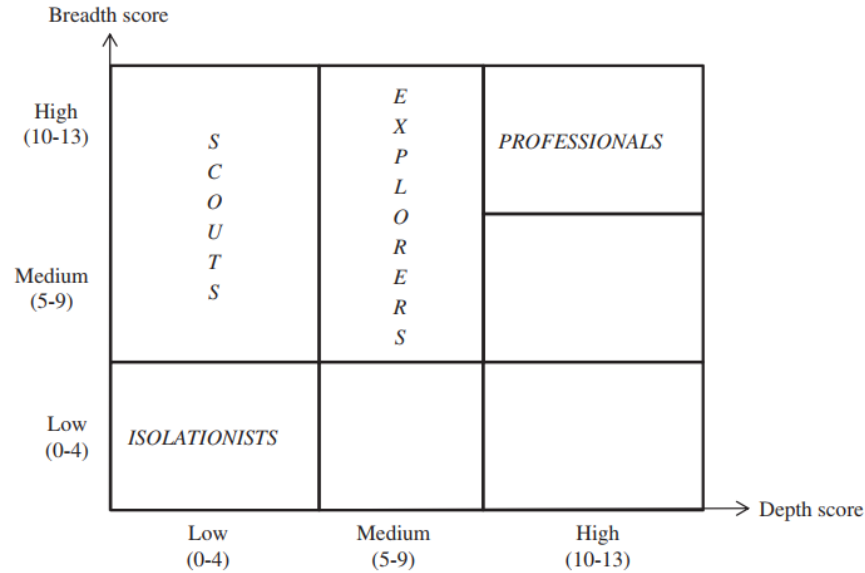


Figure 1: *Archetype users of open innovation.*

If the above paper is about the level of adaption OI into companies processes of innovation, this next research will be mentioned below is about the relationship between the openness degree and some indicators (in this paper, they mainly focus on solving three main question, ‘how the adoption of OI practices can be linked to the size and the age of companies, how inbound and outbound practices are related to each other and to internal R&D activities and last but not least, how the adoption of OI practices is linked to financial performances of companies’. In ‘Inbound and outbound open innovation: Organization and Performances’, the relationships between indicators are tested with pecuniary approach with 126 samples in bio-pharmaceutical industry from 2008 to 2012. In general, after the introduction of Chesbrough about open innovation in 2003, enterprises are more and more aware about their process to upgrade their development procedure in business activities. They realized that in-house method could not satisfy total requirements of their development and they need outsourcing for reducing cost and approach to the new solution for available issues from a huge number of knowledge resources with the cheapest and most updated ideas. In this paper, authors exposed that open innovation is ‘more pervasive among small and young companies’, and for most of which OI plays an important role in their business activities. Although the amount of samples which adopt inbound and outbound in their business to a certain extent are equal, ‘the cumulative values of inbound flows are higher, whereas outbound flows are more relevant when compared to the total business of the firms’. In another way, it can be presented that inbound performances are substitutive to internal R&D activities, companies would consider to apply inbound activities into their innovation processes if it is more beneficial than internal development, while outbound procedures could be identified as a complementary

method for internal development. It means that the ratio of adopting outbound OI and internal development is positive.

In the paper, authors have shown 6 hypotheses based on previous conclusions of others and using data from 126 enterprises to detect in which extent those hypotheses complied with the bio-pharmaceutical industry. With the first two hypotheses that related to context features of companies, researchers found that firm size and firm age effect on the adoption of companies with open practices but in a negative way. For those firms that most of their revenues coming from OI activities are mainly small and medium size entities. However, the research also shows that those larger ones which OI activities are just ancillary activity also contribute a lot to the volume of OI activities because of their large cost to open practices. Another aware from this paper is that outbound could be seen as an alternative for traditional R&D internal and inbound is the one that help to exploit thoroughly both internal and external resources.

And last but not least in this paper, researchers realized that ‘beyond a certain value of inbound the benefits deriving from leveraging external technologies are exceeded by the costs deriving from the management of external relationships; on the other side, the negative relation between performances and outbound practices can be considered as industry specific since high values of outbound are typical of biotech companies.’

A cooperation survey between the Garwood Center for Corporate Innovation at the University of California, Berkeley, in the US and the Fraunhofer Society in Germany was conducted to get an overview about the adoption of OI among large firms. Testing on those in both Europe and the US which annual sales excess of US\$ 250 million, authors figured out many essential facts that illustrate the involvement level of large firms on practicing open innovation. Some highlight results from their survey listed out in the aspect of OI are as following:

- 78% of firms in their sample report involving open innovation.
- No firms in their sample report abandoning their practice of open innovation.
- 71% report that top management support for open innovation is increasing in their firm.
- 82% report that, compared to three years ago, open innovation is practiced more intensively today.
- Inbound open innovation practices are more commonly practiced than outbound practices. The share of projects with an inbound component is 35% on average. Only about 8% of projects result in outbound activities.
- Customer co-creation, informal networking, and university grants are the three leading inbound practices in 2011. Crowdsourcing and open innovation intermediary services are rated lowest in importance.

- Joint ventures, selling market-ready products and standardization are the three leading outbound practices. Donations to commons and spin-offs play a minor role.
- Customers, universities and suppliers are the three leading open innovation partners reported by survey respondents.
- Corporate R&D and product & process development units report more autonomy in budgeting for innovation activities.
- Open innovation is not much formalized yet, and cultural norms are as important for open innovation as formal practices.
- The biggest challenges in managing open innovation are within the firm. The change process from closed to open innovation is rated as the most difficult task.
- Firms are not satisfied with their current open innovation metrics, though they are more satisfied with their overall open innovation performance to date.

Through the results from surveys on enterprises, a picture of an upward trend in application of open innovation has illustrated under the dissociation of the scientists. In which, the authors described that most of firms are gratified with what they have witnessed about the advances in their business outcomes from open innovation and also figured out the room for improvement in their business activities. One of the main points needed to be improved is that practices of inbound open innovation are noticeably widely used than outbound activities. And ‘individual practices are not rated all that highly in their effectiveness and individual metrics are not rated very highly either’. In conclusion, the authors assumed that enterprises were then on those first steps ‘in their use and understanding of open innovation’.

5. Econometric model and data analysis

5.1. An overview about transition economies:

In 1989, the Berlin Wall collapsed. This moment could be considered as the recapitulation for the end of Soviet bloc countries over the preceding three decades witnessing the dramatic slowdown in both political and economic system.

Over ten years since the Polish economic reform program occurred, the performance over political and economic aspects of these countries has been changed significantly with different directions. Some of these countries consistently pursuing their reform agendas have transformed well in mid-1990s. According to Stanley Fischer and Ratna Sahay, despite confronting many reform tasks, little by little those countries obtained a large number of achievements in both political and economic aspects, it can be shown with the GDP of these countries over periods of time (Figure2). They had gradually resurrected over the old constrain and some of them were on the way towards joining the Europe Union. These

countries are which geographically closest to Western Europe. Besides that, there were some countries which could not catch up with the speed of successful ones and still struggled with difficulties of transition process (Stanley Fischer, Ratna Sahay).

In recent years, innovation in economy is quite popular around the world and also in transition economies. It can be said that innovation has involved in the developing progress of economies in these countries and open innovation – one of most attractive branch by many scientists is widely known and applied into the economy. In this paper, I aim to illumine the impact of those factors such as firm ages, industries, education of employees, ect on open innovation in the transitions countries.

5.2. Variables:

The materials used in following testing model have covered from 2012 to 2016 of almost all countries in transition group. In order to test the dependency of OI as well as innovation on external factors, I would like to introduce the following variables as well as the definition and how I use these elements on hypothesis testing for the purpose of acknowledging about the trend of applying innovation in transition economies into practice.

Dependent variables

INN is the dependent variable defining the status of a sample about innovation. Based on BEEPS released by The EBR&D and WB in 2012 for enterprise survey, innovation activities include product & service innovation, process innovation, organization innovation, marketing innovation and other innovational activities.

OINN is the dependent variable summarizes all OI activities of all samples in dataset. As introduced on OI definition, one of interesting aspect by scientists is process outside-in of OI. This dependent variable is illustrated on product & services (OINN₁), process (OINN₂), R&D and other activities that acquired from external knowledge (OINN₃).

All 2 dependent variables are formatted to be binary with 1 demonstrating there is at least one activities on listed fields related to innovation/ outside-in OI, and 0 displaying as no record for these activities during 2012-2016. All missing and results with ‘don’t know’ are dropped out of this survey.

Independent variables

The above dependent variables are the main points will be tested and to examine the dependency and also the effects of other independent variables on decision of taking innovation for their companies in the group transition countries. These following variables are defined and collected in BEEPS published on

2012 for enterprise survey. According to the nature of dependent variables, they are divided into two sub-teams: Environment – those ones considered to be external factors and Firm's characteristics – natures of the firm.

Firm's characteristics

Exporting - One of important elements in following models is the consumers of products and services of a company, in this paper, the aspect exploited is exporting (X_1). In innovation aspect, whether exporting products to foreign countries could be an element with significant impact toward innovation or OI decision from board of directors of entities. According to the research studied by Aghion, Bergeaud, Lequien, Melitz (2017), exporting shocks is identified as an element urges the process of innovation for French examined firms. More countries in EU on economic transition process might be familiar and adopt the economic strategy of France, so I decide to pick this element into the model to test whether the trend of innovation in these countries will be similar to cases in France or not.

Firm Age - Another interesting independent variable mentioned in this paper is firm age: X_2 . According to the number of years that a firm exists, the sample will be test on how the age of firms could effect on the process of innovation of a company. In previous researches, firm age is evaluated as a negative factor to the process of innovation for entities (Hansen, 1992). However, to SMEs (In Lee, 2011), firm age is described as a no impact variable on testing the dependency of innovation on this element. For multiple judgments of this factor over periods, this is also a worthy testing factor in this case, and the age of firms is shown with unit of a decade.

Sampling size - The third crucial element in dataset is the firm size (number of employees working for a firm), X_3 . It is declared that numerous studies were conducted on the influence of firm size to innovation of enterprises (Penrose 1959; Kleinknecht 1989; Cohen & Klepper 1996; Fritsch & Meschede 2001), they found that the innovative output of entities, illustrated similarly over the researches, 'tends to rise' disproportionately with firm size (Walter M. Jenny, 2007). So, in case of entities in transitional period, could this elicitation is still correct? The following model will also answer for this question.

Legal status (Foreign ownership) – Another factorial (X_4) drawn in the picture of investigating about OI could not be missed is the legal status of firms. As we all know, there are many types of business ownership structure like sole proprietorship, LLC, partnership, ect. Almost all firms now even in any kind of the ownership, part of membership is foreign owners. In this study, from the suggestion in the form of BEEPS in 2012, foreign ownership is considered as a crucial factor for testing and this comment is supported by the conclusion about this factor by Maria Guadalupe, Olga Kuzmina, and Catherine Thomas

in their masterpiece (2010) from National Bureau of Economic Research (NBER). Those multinational firms would be easier to adopt foreign technologies, conduct products & services innovation and leading higher productivity.

Establishment part of a larger firm (X_5)? If the examining entity is under a regional control of a group or directly under an international brand, is it easier for them to access new knowledge and to apply innovative process for their business activities? The positive answer is confirmed by the research over 600 Swedish firms by Lina & Sara in 2015. However, another comment also illustrated in this article, OI seems to be more adapted by independent firms due to extra-collaboration and linkages among them. And in order to test whether these assessments are still correct in the situation of transition group, I would like to add this factor to develop the model, then it might be useful in assess this judgment on a larger scale.

Finance (Revenue) (X_6) – the sixth element dissected is the revenue of a firm. The variable will be tested by adding logarithm of revenue into the model.

Labour, in Labour field, there are 2 points is distinctly separated for examining, the scale of employees with bachelor degree & formal training for permanent staff.

- **Employees having university degree (X_7 & X_8)**, for X_7 , this variable demonstrates the number of entities that the portion of their employees with bachelor degree is under 50%, and X_8 stands for those this scale is equal and larger than 50%. Stated in an empirical study by Erik (Erik et al., 1993), innovation has a negative impact on employment over the review from nearly 900 Dutch manufacturing firms. Concerning about the opposite site of this statement, I am trying to adding and analyzing this factor in the model to clarify the impact of employment on innovation and also OI, this would be positive, negative or no affect?
- **Formal training program for permanent employee (X_9)**, the next variable is built in the model is the programs planned for permanent employees. Some unofficial statements declared that formal training program encourage employees to be more innovative and productive. However, the equipped knowledge along with employees could be barriers preventing firm from adopting external knowledge. With the survey, whether these conclusions are still correct in case of transition group?

Manager working experience (X_{10})- According to Ayyagari et al. (2011), managers from 3 to 10 years of experience tend to easily make decision for innovative activities for their business development strategies rather than those with more than 10 years of management experience. Hence, I decide to bring this element into my model for testing the dependency of innovation and OI on this variable.

Technology

For Technology category, I divide it into 2 small parts, **Company's owned website (X₁₁)** and **Technology licensed from a foreign-owned company (X₁₂)**. Despite of mentioning about 2 separate fields of technology, they are all elements to evaluate generally about the involving of technology to innovation actions of various entities in Former Soviet Union countries. I view of Ulrich and Holger (2008), technology obviously plays as an important supporting factor for approaching OI of many firms over nearly 154 industries. External technology exploitation and acquisition in this article is considered as an empirical study explaining for prior theoretical research about OI.

Environment

Besides internal factors on innovation and OI, some of outsiders also impact on the decision of implementing innovation and OI into their business strategies.

Competitors

The impact of market structure on innovation has attracted researcher attention throughout years. Arrow (1962) stated that monopolistic industry is less innovative than a competitive environment due to the fixed costs to apply new technology into current procedure. However, this assumption is also challenged on theoretical rounds when the higher level of competition in an industry leads to less innovative adoption. A survey has been conducted by Thomas, David and James (2008) to consolidate for Arrow's idea by adding switchover disruptions problem into their survey model. To test the accuracy of these assumptions on cases of transition group, I also add this element into the model and divide the market structure into 3 small variables: **Monopoly (X₁₃)**, **Oligopoly (X₁₄)**, **Monopolistics (X₁₅)**.

Industry sampling sector (X₁₆), the variable illustrates industry sectors of samples. There are three main sectors, manufacturing, retail and services defined in BEEPS (2012). Manufacturing includes food, wood, chemicals, ect. And service represents for wholesale, IT, hotel and restaurant, ect. Based on evidence from hotel industry testing on 331 entities in the Balearic Islands, Francian and Jan (2009) displayed that innovation on some hospitality indexes results in positive outcomes on hotel industry. And from the opposition, adding industry sectors into model could help to explain the impact of industries on decision of BoD of firms on innovative activities.

Main business city (X₁₇) – is the critical element in the model to test about the dependency of innovation and OI on geographical location of firms. From the study of João et al (in 2017), firm location is agreed to have effect on innovative activities of firms. It is stated that the more geographic proximity to urban centres of a firm, the easier for this entity to adopt innovation process for their business line. This study

was conducted with data of nearly 900 companies and apart from the positive correlation of these two elements, this article also studied about 'the levels and types of innovation in accordance with the company location. Imitating this article, I also add location feature into my study with similar idea. The samples are examined to explore the correlation between urban position of items with the capacity of innovation as well as OI.

GDP per capita (X_{18}), last but not least, the final element will be added to complete the research model is GDP per capita over five years from 2012 to 2016 of all countries in the transition group. The idea of testing GDP per capita for the correlation with innovation coming from a huge number of previous studies of these two elements. One of important study is inspired by the research paper conducted by Hulya in 2004, R&D has positive effect on innovation and innovation is conducive to the increase on GDP per capita with data clustered of 20 OECD and 10 non-OECD countries from 1981 to 1997. With different period of time and targets, is the statements of Hulya is still accepted or replaced by new result? These concerns will be explained with following testing model.

5.3. Data description:

The data for my survey is extracted from records conducted by the European Bank for Reconstruction and Enterprise Performance and World Bank Enterprise Survey from 2012 to 2016. This accumulating data set provides records from transition countries in this period with various business criteria, especially a version of survey has been designed for the most part focusing on innovation. This innovation enterprise survey separately classifies entities into 2 main group primarily relied on business activities: Services (51.61%) or Manufactures (48.39 %). The sample size includes 16,321 entities from 32 countries in former Soviet Union with 33,61% of sample set is positively innovative and only 16,19% aggregated data illustrated the OI level of these countries (sample size is 16,052 items) in business environment. The survey is tabulated under 2 types: pooled cross sectional data (introduced by Steven Buck) and data over the years (from 2012 to 2016).

In general, dataset from the Enterprise Survey contains diversely economical information of business activities of all entities joining to the survey. These raw materials could be transformed appropriately suiting for the purposes of researchers and beside that, some testing data methods would be supplemented into original data set for more reliable results.

5.4. Heckman correction

Practically, there might be no sample practically representing for the population, since the data set seems to be biased estimated by researchers. These entities are not randomly selected by data collecting experts,

and in order to fix this unavoidable error during the time of data collection, Heckman correction could be seen as a correction method for this unwanted issue. This method from Heckman results in Mill inverse ratio with the aim of correcting the biased data sample set for the testing model. Take into consideration about a single sample with a variable data set pooled from biased data with linear model:

$$y_1 = x_1\beta_1 + \varepsilon \quad (1)$$

Suppose the selection of individuals in sample is determined by following equation:

$$y_2 = \begin{cases} 1, & \text{if } x\delta + v \geq 0 \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

We can observe y_1 if $y_2 = 1$ and equals to zero otherwise (ε and v are error terms). Assuming that $E(\varepsilon, v) = 0$, and $E(\varepsilon | v) = \gamma$. (γ is the correlation between ε, v and $v \sim N(0,1)$).

Derivation of the bias:

$$E(y_1 | x, v) = x_1\beta_1 + E(\varepsilon | x, v) = x_1\beta_1 + E(\varepsilon | v) = x_1\beta_1 + \gamma \cdot v$$

Next, the expected value of y_1 conditional on x and the selection outcome:

$$E(y_1 | x, y_2) = E[(x_1\beta_1 + \gamma \cdot v) | x, v, y_2] = x_1\beta_1 + \gamma \cdot E(v | x, y_2) = x_1\beta_1 + \gamma \cdot g(x, y_2)$$

In the selected sample, we have $y_2 = 1$, we find $g(x, 1)$:

$$E(v | x, y_2 = 1) = E(v | v \geq -x\delta)$$

And

$$E(z | z > a) = \frac{\varphi(a)}{1 - \Phi(a)}$$

where z follows a standard normal distribution, a is a constant, φ is the standard normal probability distribution function and Φ the standard normal cumulative distribution function:

$$E(v | v \geq -x\delta) = \frac{\varphi(-x\delta)}{1 - \Phi(-x\delta)} = \frac{\varphi(x\delta)}{\Phi(x\delta)} = \lambda(x\delta) \quad \text{and } \lambda \text{ is the inverse Mills ratio.}$$

$$\Leftrightarrow E(y_1 | x, y_2 = 1) = x_1\beta_1 + \gamma \cdot \lambda(x\delta)$$

$$\Leftrightarrow y_1 = x_1\beta_1 + \gamma \cdot \lambda(x\delta) + \varepsilon$$

This regression will give an unbiased estimate of β_1 and γ .

5.5. Model, Results and Interpretation:

5.5.1. The correlation between innovation and economic factors:

The first regression model is written to test for the correlation of innovation with other economic variables mentioned above:

$$INN = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{13}\beta_{13} + X_{14}\beta_{14} + X_{15}\beta_{15} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma \cdot \lambda(x\delta) + \varepsilon \quad (1)$$

This regression model is tested over the years, from 2012 to 2016 and summarize for the whole period of times.

Similar to model (1), the following model is designed with the same purpose, however, a variable has been removed from initial regression model, Competitor variables set. This elimination is for Robustness Testing about the uncertainty of model, whether estimated effects of the model are sensitive to changes in model specifications or not.

$$INN = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma \cdot \lambda(x\delta) + \varepsilon \quad (2)$$

As the first model, this second one is implemented with the same period of time.

5.5.2. The correlation between open innovation and economic factors:

The following models are established to demonstrate the economic relationship between economic factors with the extension of OI in enterprises from transition countries. The third and the fourth models are designed to test the correlation among factors and also test the responsiveness of OI to the change of model factors.

$$OINN = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{13}\beta_{13} + X_{14}\beta_{14} + X_{15}\beta_{15} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma \cdot \lambda(x\delta) + \varepsilon \quad (3)$$

The fourth model has been shorten with the absence of competitor variables.

$$OINN = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma \cdot \lambda(x\delta) + \varepsilon \quad (4)$$

In general, these four above models are tested over the years (from 2012 to 2016) and also the summary for this whole period of testing.

Furthermore, the open innovation dependent variable is created by gathering from three different aspects of OI in enterprises' business activities, including: product & services OI (OINN₁), process OI (OINN₂), R&D with OI and other activities that acquired from external knowledge (OINN₃). So, in order to observe more particular information about the level of OI adaption on companies in some defined regions, I also add two more models into the surveys,

Model (5):

$$OINN_1 = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{13}\beta_{13} + X_{14}\beta_{14} + X_{15}\beta_{15} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma. \lambda(x\delta) + \varepsilon \quad (5')$$

$$OINN_2 = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{13}\beta_{13} + X_{14}\beta_{14} + X_{15}\beta_{15} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma. \lambda(x\delta) + \varepsilon \quad (5'')$$

$$OINN_3 = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{13}\beta_{13} + X_{14}\beta_{14} + X_{15}\beta_{15} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma. \lambda(x\delta) + \varepsilon \quad (5''')$$

Model (6) with the elimination of Competitors variables:

$$OINN = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma. \lambda(x\delta) + \varepsilon \quad (6')$$

$$OINN = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma. \lambda(x\delta) + \varepsilon \quad (6'')$$

$$OINN = \alpha + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_6\beta_6 + X_7\beta_7 + X_8\beta_8 + X_9\beta_9 + X_{10}\beta_{10} + X_{11}\beta_{11} + X_{12}\beta_{12} + X_{16}\beta_{16} + X_{17}\beta_{17} + X_{18}\beta_{18} + \gamma. \lambda(x\delta) + \varepsilon \quad (6''')$$

5.5.3. Results and interpretation:

5.5.3.1. The impacts of externally economic factors on innovation:

From 2012 to 2016, the influent factors in business environment on the decision of enterprises about business innovation are demonstrated as following table:

VARIABLES	(1) Innovation in 2011	(2) Innovation in 2012	(3) Innovation in 2013	(4) Innovation in 2014	(5) Innovation in 2016	(6) Innovation panel data
I. Firm's characteristics						
1. Exporting (X_1)	0.672*** (0.183)	0.516** (0.217)	0.628*** (0.0824)	0.273 (0.295)	1.090*** (0.319)	0.608*** (0.0662)
2. Firm Age (X_2)	-0.0189 (0.0491)	0.0619 (0.0687)	0.0138 (0.0305)	-0.0784 (0.125)	-0.0198 (0.0867)	0.00375 (0.0221)
3. Sampling size (X_3)	-0.108 (0.0985)	-0.176 (0.134)	-0.0550 (0.0562)	0.100 (0.192)	0.173 (0.211)	-0.0607 (0.0426)
4. Legal status (foreign ownership) (X_4)	0.200 (0.381)	0.528 (0.392)	-0.116 (0.141)	1.340** (0.647)	0.0814 (0.799)	0.00256 (0.119)
5. Establishment part of a larger firm? (X_5)	-0.0461 (0.199)	-0.340 (0.263)	0.114 (0.127)	0.178 (0.332)	0.212 (0.494)	0.0521 (0.0907)
6. Finance Revenue (X_6)	0.0687* (0.034)	0.0522 (0.026)	0.0489** (0.024)	-0.0154 (0.012)	-0.112 (0.089)	0.0429*** (0.014)

	(0.0368)	(0.0553)	(0.0225)	(0.0760)	(0.104)	(0.0166)
7. Labour						
Employees having university degree						
≤ 50% (X_7)	0.757 (0.632)	-0.319 (0.348)	0.384*** (0.103)	-0.621* (0.374)	0.232 (0.351)	0.257*** (0.0894)
> 50% (X_8)	0.867 (0.634)	-0.324 (0.371)	0.556*** (0.131)	-0.255 (0.644)	0.535 (0.469)	0.383*** (0.105)
8. Formal training programs for permanent (X_9)	-0.660*** (0.106)	-0.889*** (0.146)	-0.606*** (0.0666)	-0.531* (0.288)	-0.442 (0.314)	-0.639*** (0.0502)
9. Managers experience Working (X_{10})	0.170*** (0.0582)	0.237*** (0.0747)	0.0383 (0.0335)	-0.0467 (0.132)	0.0721 (0.120)	0.0812*** (0.0254)
10. Technology Have its owned website? (X_{11})	-0.992*** (0.114)	-0.606*** (0.166)	-0.441*** (0.0715)	-1.775*** (0.453)	-0.530 (0.351)	-0.619*** (0.0548)
11. Technology licensed from a foreign-owned company (X_{12})	-0.323* (0.195)	-0.987*** (0.263)	-0.694*** (0.0877)	-1.134*** (0.267)	-1.150*** (0.359)	-0.706*** (0.0706)
II. Environment						
1. Competitors						
Monopoly (X_{13})	0.386 (0.302)	0.583* (0.348)	0.436*** (0.160)	0.0896 (0.809)	1.178 (1.191)	0.458*** (0.129)
Oligopoly (X_{14})	0.548*** (0.135)	0.344* (0.181)	0.231*** (0.0810)	0.0501 (0.350)	-0.263 (0.339)	0.288*** (0.0618)
Monopolistics (X_{15})	0.287** (0.121)	0.500*** (0.176)	0.171** (0.0759)	-0.283 (0.336)	-0.162 (0.303)	0.220*** (0.0572)
2. Industry sampling sector (X_{16})	-0.0203*** (0.00378)	-0.0194*** (0.00529)	-0.0182*** (0.00226)	-0.00270 (0.0117)	-0.0155* (0.00863)	-0.0185*** (0.00173)
3. Main business city? (X_{17})	-0.210 (0.266)	-0.262 (0.216)	-0.259*** (0.0753)	1.272*** (0.371)	0.538 (0.451)	-0.172*** (0.0657)
4. GDP per capita (X_{18})		0.0589 (0.342)	1.202*** (0.409)	3.433*** (0.934)	-6.062*** (1.409)	-0.157 (0.485)
Constant	1.560 (1.211)	3.609 (3.560)	-9.582*** (3.445)	-30.76*** (8.356)	63.21*** (14.68)	2.926 (4.038)
Observations	1,876	1,063	6,028	461	361	9,790
Country	yes	Yes	yes	yes	Yes	Yes
Year	NA	NA	NA	NA	NA	Yes
Pseudo R2	0.122	0.150	0.167	0.215	0.195	0.153

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 1: Logit regression of innovation over years with full external factors

And according to second model, which has been built on above with the missing of competitor factors, Robustness checking method is applied on this model with the aim of testing the sensitivity of model to differently influent elements in original one.

VARIABLES	(1) Innovation in 2011	(2) Innovation in 2012	(3) Innovation in 2013	(4) Innovation in 2014	(5) Innovation in 2016	(6) Innovation panel data
I. Firm's characteristics						
1. Exporting (X_1)	0.572*** (0.169)	0.313 (0.193)	0.479*** (0.0703)	0.170 (0.261)	0.873*** (0.288)	0.457*** (0.0579)
2. Firm Age (X_2)	-0.0155 (0.0488)	0.0306 (0.0666)	0.0329 (0.0276)	-0.0535 (0.101)	-0.00313 (0.0789)	0.0148 (0.0205)
3. Sampling size (X_3)	-0.106 (0.0969)	-0.189 (0.129)	-0.0577 (0.0518)	0.122 (0.163)	0.174 (0.200)	-0.0645 (0.0398)
4. Legal status (foreign ownership) (X_4)	0.212 (0.350)	0.403 (0.371)	1.16e-05 (0.119)	1.260** (0.570)	-0.274 (0.674)	0.0790 (0.102)
5. Establishment part of a larger firm? (X_5)	-0.0616 (0.194)	-0.271 (0.254)	0.0338 (0.114)	0.129 (0.286)	0.102 (0.459)	0.0282 (0.0843)
6. Finance Revenue (X_6)	0.0822** (0.0361)	0.0914* (0.0537)	0.0489** (0.0210)	-0.0147 (0.0660)	-0.103 (0.0973)	0.0477*** (0.0158)
7. Labour Employees having university degree	Vietnamese - German University					
≤ 50% (X_7)	0.855 (0.662)	-0.134 (0.323)	0.399*** (0.0980)	-0.467 (0.340)	0.281 (0.346)	0.285*** (0.0849)
> 50% (X_8)	0.968 (0.664)	-0.139 (0.351)	0.631*** (0.124)	-0.226 (0.619)	0.573 (0.454)	0.442*** (0.100)
8. Formal training programs for permanent (X_9)	-0.663*** (0.105)	-0.893*** (0.143)	-0.622*** (0.0621)	-0.271 (0.252)	-0.371 (0.301)	-0.633*** (0.0478)
9. Managers experience working (X_{10})	0.161*** (0.0573)	0.251*** (0.0728)	0.0419 (0.0310)	0.0260 (0.106)	0.0351 (0.112)	0.0813*** (0.0239)
10. Technology Have its owned website? (X_{11})	-0.999*** (0.112)	-0.660*** (0.162)	-0.474*** (0.0676)	-1.642*** (0.402)	-0.611* (0.341)	-0.649*** (0.0527)
11. Technology licensed from a foreign-owned company (X_{12})	-0.323* (0.195)	-0.909*** (0.239)	-0.677*** (0.0804)	-0.775*** (0.239)	-1.119*** (0.335)	-0.672*** (0.0657)
I. Environment						
1. Industry sampling Sector (X_{16})	-0.0209*** (0.00376)	-0.0221*** (0.00505)	-0.0173*** (0.00210)	-0.000520 (0.0102)	-0.0172** (0.00825)	-0.0182*** (0.00163)
2. Main business city?	-0.163	-0.0989	-0.225***	0.883***	0.443	-0.133**

(X_{17})	(0.257)	(0.205)	(0.0703)	(0.301)	(0.439)	(0.0617)
3. GDP per capita (X_{18})		-0.112	1.029***	3.829***	-5.701***	-0.187
		(0.327)	(0.394)	(0.774)	(1.341)	(0.492)
Constant	1.422	4.265	-8.099**	-35.37***	59.84***	3.033
	(1.205)	(3.400)	(3.313)	(6.773)	(13.86)	(4.094)
Observations	1,899	1,119	6,690	563	390	10,662
Country	yes	Yes	yes	yes	Yes	Yes
Year	NA	NA	NA	NA	NA	Yes
Pseudo R2	0.113	0.149	0.164	0.195	0.186	0.151

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2: *Logit regression of innovation over years with Robustness checking method*

In general, the outcomes are quite similar and obviously witnessed from two above tables in spite of the absence of competitor elements in the second one. It can be seen from two tables, exporting is described as a strongly positive element on both model, this result can be predictable since this outcome could be considered as an evidence to strongly support for the verdict of Aghion, Bergeaud, Lequien, Melitz (2017). The next variables firmly impacting on the innovation decision of enterprises are the revenue of the company with positive outcome; formal training for permanent workers with negative result, this has been argued in some newspapers that this element could lead to a negative impact on both innovation and OI decisions due to no external knowledge acquisition; manager experience as a positive one, reinforcing to the opinion of Ayyagari et al. (2011), however, there is also a statement also announced in the research of Ayyagari that the number of years increasing could result in the downward trend in innovation if this is over the peak; technology on both variable (their own webpage and technology license from a foreign-own company) are all significantly negative to innovation activities. Comparing to the previous inside mentioned elements, environmental variables are all significantly effective on innovation process of entities. However, except for competitors (in the first model), the other elements all get negative impacts on innovation decisions.

And it can be seen from two tables illustrating the decision of innovation that the reflection from above results includes both the consensus as well as the dissension between the results from model and other outcomes from other researchers. On the other side, the impact of these variables fluctuates over the year about the intensity of the impacts, but overall, the trend of impact remains unchanged in total (only positive over the years or only negative over the years).

5.5.3.2. The impacts of external factors on open innovation:

On the next part of the survey, the outcomes resulted from open innovation models are illustrated as following, it seems to be that unlike the result of Robustness checking on impacts of all variables on innovation decision of enterprises, the model testing for the relationship between OI and variables has resulted an unstable outcomes. However, from these points of view in the next models, we could partially understand the decision making of enterprises over OI, showing the adaption of new concept in open innovation in the particular economic environment in general and in transition economies in specifically:

VARIABLES	(1) Open Innovation in 2011	(2) Open Innovation in 2012	(3) Open Innovation in 2013	(4) Open Innovation in 2014	(5) Open Innovation in 2016	(6) Open Innovation panel data
I. Firm's characteristic						
1. Exporting (X_1)	-0.422 (0.382)	0.762** (0.374)	0.289* (0.148)	1.029 (0.999)	1.015** (0.484)	0.230* (0.119)
2. Firm Age (X_2)	-0.00698 (0.0525)	-0.0101 (0.0744)	0.0100 (0.0352)	0.0592 (0.186)	-0.115 (0.0892)	-0.00509 (0.0253)
3. Sampling size (X_3)	0.199* (0.120)	-0.200 (0.171)	-0.0327 (0.0687)	0.107 (0.368)	0.0796 (0.250)	-0.00508 (0.0527)
4. Legal status (foreign ownership) (X_4)	0.525 (0.373)	0.488 (0.421)	0.111 (0.151)	2.210** (0.926)	0.305 (0.743)	0.205 (0.128)
5. Establishment part of a larger firm? (X_5)	-0.251 (0.233)	-0.388 (0.297)	0.229 (0.151)	-0.301 (0.519)	0.208 (0.535)	0.0377 (0.110)
6. Finance Revenue (X_6)	0.0111 (0.0473)	0.0641 (0.0708)	0.0515* (0.0297)	0.0735 (0.112)	-0.123 (0.123)	0.0433** (0.0219)
7. Labour Employees having university degree $\leq 50\%$ (X_7)	13.04*** (0.342)	0.0270 (0.423)	0.253* (0.148)	-1.358** (0.643)	0.118 (0.491)	0.1000 (0.127)
> 50% (X_8)	13.15*** (0.391)	0.0330 (0.471)	0.213 (0.188)		0.103 (0.654)	0.118 (0.150)
8. Formal training programs for permanent (X_9)	0.213 (0.457)	-1.007** (0.423)	-0.327** (0.160)	-0.397 (0.902)	-0.245 (0.518)	-0.276** (0.129)
9. Managers experience working (X_{10})	-0.0363 (0.0853)	0.261*** (0.0957)	-0.0567 (0.0439)	-0.238 (0.228)	0.126 (0.131)	-0.0120 (0.0334)
10. Technology Have its own website? (X_{11})	-0.129 (0.495)	-0.706 (0.453)	-0.0420 (0.174)	-2.824 (1.914)	-0.206 (0.726)	-0.162 (0.143)
11. Technology licensed from a foreign-owned company (X_{12})	0.0814	-1.187***	-0.420**	-0.854	-1.249**	-0.430***

	(0.445)	(0.401)	(0.166)	(0.888)	(0.630)	(0.134)
II. Environment						
1. Competitors						
Monopoly (X_{13})	0.0147 (0.458)	0.286 (0.553)	-0.435* (0.246)	0.377 (1.347)	-0.0319 (1.153)	-0.227 (0.189)
Oligopoly (X_{14})	-0.0685 (0.257)	0.494* (0.276)	-0.0634 (0.115)	0.158 (0.572)	0.327 (0.468)	0.0124 (0.0899)
Monopolistics (X_{15})	-0.114 (0.212)	0.545** (0.267)	0.0636 (0.103)	-1.252** (0.619)	0.492 (0.377)	0.0817 (0.0802)
2. Industry sampling sector (X_{16})	0.0149 (0.0129)	-0.0153 (0.0117)	0.00468 (0.00470)	0.0238 (0.0276)	0.00759 (0.0156)	0.00457 (0.00378)
3. Main business city? (X_{17})	0.194 (0.319)	-0.484* (0.253)	-0.194** (0.0954)	1.086* (0.580)	0.491 (0.553)	-0.109 (0.0807)
4. GDP per capita (X_{18})		0.365 (0.556)	1.060 (0.669)	3.256 (4.438)	-4.488 (4.180)	0.219 (0.336)
inv mills2	-1.833* (1.036)	0.658 (0.864)	-0.760** (0.328)	-0.101 (1.673)	0.156 (1.220)	-0.788*** (0.271)
Constant	-13.90*** (1.387)	-0.733 (5.308)	-9.516* (5.707)	-30.75 (42.11)	45.10 (42.19)	-1.812 (2.865)
Observations	1,876	1,063	5,852	409	361	9,614
Country	yes	Yes	yes	Yes	Yes	Yes
Year	NA	NA	NA	NA	NA	Yes
Pseudo R2	0.0926	0.117	0.134	0.286	0.126	0.119

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Logit regression of open innovation over years with full external factors

VARIABLES	(1) Open Innovation in 2011	(2) Open Innovation in 2012	(3) Open Innovation in 2013	(4) Open Innovation in 2014	(5) Open Innovation in 2016	(6) Open Innovation panel data
I. Firm's characteristics						
1. Exporting (X_1)	-0.349 (0.275)	0.352 (0.300)	0.349*** (0.132)	0.965 (0.888)	0.887** (0.424)	0.235** (0.104)
2. Firm Age (X_2)	-0.00693 (0.0523)	-0.0105 (0.0724)	0.0101 (0.0351)	0.0640 (0.183)	-0.112 (0.0872)	-0.00461 (0.0252)
3. Sampling size (X_3)	0.190 (0.118)	-0.150 (0.168)	-0.0454 (0.0685)	0.0800 (0.333)	0.112 (0.234)	-0.00788 (0.0523)
4. Legal status (foreign ownership) (X_4)	0.529 (0.372)	0.496 (0.412)	0.107 (0.151)	1.867** (0.915)	0.221 (0.752)	0.204 (0.128)
5. Establishment part of a larger firm? (X_5)	-0.236 (0.231)	-0.415 (0.299)	0.249* (0.150)	-0.460 (0.530)	0.145 (0.510)	0.0414 (0.109)
6. Finance						

Revenue (X_6)	0.0171 (0.0442)	0.0403 (0.0694)	0.0585** (0.0294)	0.0649 (0.108)	-0.138 (0.121)	0.0445** (0.0216)
7. Labour						
Employees having university degree $\leq 50\%$ (X_7)	13.97*** (0.281)	-0.168 (0.416)	0.282* (0.145)	-1.291** (0.624)	-0.0356 (0.441)	0.101 (0.123)
> 50% (X_8)	14.10*** (0.345)	-0.252 (0.459)	0.257 (0.183)		-0.108 (0.607)	0.120 (0.144)
8. Formal training programs for permanent (X_9)	0.108 (0.279)	-0.478 (0.311)	-0.403*** (0.134)	-0.403 (0.824)	-0.0543 (0.452)	-0.283*** (0.105)
9. Managers experience working (X_{10})	-0.0217 (0.0727)	0.208** (0.0899)	-0.0477 (0.0429)	-0.300 (0.214)	0.100 (0.126)	-0.0114 (0.0324)
10. Technology						
Have its owned website? (X_{10})	-0.238 (0.305)	-0.169 (0.329)	-0.125 (0.148)	-2.675 (1.834)	0.0298 (0.629)	-0.171 (0.118)
Technology licensed from a foreign-owned company (X_{11})	-0.0111 (0.298)	-0.759** (0.327)	-0.490*** (0.146)	-0.683 (0.843)	-0.993* (0.546)	-0.435*** (0.116)
I. Environment						
1. Industry sampling sector (X_{16})	0.0119 (0.00861)	-0.00106 (0.00917)	0.00255 (0.00410)	0.0192 (0.0253)	0.0132 (0.0142)	0.00444 (0.00323)
2. Main business city? (X_{17})	0.174 (0.313)	-0.328 (0.239)	-0.216** (0.0907)	1.107* (0.582)	0.579 (0.545)	-0.109 (0.0772)
3. GDP per capita (X_{18})		-0.257 (0.476)	1.318** (0.619)	3.535 (4.071)	-2.747 (3.488)	0.221 (0.335)
inv mills2	-1.581*** (0.594)	-0.543 (0.577)	-0.585** (0.261)	-0.0889 (1.505)	-0.456 (0.957)	-0.777*** (0.209)
Constant	-14.67*** (1.289)	4.633 (4.766)	-11.81** (5.255)	-33.32 (38.53)	27.83 (35.40)	-1.833 (2.859)
Observations	1,876	1,063	5,852	409	361	9,614
Country	yes	Yes	yes	Yes	yes	Yes
Year	NA	NA	NA	NA	NA	Yes
Pseudo R2	0.0923	0.112	0.133	0.263	0.121	0.119

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Logit regression of open innovation over years with Robustness checking method

As can be seen from table 3 and 4, except for the result in 2011, exporting still has a positive impact on the decision of OI, similar to its impact on innovation. This seems to be that exporting impact is unchanged over innovation or open innovation. The next element is considered to have impact on OI

decision is revenue of companies. According to Henry Chesbrough announces his statement in the research in 2011 that OI could help companies achieve the increase of revenue for technology industry. This result (despite $p > 0.1$), in some extent, explains that not only in one industry, the impact could be over many different industries. The third variable should be taken into consideration is that ‘Formal training program for permanent workers’ with the same statement of that in the relationship with innovation actions of entities: A significant negative impact of this variable on both innovation and OI. Next, the fourth variable being attentive to evaluate the accurate of models testing on OI decision is that ‘Technology licensed from a foreign-own company’. The correlation between them is negative, similar to the impact of that on innovation models, becoming a strongly evidence for the statement of Erica Mazzola, Manfredi Bruccoleri and Giovanni Perrone (in 2016) about innovation and also OI.

To sum up, although results from the third and fourth tables coming from OI correlation testing models could not strongly confirm each impacts of these independent variables to OI decision of entities in the survey, it partially help us to have a general view on the effects of elements both inside and outside of enterprises on OI activities. And comparing to innovation activities of enterprises joining to this survey, OI activities seems to be dominant by innovation activities. Furthermore, it can be said that these models could give out strong evidence for the impacts of innovation with independent variables, however, the models might need more adjustment for OI adoption testing.

On the following part of the survey result is the illustrating tables for models set 5 and 6. In these tables, the open innovation will be separated into different forms including: Products and services, Process and R&D. These testing models also apply Robustness checking method then table 6 will not contain Competitors variables similar to previous ones.

VARIABLES	(1) OI panel	(2) OI Products & services	(3) OI Process	(4) OI R&D
I. Firm's characteristics				
1. Exporting (X_1)	0.230* (0.119)	-0.137 (0.163)	-0.155 (0.198)	0.134 (0.241)
2. Firm Age (X_2)	-0.00508 (0.0253)	-0.0317 (0.0395)	-0.00521 (0.0440)	0.0540 (0.0555)
3. Sampling size (X_3)	-0.00515 (0.0527)	0.00434 (0.0805)	0.0697 (0.100)	-0.0527 (0.128)
4. Legal status (foreign ownership) (X_4)	0.205 (0.128)	0.355* (0.194)	0.362 (0.246)	0.313 (0.303)
5. Establishment part of a larger firm? (X_5)	0.0378 (0.110)	-0.0506 (0.164)	-0.106 (0.191)	0.400 (0.254)
6. Finance Revenue (X_6)	0.0433** (0.0219)	0.0296 (0.0331)	0.0589 (0.0404)	0.0792 (0.0486)

7. Labour				
Employees having university degree				
≤ 50% (X ₇)	0.1000	0.168	-0.373	-0.0642
	(0.127)	(0.192)	(0.248)	(0.354)
> 50% (X ₈)	0.118	0.167	-0.192	0.166
	(0.150)	(0.227)	(0.283)	(0.401)
8. Formal training programs for permanent (X ₉)	-0.276**	0.0177	-0.115	-0.560**
	(0.129)	(0.180)	(0.221)	(0.272)
9. Managers working experience (X ₁₀)	-0.0119	-0.0579	0.0631	-0.0293
	(0.0334)	(0.0501)	(0.0600)	(0.0789)
10. Technology				
Have its owned website? (X ₁₁)	-0.162	0.0737	0.0627	-0.328
	(0.143)	(0.202)	(0.244)	(0.323)
Technology licensed from a foreign-owned company (X ₁₂)	-0.431***	-0.389**	-0.540**	-0.381
	(0.134)	(0.186)	(0.221)	(0.264)
II. Environment				
1. Competitors				
Monopoly (X ₁₃)	-0.227	-0.425	-0.476	-0.159
	(0.189)	(0.272)	(0.335)	(0.408)
Oligopoly (X ₁₄)	0.0125	-0.154	-0.0214	0.0760
	(0.0899)	(0.132)	(0.157)	(0.211)
Monopolistics (X ₁₅)	0.0817	-0.0123	-0.0342	0.250
	(0.0802)	(0.117)	(0.141)	(0.179)
2. Industry sampling sector (X ₁₆)	0.00456	0.0185***	0.0127**	0.000788
	(0.00378)	(0.00520)	(0.00606)	(0.00776)
3. Main business city? (X ₁₇)	-0.109	0.0324	0.0873	-0.0912
	(0.0807)	(0.123)	(0.153)	(0.195)
4. GDP per capita (X ₁₈)	1.13e-05	0.000809	-0.000299	-0.00110
	(1.94e-05)	(0.000555)	(0.000553)	(0.000990)
invmls2	-0.787***	-0.0376	-0.204	0.301
	(0.271)	(0.383)	(0.467)	(0.585)
Constant	-0.0353	-1.840	0.186	2.561
	(0.611)	(1.814)	(2.039)	(2.747)
Observations	9,614	2,412	1,843	1,038
Country	yes	yes	Yes	Yes
Year	yes	yes	Yes	Yes
Pseudo R2	0.119	0.0532	0.0541	0.0869

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Logit regression of open innovation in different categories

From the fifth table showing outcome of regression model of OI in different categories, it can be said that the impact of independent variables on decision making of OI in different categories are not the same. For example, Exporting has a negative impact on OI in products & services and Process of enterprises, however, this has an opposite trend for OI in R&D and in general.

VARIABLES	(1) OI panel	(2) OI Products & services	(3) OI Process	(4) OI R&D
I. Firm's characteristics				
1. Exporting (X_1)	0.301*** (0.0925)	-0.0348 (0.146)	-0.0877 (0.179)	0.0839 (0.226)
2. Firm Age (X_2)	-0.00562 (0.0253)	-0.0326 (0.0394)	-0.00461 (0.0440)	0.0528 (0.0558)
3. Sampling size (X_3)	-0.0196 (0.0517)	-0.0151 (0.0798)	0.0591 (0.0995)	-0.0419 (0.129)
4. Legal status (foreign ownership) (X_4)	0.204 (0.128)	0.342* (0.194)	0.355 (0.246)	0.326 (0.302)
5. Establishment part of a larger firm? (X_5)	0.0449 (0.110)	-0.0306 (0.164)	-0.0912 (0.191)	0.430* (0.253)
6. Finance Revenue (X_6)	0.0510** (0.0211)	0.0390 (0.0325)	0.0621 (0.0402)	0.0773 (0.0490)
7. Labour Employees having university degree ≤ 50% (X_7)	0.144 (0.119)	0.223 (0.188)	-0.334 (0.243)	-0.0629 (0.347)
> 50% (X_8)	0.191 (0.135)	0.240 (0.219)	-0.139 (0.276)	0.161 (0.391)
8. Formal training programs for permanent (X_9)	-0.378*** (0.0808)	-0.114 (0.152)	-0.202 (0.189)	-0.485*** (0.243)
9. Managers experience working (X_{10})	-0.000568 (0.0314)	-0.0400 (0.0483)	0.0716 (0.0585)	-0.0330 (0.0777)
10. Technology Have its owned website? (X_{11})	-0.268*** (0.0951)	-0.0725 (0.171)	-0.0340 (0.209)	-0.277 (0.289)
Technology licensed from a foreign-owned company (X_{12})	-0.524*** (0.0956)	-0.512*** (0.161)	-0.621*** (0.193)	-0.323 (0.239)
II. Environment				
1. Industry sampling sector (X_{16})		0.0152*** (0.00449)	0.0104* (0.00537)	0.00245 (0.00705)
2. Main business city? (X_{17})	-0.130* (0.0761)	-0.00634 (0.119)	0.0596 (0.150)	-0.0729 (0.192)
3. GDP per capita (X_{18})	9.47e-06 (1.92e-05)	0.000817 (0.000553)	-0.000295 (0.000553)	-0.00110 (0.000985)
inv mills2	-0.558*** (0.134)	0.281 (0.298)	0.00847 (0.375)	0.136 (0.490)
Constant	0.0604 (0.607)	-1.953 (1.808)	0.202 (2.039)	2.388 (2.741)
Observations	9,614	2,412	1,843	1,038
Country	Yes	yes	Yes	Yes
Year	Yes	yes	Yes	Yes
Pseudo R2	0.118	0.0521	0.0530	0.0849

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: *Logit regression of open innovation in different categories with Robustness checking*

Taking into consideration on both regression models (5) & (6), the outcome from Robustness checking method on the sixth model describes a more reliable result than the outcome from regression model (5). Furthermore, it also brings out some observations illustrating the correlation between OI categories and other elements in models. According to table 6, under some testing variables, the OI from small categories might have opposite results. Taking into consideration of exporting, while the summary of all types and R&D outcome have positive results but OI in products & services or in process have negative impacts. However, besides that, we can witness all small categories and summary have the same trend over a testing element in model. For example, Technology licensed from a foreign-own company brings negative impacts on all categories. To sum up, both original model and the one with Robustness checking method try to externalize the impacts of independent variables on OI decision making. Though they could not describe exactly, in some extent, two tables with evidence could show the impacts of these elements on OI activities. It would help us gain some knowledge about the facts of OI application in transition economies area.



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6. Conclusion

This study presents the development of both open innovation and innovation taking many inside and outside factors into account. The literature demonstrated that along with innovation, open innovation is now globally well-known and studied not only by scientists or researchers but also managers of many enterprises. Open innovation is also classified under many categories and tested to acknowledge about how this involved in business activities. With the curiosity about this topic and the sensibility of it over surrounding elements, I have studied and acquired some interesting results. The impact of any element is not the same over years and each variable has different effect on both open innovation and innovation activities.

The models are built basing on different factors and tested with dataset over years to draw a general conclusion about OI & Innovation activities of all enterprises joining the survey. Besides, in order to increase the accuracy of models in the model evaluation, some econometric methods have been used: Heckman method and Robustness checking. These methods are intended to make it possible to create suitable models and evaluate the impact of these variables as well as show those effects on the dependent variable.



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In general, from the results achieved in this study, it is difficult to assess these are truly useful and accurate models, but it can be concluded that it gives some preliminary information about O&I activities in this transition area. And of course, this model still has many limitations that need to be improved in the future to be able to more accurately record these models. First of all, although the database stretches from 2012 to 2016, to some countries, data is still limited to some other countries in the region. Or it can be said that the factor was not really suitable to be able to predict the current situation of this area. In addition, while applying econometric methods to models, it is not always effective to evaluate the most clearly which factors are most suitable to evaluate the decision making of entities on open innovation and innovation. However, this study can still be considered as a result being able to refer to the OI & innovation evaluation process in this area in the future or may create a premise for the following studies to apply and modify the models to fit different regional locations globally.

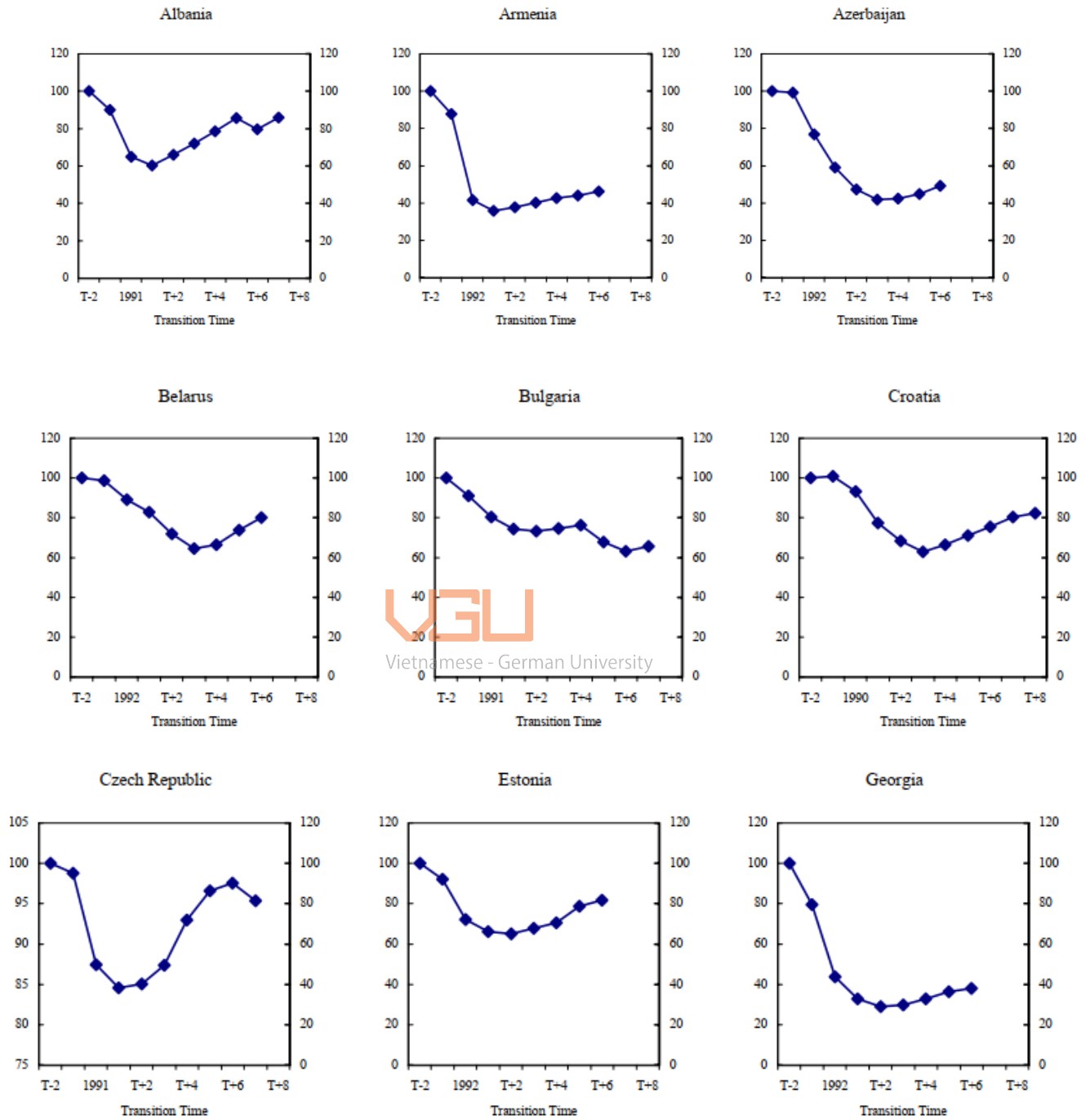
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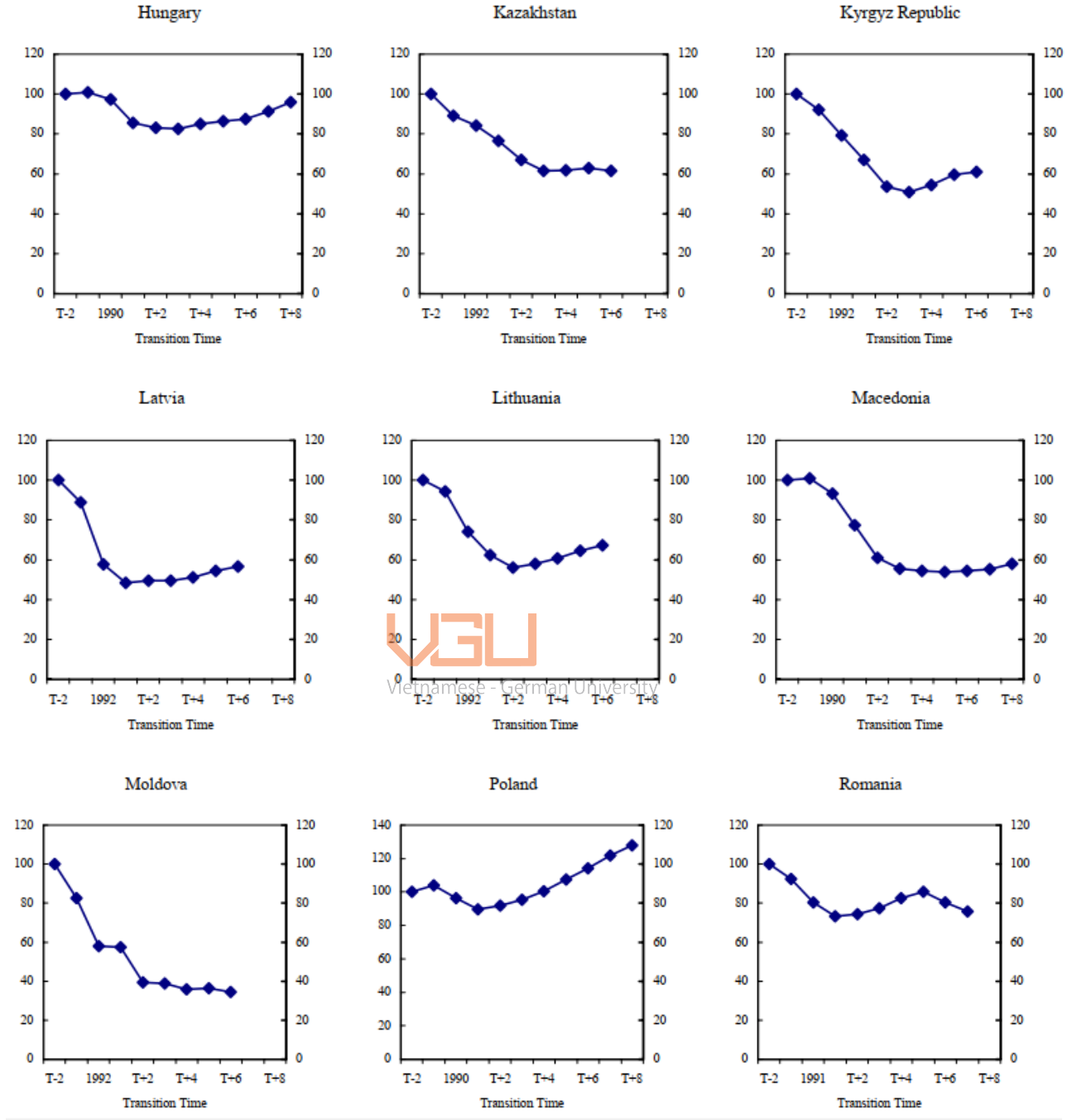
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Figure 2: GDP Index in Transition Time (T-2=100)



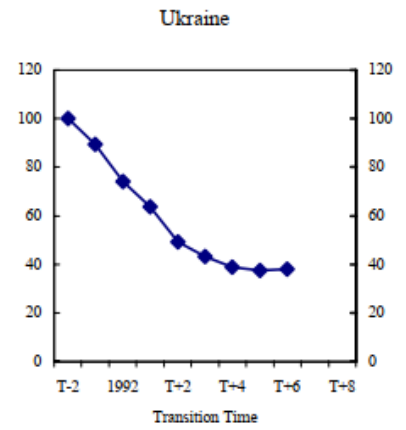
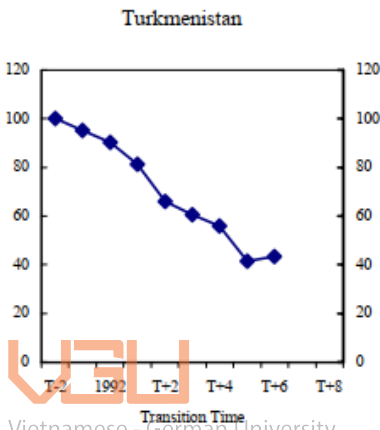
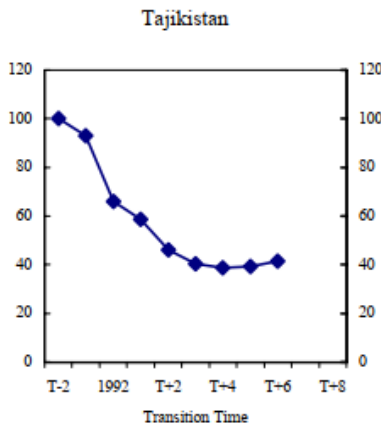
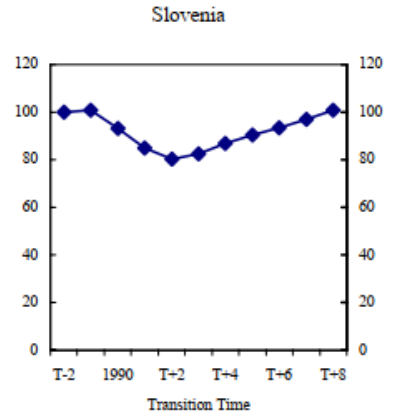
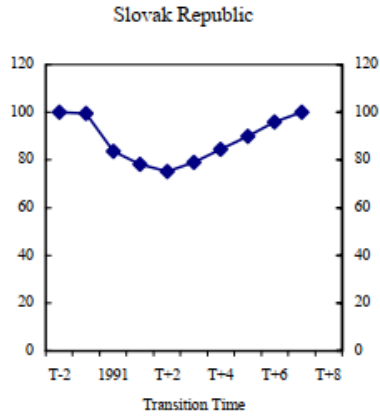
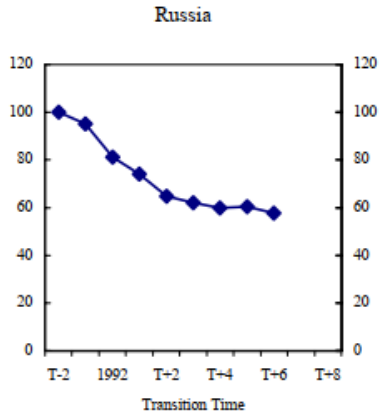
Source: International Monetary Fund

Figure 2: GDP Index in Transition Time (T-2=100) (Continued)

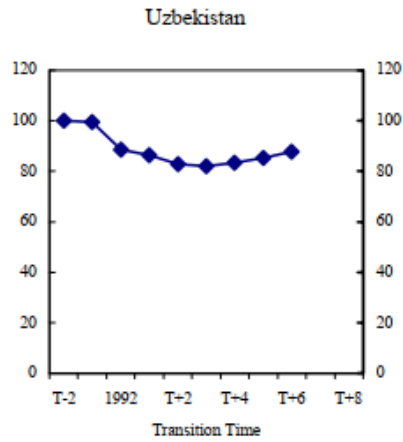


Source: International Monetary Fund

Figure 2: GDP Index in Transition Time (T-2=100) (Continued)



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Source: International Monetary Fund



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Statutory declaration

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TRANSITION ECONOMIES FROM 2012 TO
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