International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 02, 2020
ISSN: 1475-7192

Econometric Modelling of the Innovation Process in Uzbekistan

Mulaydinov Farkhod[1]

Abstract— *This paper is dedicated to the analysis of factors affecting innovation in Uzbekistan taking the case of the Joint Stock Company "Uzkimyosanoat". It involved obtaining primary data for 10 enterprises in the company and analysing this data. Factors to be looked at were chosen as research and development, intellectual knowledge, human abilities, level of satisfaction, demand for changes, usage of ICT and product development, growth of enterprise.*

The results showed that after econometric analysis only 4 out of 8 the chosen factors had a significant effect on the innovation process in the enterprises of "Uzkimyosanoat". These were intellectual knowledge, R&D, product development and enterprise growth levels. In order to develop innovation in the enterprise effectively, these factors need to be looked at more carefully and policies undertaken to increase their development.

Keywords— *innovation, variables, econometric model, factor, enterprise*

I. INTRODUCTION

We are moving to an era of knowledge economy. Knowledge economy is broken into 4 sub categories which are innovation, education, ICT and Business conditions. Innovation makes up 50% of the knowledge economy, thus improving innovation and knowing which factors affect it is very important in order to make the economy grow. Innovation is counted as not only new products, which have been found through Research and development, but also products with "improved designs" and "adoption of new technology" in a firm.

Taking developed nations as an example, Uzbekistan as a developing nation and needs to expand its innovation strategy and the usage of knowledge economy in sectors in the economy. In the market economy, the progression of innovation effects GDP growth, employment, and increase the competitiveness in the world market.

Innovation is a very wide area of study, and each industry has its own particular factors which may influence the development of innovation more. Each industry needs its own particular type of innovation and development. This particular paper will analyse the chemical sector in Uzbekistan and in particular try to identify the main factors which affect the innovation in this sector, taking the JSC "Uzkimyosanoat" as an example.

The aims of the research were:

[1]*Mulaydinov Farkhod, Head of the Department of Economics and Humanitarian subjects at Kokand university, Uzbekistan, E-mail: fergahanasoft@gmail.com*

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

1. Clarify the meaning of innovation; critically identify the main factors which are affecting on innovation according to other research
2. Explore these factors for "Uzkimyosanoat" using primary data
3. Make econometric equations and model to show the quantitative influence of the factors of innovation

Innovation is becoming a topic which many firms and governments are paying bigger and bigger attention to. This is because of the fact that innovation means responding to the conditions, which are changing daily, and to the technologies that are getting more and more developed as we speak. The more innovation you have the better the country grows and the enterprises develop. Innovation influences the economy to prosper and grow thus leading to bigger employment levels and income in that economy. Innovation is a process, a strategy, a benchmark, leadership skills, management techniques and much more.

II. LITERATURE REVIEW

Policies to support SME's are being implemented all over the world, and these policies include many factors in order to encourage innovations. Dr. Vigier stated that the EU stimulates an 'open innovation' model where knowledge and experiences are shared in between the people inside the networks. The EU aims to promote the interaction of a broad range of policy areas, such as structural funds, state aid policies, education and training.

According to Buddelmeir, Jensen and Webster, without innovation a firm will not be able to survive thus it needs innovation needs to be encouraged by the government to stimulate growth. This was supported by the research made in Canada to try and find out the determinants of innovation showed that many factors including finance, culture, incentives nad governance stimulate innovative growth and prosperity.

Kirzner states that there are four types of innovation that a firm can have, first is making new products using the technology they had, producing a new product through new technology, third is producing old products through new technology or finally old. products at a lower price.Klette and Kortum (2004) together with Cohen and Klepper (1996) also try to prove that this theory is correct. Oslo Manual by OECD stated that innovation must be broken down into other four types which are "organizational, marketing, product and process".

Some theories tries to explain innovation affecting factors through geographic models such as Jacobs in 1969 stating that different industry should be located nearer to each other thus sharing their ideas and increasing innovation.This theory was contradicted by many authors such as Marshal (1890) and (1986) who stated that if an industry is concentrated in one place this has a positive effect on innovation and growth.

Becker in his theory in 1962 first gave the idea that innovation is strongly correlated with "human capital accumulation". This theory was further established by Barro and Lee when they showed that the more workers a country has, the more skill the workers have the higher the innovation level in that country. Koppel looked at it from a different point of view in his theory of induced innovation where he showed that the more demand there is for a product the more innovation is stimulated to grow and prosper. When there is a high demand, the government also in its turn tries to give extra incentive for the innovations to take place.

Humphreys, McAdam, and Leckey showed that factors such as Leadership, Empowerment, Culture,

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

Technology, Learning, Structure and management helps to develop innovation and attention should be focused to them in all enterprises.Research undertaken in Greece tried to find the factors affecting the innovation performance in Small enterprises. This studied found that although technology was thought to be important, it came as having an insignificant role for Greece's case, market and learning factors had a significant effect as well as industry concentration and barriers to entry which explains their innovative activity.

Duygulu, Kok and Ozdemir also explored the factors affecting the innovations in small enterprises in Turkey and tried to compare it among different regions in Turkey. They tested factors such as formalization, standardization, degree of Specialization, degree of centralization, individual Autonomy, Control, Training, Entrepreneurship and Competition, Team Orientation, Capability. They found that not only producing new products is sufficient to gain good results, other innovative methods should be used but as the role of SME's is significantly lower in Turkey compared to other countries their findings can not be applied to everyone.

According to OECD, in the CIS countries Research and Development does not have a significant impact on innovation. In the case of Small and Medium Enterprises the innovation can have either "capital equipment or input-embodied innovation" or "design innovation". Although not all firms make innovations, many have the potential to do so and according to their research those companies who have higher educated employees, introduced at least one new product, give a considerable weight to client satisfaction and research their markets, have good relationships with other companies, don't get subsidies or own patent.

The UNDP states that the biggest tool to improve innovation in Uzbekistan is education. According to the research made by the International Finance Corporation in 2005 SME's comprised 38.2% of GDP and 66% of the employment in Uzbekistan. Thus developing this sphere through the use of innovations is becoming more and more important by each day. Not many researches have been made in small countries regarding determinants of innovation and their effects.

According to the 2007 Uzbekistan Presidential decree, industries are encouraged to innovate and modernize their technological process in order to be in the competitive world market.Research regarding innovation development policies in Uzbekistan are being studied by authors such as Karimov (2005) , Bekmuradov A., Ishmuhamedov A., Akabirova (2007) has discussed the ways of developing manufacturing industry in Uzbekistan through the usage of innovation. Abdukarimova M., Madjidov Sh. and others.

As the topic of innovation is relatively new to Uzbekistan, there has not been alot of research done on it. Azamatov looked at the development of innovation and its usage in Uzbekistan and according to his research innovation is only in its beginning stage of development, which means that further development can be accelerated if the factors which affect it can be found and correctly managed. Authors such as Hassanov, Nazarov, Batirov Yakubov, Matyokubov, Abidov, and others have looked at some of the innovation spheres and have written formal papers on them. At this point in time, governments' organizations and enterprises are trying to make their own researches.

The sampling made was for the whole SJC "Uzkimyosanoat" for 11 year period. 10 largest enterprises were looked at and analyzed, these were "Navoinazot", "Maksam-chirchik", "Ferghanaazot", "Ammophos-maksam", "Electrohimzavod", "Samarkandkimyo", "Kukonsuperfosfat plant", "Ferghana CPFC", "Kungrad soda plant", "DjizzakPlastmassa", "UzkimyosanoatLoyiha".

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

Innovation is a new meaning in both Uzbekistan's research area and business area. Innovation is a word which has the meaning of "emerging with something new". Something new means new method, new usage, new product, new idea, new way of doing something. The process of thinking of this "new" thing and distributing it is called the "innovation process". The period when the innovation is thought up of up to the time period when it is started to be used in real life is called the "Innovation period".

In order to move from one quality to another, better one, resources such as energy, time, money, workers and other inputs are needed. The same can be applied to innovation, in order to bring it to life; it also needs some necessary inputs from which the most important are investments and time. Innovation, in the broad meaning is to increase the profitability by using new technology, new products or services, to make organizational decisions and using these "new" ideas in life.

When reaching the first objective, Innovation has had many definitions and is a word used widely today, thus it was very difficult to obtain an exact meaning. Some authors as shown in the literature review stated innovation as anything that is new others as responding to changes. This case it was chosen to use innovation as the definition used by Kirzner which stated that innovation is making new products from old technology or from new technology and making old products from old technology (lowering cost) or new technology

The Presidents book "The effectiveness of anti-crisis programs and prorities of post-crisis development (in the example of Uzbekistan)" states that in order to increase competitveness in the market during the financial crisis, innovation technology programs should be thought of implemented.

An "innovation center" was opened at Uzkimyosanoat in the year 2007 with the aim of developing innovation and attracting innovation projects. The companies innovation activities according to Republic of Uzbekistan presidential decree "Additional ways of Attracting Innovation projects and technology production", "Additional ways of increasing the growth and new product development in enterprises in the chemical industry", "Additional ways of modernizing production, to implement the most important projects that develop technology for the years 2009-2014"

III. METHODOLOGY

According to the aims stated in the presidential decree on the 12th march 2009, all enterprises in "Uzkimyosanoat" are implementing 3 building projects, 7 projects with foreign investment decisions and criteria, 5 new projects are under construction. By 2009, "Uzkimyosanoat" has started to produce 18 new products worth 15 billion soums.

Identifying the main factors which influence the innovation in this enterprise will help the chemical industry develop more by paying more attention to those factors and adopting necessary policy tools. Previous work of scholars will be reviewed and factors to be looked at identified. It has to be taken into account that this works make a sophisticated econometric model that will serve as a statistical tool but to analyse innovation and make a step further to try and find some influences to the innovation process and development.

The Center for innovations main aim is to work to develop the whole enterprise, find the best targets to achieve; control already implemented researches, think of new projects in order to produce new products. The

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

innovation projects proposed are being implemented. A large proportion of the implenented projects are trying to produce new goods instead of imported goods used. “Uzkimyosanoat” has taken part in the 2008-2009 “Innovation ideas, technologies and projects” fair with 20 new projects. These projects were presented and certificates, patents, new product usage advices obtained.

The patents obtained for innovation usage, rationalizing certificates are the documents which show that they are new and giving them the ownership rights on the innovation. For example “Ammofos-Maksam” owns 9, “Maksam-Chirchik” owns 5 patent rights in the Republic of Uzbekistan. According to the CEO of the Company, MrGulomov, this work in the shpere of innovation is still not enough and needs to be developed further.

In order to make a regression and obtain an econometric equation, factors or independent variables to be tested needed to be chosen. As there is no exact model for calculating innovation, a model will be created. After looking through many researches made which has been discussed in the literature review above, it has been chosen to make a model by using the factors shown in the table below. The reason for this is that in my opinion is that these factors play a key role in the company and its management and affect innovation significantly. The dependant variable will be innovation.

Table 1: How to measure factors chosen to be looked at

№	FACTOR	HOW TO MEASURE IT
1.	Research and development	Money spent on R&D each year
2.	Intellectual knowledge increasing	Qualification courses passed per year
3.	Human abilities	Percentage of workers with higher education
4.	Level of satisfaction	Satisfaction of workers through company surveys
5.	Demand for change	Satisfaction of customers through surveys
6.	Usage of ICT	Internet connection, computer availability
7.	Product development	New products in production

It was planned to measure innovation through both the number of new products in the enterprises and with money spent on new technology. Through the course of the research it was found that technology that is new to the company and is being used efficiently is a better measure for this case. The reason behind this is that as “Uzkimyosanoat” is a very large company, the number of new products being produced is very small compared to total production thus after attempting several regression models it was seen that this dependant variable could be explained by all the independent variable and the results were unreliable.

IV. RESEARCH RESULTS

The Table in appendix shows the Log-Log regression results using 7 independent variables, looking at the probabilities of the coefficients, we can see that at a 5% significance only 3 independent variables are statistically significant, those are Research and development, Increasing qualification levels and higher education level. Thus the next regression was made for only the statistically significant independent variables using the method applied above.

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

The table above shoes the Log-Log model obtained with statistically significant independent variables used to try to explain the variation in the dependant variable. In this model, the coefficients are statistically significant at 5% and the standard errors are low. The adjusted R-squared of the model is 56% which is a significantly high results. No problems of autocorrelation and multicollinearity were observed. This particular model was deemed as the most appropriate model from those attempted.
Thus the model is:

Log(Innovation) = 0.470273*log(R&D) + 0.444175*log(increasing qual) + 0.307230*log(new products) + 0.273577*log(growth of employees) + ε

As we know, the world financial crisis has caused many firms to decrease the number of its employees but we can observe from the given charts that "Uzkimyosanoat" was quite stable and the total employee percentage change was positive most of the period observed.

The third chart, namely the number of employees who pass increasing qualification courses shows us how important this factor is becoming to "Uzkimyosanoat". The company is paying higher attention to educating its employees and the qualifications they have. "Uzkimyosanoat" has made special agreements with universities where they pay the tuition fee of some employees while they go to university and after graduations come to the firm to work.

The IT literacy, money spent on research and development, new product development and technological progress are all increasing significantly in the firm in hand. Especially during the past 3 years as the development of these spheres were paid higher attention to due to the fact that they are a large factor affecting development of the innovation activities int eh firm. Thus it can be concluded from this fact that the enterprise think that these factors in particular affect innovation activities.

During the econometric modelling, panel data was analysed. This type of data is more complicated then simple time-series or cross sectional as it combines them together. It requires careful handling and manipulation. As Baltaki stated panel data shows more variability, more degree of freedom, higher efficiency and less collinearity of the data source. Panel data estimations are assumed to be more accurate as the data varies across 2 dimensions as the data observed becomes more realistic and accurate.

V. CONCLUSIONS

After 4 estimations of different models were attempted, the last estimation of the Log-Log model was chosen to be the most accurate model. The reason for this is the fact that the previous models such as the Linear model had very high coefficients, large p-values, small t-statistics, low D-W and the explaining power of the model other models were lower then the Logarithmic model. This model will further be discussed below and conclusion obtained from them analysed.

The biggest problem of panel data is the fact that the problem of multicollinearity and autocorrelation among observations may occur; the reason is the fact that as observations are repeated this may mean that the observations are no longer independent from each other. It can be seen that in this model that the sign showing that multicollinearity exists are not there. These signs are large variance and large confidence intervals, low t-stats but very high R-squares. Looking at the model we can see that these problems are not present. The problem

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

of autocorrelation is tested using the Durbin-Watson D-statistics. The model that was chosen as the best representative, which is the Log-Log model has a DW d-stat of 1.89. From econometrics lessons we know that the closer the DW is to 2, the more it means that autocorrelation does not exist.

The fixed effect approach was used when regressing the panel data (results shown in previous chapter) because it decreases the problem of correlation between the individual effects of the explanatory variables in independents.

As was stated previously, these measurement tools (R&D expenditure, number of increasing qualifications passed, new products in production, growth of employment) are in fact used to measure Research and development, Intellectual knowledge, Product development and enterprise growth. Thus those particular factors are significant in the explanation of the dependant variable innovation. We can state that a 1unit increase in the log of Research and development activities, while other variables are held constant, will cause a 0.47unit increase in the logarithm of innovation activities undertaken at "Uzkimyosanoat". A unit increase in the logarithm of the intellectual knowledge will lead to a 0.44 unit increase in the logarithm of innovation. A 1 unit increase in the product development after holding other factors constant will cause a 0.3072 unit increase in the innovation levels.

The Adjusted R-squared of the model is equal to 0.564. R-squared shows the explanatory power that the independent variables have over the dependant variables. Adjusted R-squared is adjusted for the number of independent variables in the model. Thus in this equation, 56% of the change in Innovation is explained by the changes in the research and development activities, intellectual knowledge, product development and enterprise growth.

Total money spent on Research and Development is one of the biggest factors and it has the biggest influence on the innovation in any firm. This statement has been proven by all the equation where this variable was statistically significant everywhere. While it was concluded that factors such as demand for change, usage of ICT did not have a significant role in any of the models attempted. Level of satisfaction of workers and human abilities had their own effects but these effects were insignificant at the 5% level. The reason for this is that without worker satisfaction and human abilities, the companies would not be able to exist. As these factors are already playing a huge role in maintaining the companies' production and quality levels, they have a lower effect on the innovation activities that the SJC would like to increase.

REFERENCES

1. Akabirova, D. N., 2008. *Methods of developing the manufacturing industry in Uzbekistan*. Uzbekistan
2. Azamatov, Sh.. 2009. *The development of innovation in the republic of Uzbekistan and how to use it.* TDIU: Tashkent.
3. Baltagi, H., 2002. *Econometric Analysis of Panel Data,* ed.2. John Wesley & Sons Ltd.: New York
4. Barro, Robert and Lee, 1996. "International Measures of Schooling Years and Schooling Quality." *American Economic Review*, *Papers and Proceedings*, vol. 86, no. 2 p.218-23.
5. Becker, Gary. "Investment in Human Capital: A Theoretical Analysis." *Journal*
6. *of Political Economy*, 70, 5, Part 2 (October 1962):S9-49.
7. Buddelmeyer, H., Jensen, P. and Webster, E., 2006. Innovation and the determinants of firm survival. Retrived from ftp://repec.iza.org/RePEc/Discussionpaper/dp2386.pdf
8. Dougherty C., 2002. *Introduction to Econometrics*, 2nd Ed. Oxford
9. Duygulu, E., Kok, R. and Ozdemir, A. *Factors influencing innovation in SME's in Turkey: An interregional comparison*. Retrieved October 20, 2009 from
10. Eshimov B., 2009. *Choosing an innovation strategy and methods of implementing them.* Tashkent

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

11. Gozibekov, D., 2003. *Methods of turning investment into money*
12. Ishmuhamedov, A and Abdusattarova, H., 2007. *Innovation strategies.* TDIU: Tashkent
13. Gulomov, I., 2009. The innovation environment in SJC "Uzkimyosanoat" *Report of company director.* Tashkent
14. Hisamov, A., 2009. The innovation strategy of developing the energy sector in Uzbekistan in the financial crisis. TDIU: Tashkent
15. Humphreys, P., McAdam, R. and Leckey, J., 2005. "Longitudinal evaluation of innovation implementation in SMEs" *European Journal of Innovation Management*, vol. 8, no. 3 , p. 283 – 304. Retrieved October 20, 2009 from
16. http://www.emeraldinsight.com/Insight/viewPDF.jsp?contentType=Article&Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/2200080302.pdf
17. Igoshin, N., 2005. 2005. *Investment, organization, management, financing.* Yunity: Dana
18. International Finance Corporation, 2009. *Business environment in Uzbekistan as seen by Small and Medium Enterprises 2009.* Tashkent: Federal Department of Economic affairs.
19. Ishmuhamedov A., Abdusattarova H., Akabirovna D. and Rasulova I., 2007. Innovation Strategy. Tashkent
20. Jacobs, J., 1969. *The Economy of Cities*. New York: Random House.
21. Karimov, I., 2005. *Our main aim is to make our economy a democracy and innovate, to modernize and develop our country.* Uzbekistan
22. Karimov, I., 2010. *The effectiveness of Anti-crisis programs and priorities of post-crisis development (in the example of Uzbekistan).* Ministry of Finance, Tashkent
23. Kirzner, 1997. "Enterpreneurial Discovery and the Competitive Market Process: An Austrian Approach." *Journal of Economic Literature*, vol. 35, no. 1. p. 60-85.
24. Kuczmarski, T., 2003. "What is innovation? And why aren't companies doing more of it?" *Journal of Consumer Marketing*, vol. 20, no. 6, p. 536 – 541
25. Kuntz, R., 2009. *Econometric model for Panel Data.* Retrieved Mrch 2, 2010 http://homepage.univie.ac.at/robert.kunst/panels2e.pdf
26. Kuzik, B and Yakovets, Y., 2004. *Russia-2050 Innovation strategies.* Economics
27. Leger, A. and Swaminathan, S., 2007. Innovation theories: Relevance and implications for developing country innovation. Retrieved November 19, 2009 from
28. Matmurodov, F. and Gimush, R., 2008. Innovation management. Tashkent
29. Maxam-Chirchiq, 2009. *About the company.* Retrieved March 2, 2010 from http://www.uzehp.com/
30. Mel, S., McKenzie, D. and Woodruff, C., 2009. *Innovative Firms or Innovative Owners? Determinants of Innovation in Micro, Small, and Medium Enterprises.* Retrieved November 21, 2009 from http://ftp.iza.org/dp3962.pdf
31. Ministry of Economic Development, 2006. *What is knowledge economy*. Retrieved October 30, 2009 from http://www.med.govt.nz/templates/MultipageDocumentPage____17263.aspx
32. OECD, 2000. *Enhancing the competitiveness of SME's through innovation*. Retrieved October 23, 2009 from http://www.openinnovation.eu/download/De%20Jong%20Vanhaverbeke%20Van%20de%20Vrande%20De%20Rochemont%20-%20Open%20innovation%20in%20SMEs.pdf
33. Republic of Uzbekistan presidential decree, 2007. About *Modernization of the* production process, technical and technological development and competitiveness. Newspaper "People's Words" N52.

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020

Appendix

Table 1: Regression results for LOG_LOG model, only significant independent variable

Dependent Variable: LOG(NEWT)				
Method: Pooled Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(RD?)	0.470273	0.126771	3.709625	0.0011
LOG(INC_QUAL)	0.444175	0.140446	3.162599	0.0042
LOG(NEWP)	0.307230	0.157503	1.950629	0.0629
LOG(GROWTH_NO)	0.273577	0.121634	2.249188	0.0339
Fixed Effects				
_A_M01--C	10.33414			
_CPFC01--C	9.182201			
_ELEC01--C	10.37861			
_FERG01--C	11.49604			
_KUK_S01--C	8.327275			
_KUNG01--C	10.91167			
_M_K01--C	11.86154			
_NAV01--C	11.29322			
_SAMAR01--C	9.920328			
_UZLOY01--C	10.53537			
R-squared	0.710796	**Mean dependent var**		15.70295
Adjusted R-squared	0.564144	**S.D. dependent var**		0.761321
S.E. of regression	0.508353	**Sum squared resid**		6.202146
F-statistic	19.66214	**Durbin-Watson stat**		1.894001
Prob(F-statistic)	0.000001			

DOI: 10.37200/IJPR/V24I2/PR200343
Received: 16 Dec 2019 | Revised: 02 Jan 2020 | Accepted: 15 Jan 2020