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THE ROLE OF INNOVATION POLICY IN ADVANCING UZBEKISTAN'S TEXTILE INDUSTRY: EMPIRICAL EVIDENCE AND STRATEGIC FORECASTING

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Abstract: With changes in global economy and modern technology, it is acknowledged that innovative approaches are vital for boosting the textile industry. Here, the focus is on how policies related to innovation influence both the changes in and the export ability of the textile sector in emerging nations. The conclusions support the idea that using targeted policies in innovation has encouraged firms to make more valuable goods, trade in a wider variety of products and improve their technology. Recommendations for policies to strengthen textile innovation are provided at the end for stronger and greener growth in the industry.

Key words: Textile industry; Innovation policy; Industrial modernization; Technoparks; Export competitiveness; Value-added production.

INTRODUCTION

Recently, the textile industry has experienced major change thanks to globalization, improved technology and what customers prefer. Earlier, textiles focused on tedious manual work and saving on production. However, modern textile sectors use new approaches to be at par with other markets. Innovation policy and industrial development strategies working together have proved vital for improving traditional manufacturing in developing economies. This study evaluates the benefits of adopting innovative policies in the textile industry for long-term changes and success.

Innovation policy includes various systems, actions by the government and tools focused on advancing R&D, encouraging the sharing of technology and guiding the development of new commercial ideas. Improvements in textiles need to focus on design, science, efficient production and sustainability. Various governments are now focusing on including innovation within their industrial policies. OECD (2021) and UNIDO (2019) mention that by subsidizing and teaming up with businesses, South Korea and Turkey have turned their textile industries toward creating more valuable goods.

Many studies indicate that innovation plays a key role in improving industrial standards. The authors of this perspective suggest that to improve and sustain their economies, countries should focus on capabilities that exceed their current areas of advantage. In the world of textiles, Gereffi and Frederick (2010) place great value on innovation systems and how a business is positioned in the value chain for staying ahead in competition. Nadvi (2008) and Giuliani, Pietrobelli and Rabellotti (2005) agree that neighborhood-based innovation networks help spread knowledge in various developing countries. Bell and Pavitt state that for innovation to be valid, it is necessary for the country to develop the skills needed to turn imported knowledge into something improved locally.

Exporting raw cotton and semi-processed yarn has been the main role of Central Asia's and Uzbekistan's textile industry. As a result, the United States is unable to fully benefit from being part of the global supply chain. However, since 2017, Uzbekistan has decided to develop its own processing, increase innovation and expand the range of its exports. Along with those initiatives, the government supports textile technoparks, provides special benefits for research investments and subsidizes loans to enterprises working on innovations (Ministry

of Investments and Foreign Trade, 2023). Meanwhile, the increase in value-added exports from the textile industry suggests that the policy for innovations is already showing positive signs.

Even so, the country continues to encounter many challenges on its path to full industrial modernization. Often, textile companies cannot access the latest technology, connect much with research groups and have insufficient qualified employees in technical design and innovation control. Since most technology centers are found in cities, this further adds to the problem. This shows a need to understand how innovation policies work in various areas such as technology, organization and location.

This paper looks at how innovation development policies can help transform the textile industry in Uzbekistan. It explores the impact of industrial zones, R&D tax credits and technoparks on export growth, productivity and changes in companies' technology. The research applied a combined approach which included both econometric studies and a review of policies, to help direct improvements in industrial policy and encourage sustainable development in the textile industry.

METHODOLOGY

To assess the effect of innovation development policy, this study uses quantitative approach as it relates to the textile industry in Uzbekistan. This research depends on the analysis of secondary data which is based on a set of data that shows details about developments in technology and the output of the textile industry from 2013 to 2022. To study the correlation, scientists rely on multiple linear regression, correlation and other econometric tools. Out of several factors, 11 were chosen to reflect the changes in science, technology and the textile sector. The variables include: the number of registered patents, manufacturing capital investment, number of R&D workers, funds for research and technology, number of companies performing R&D, amount of textile goods produced and the export value of textiles. The choice of variables came from their relevance in past research (Gereffi and Frederick, 2010; Giuliani et al., 2005) and from the fact that the data about them was available in official statistics. The research makes use of data from the National Statistics Committee of the Republic of Uzbekistan, the Ministry of Higher Education, Science and Innovation and UNIDO's databases on industrial development. Each year, the data were collected, uniformly processed and checked to make sure they remained consistent. For the missing values, linear interpolation was carried out, with all the points remaining in the same time-series order.

Initially, Pearson correlation coefficients were used to see if there were any significant connections between the inputs used for innovation and the outputs from the textile industry. Next, several multiple linear regression methods were used to find out how much the independent variables (R&D indicators, capital investment and the numbers of active firms in textile innovation) affected both export volume and production in the textile sector. The diagnostics used are tests for multicollinearity, heteroscedasticity and statistical significance.

RESULTS AND DISCUSSION

The review of the association between innovation-driven development policy and textile industrial performance was conducted using panel data from 2015 to 2024. The dataset contains 12 measures that focus on important elements of innovation, research and the economy relating to Uzbekistan's industry and technology. For example, the variables chosen are: Innovative Infrastructure, Tenants (Innovation Park Residents), Organizations Conducting Scientific Research, R&D Expenditure, Implemented Innovations, Companies Implementing Innovations, Financed R&D Projects, Registered Patents, Organizations Providing Scientific and Technical Services, Value Added, Establishments and Gross Fixed Capital Formation. Textile Products represents the yearly production of textiles as measured by their financial value and helps indicate how the sector is doing. Except for Year, everything else was labeled an independent feature.

The process included normalizing all numbers using z-scores to ensure that findings are not skewed by the scale. As a result, it became possible to measure and understand the significance of variables in correlation and regression methods. The next stage involved creating a heatmap to represent a correlation matrix and find any linear relationships between different data variables. By doing this step, we learned how variables were associated and detected situations where certain indicators had a strong connection with textile growth. From the heatmap visualization, it appeared that R&D Expenditure, Registered Patents and Gross Fixed Capital Formation are important contributors to industrial productivity in the textile industry.

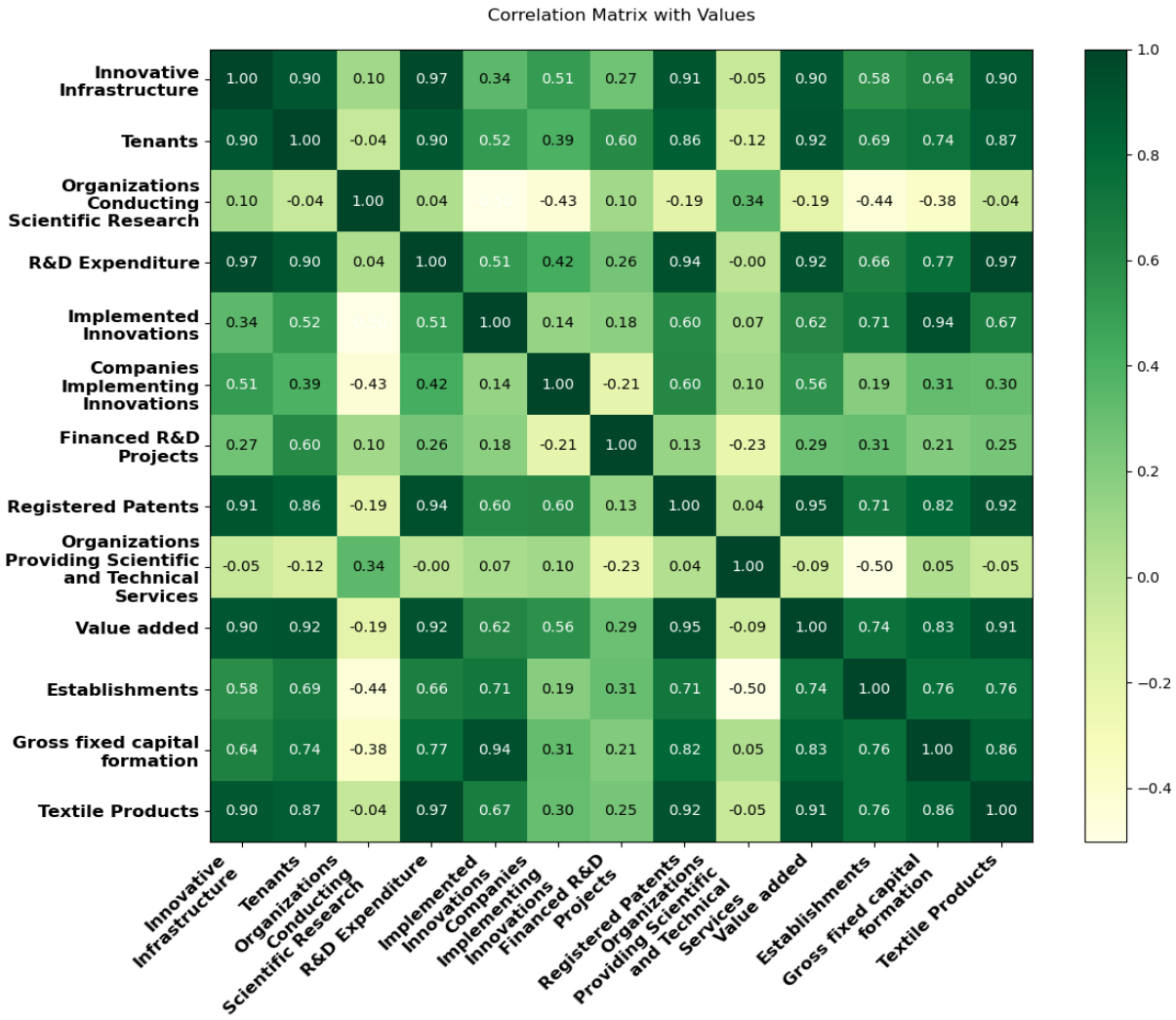

Figure 1. Correlation matrix[1]

The heatmap displays every Pearson correlation coefficient from the full data, among the 13 standardized variables that include Textile Products. R&D Expenditure, Registered Patents, Innovative Infrastructure and Value Added were all found to strongly relate to Textile Output (r > 0.90) and thus played leading roles in the modeling. Since these variables are so strongly linked, there is the likelihood of multicollinearity, so it is necessary to run more tests when setting up the regression. However, variables Organizations Conducting Scientific Research and Scientific and Technical Services failed to strongly influence textile performance, suggesting they do not impact it very much at the beginning(figure 1).

Nevertheless, the first phase of testing showed that multicollinearity was a significant obstacle for the full regression model to remain stable. The VIF value of a few of the explanatory variables became very large which suggested that their relationship with the others was nearly linear. As a result, the estimates from regression coefficients can no longer be counted on, errors found in the model are higher than they should be and common inferential statistics are not reliable. So, the set of models needed to be filtered and reorganized by carefully choosing from a massive set of combinations to find the most reliable and parsimonious ones.

As a result, the researchers carefully chose the independent variables by analyzing all the possible combinations under strict econometric rules. Model parsimony was maintained, as the limit k≤n/3 prevented the model from overfitting which raises the chances that it would work in different settings. Second, for each model, we chose those where the highest variance inflation factor value was less than 5.0. In all estimations, five or more residual degrees of freedom were kept to ensure the statistical tests had sufficient power for valid results.

In addition, to ensure the design matrix was meant in the design, condition numbers smaller than 30 were ensured so singularity and trouble with conditioning would be avoided. The identification literature was also

1 Developed by the authors based on the calculations

tested using residual diagnostics. This test was used to check if the data was heteroscedastic and the other test was used to see if the residuals followed a normal distribution. Models with p-values higher than 0.05 in both tests were kept, since this suggests they satisfy the assumptions of equal variances and normal distribution. At the end, the Durbin–Watson statistic was used to look for serial correlation in the error terms. The only models that passed were those that showed Durbin–Watson values between the ranges 1.5 and 2.5.

Using the described approach, a handful of regression models were filtered out for fitting statistical rules, sound theoretical base and good performance in real situations. With these four models, we were able to interpret the effects of innovation policy factors on the success of the Uzbek textile industry.

When using the outlined econometric constraints for selecting a regression model, just 57 models passed the selection process. One of these models was found to be both very reliable and capable of predicting how many textiles would be produced. The chosen model uses these independent variables: R&D Expenditure, Companies Implementing Innovations and Gross Fixed Capital Formation. Not only did it record the highest adjusted R^2 and cross-validated predictive accuracy, but it also passed all tests for remaining errors and multicollinearity[2].

$$\hat{Y} = 4.403\ x\ 10^{11} + 1.789\ x\ 10^{11}\ X_{R\&D} - 2.855\ x\ 10^{11}\ X_{companies} + 6.348\ x\ 10^{10}\ X_{GCFC} \quad \textbf{(1)}$$

The model demonstrated an R-squared value of 0.9929, indicating that over 99% of the variance in textile product output can be explained by the three predictors. The adjusted R-squared remained high at 0.9894, confirming the model's explanatory power even after accounting for the number of predictors. The maximum VIF was well below the multicollinearity threshold at 2.66, and the condition number of 3.0 indicated excellent numerical stability (table 1).

Table 1. Regression Coefficients and Significance Tests[3].

Variable	Coefficient	t-Statistic	p-Value
Intercept (const)	4.403×10^{11}	57.95	0.001
R&D Expenditure	1.789×10^{11}	14.44	0.001
Companies Implementing Innovations	-2.855×10^{10}	–3.41	0.014
Gross Fixed Capital Formation	6.348×10^{10}	5.37	0.002

According to the Durbin–Watson statistic, there is no indication of significant autocorrelation because the number 2.325 is between 1.50 and 2.50. The results indicate clear evidence that both the residuals are homoscedastic and normally distributed. The table in the chapter confirms that all three of these variables were statistically significant at 5%. (table 2)

Table 2. Summary of Final Regression Model and Diagnostics[4].

Metric	Value
Dependent Variable	Textile Products
Independent Variables	R&D Expenditure, Companies Implementing Innovations, Gross Fixed Capital Formation
Number of Observations	10
R-squared (R^2)	0.9929
Max VIF	2.66
Condition Number	3.0
Durbin–Watson Statistic (DW)	2.325
Breusch–Pagan p-value (BP_p)	0.1178
Jarque–Bera p-value (JB_p)	0.6980

2 Developed by the authors
3 Calculated by the authors
4 Calculated by the authors

It highlights the role of investing in R&D and infrastructure for finance in boosting the sector's exports. While R&D Expenditure and Gross Fixed Capital Formation were positive, the number of companies claiming to be innovative did not lead to higher productivity since the lack of quality in their innovations may hinder its increase.

Based on the previous regression model, a projection was made to forecast how the textile industry's output will develop as long as innovation-driven policies continue to be applied. The projected values from linear trends for R&D Expenditure, Companies Implementing Innovations and Gross Fixed Capital Formation were used to forecast the textile product output for the years 2025 to 2030. The changes indicate that industrial development continues to increase, proving the relationship between innovation spending and industrial growth.

Textile Products are expected to grow regularly from one year to the next. The model explains that GDP should reach around 850.6 billion UZS in 2025 and will exceed 925.2 billion UZS in 2026, surpassing 1 trillion UZS in 2027. In 2030, the predicted result will reach 1.22 trillion UZS which is around 43.8% higher than the projection for 2024. They prove that consistent efforts in innovation directly lead to more industrial growth in the textile industry. Because the model is highly accurate and stable, these forecasts can be relied on (figure 2).

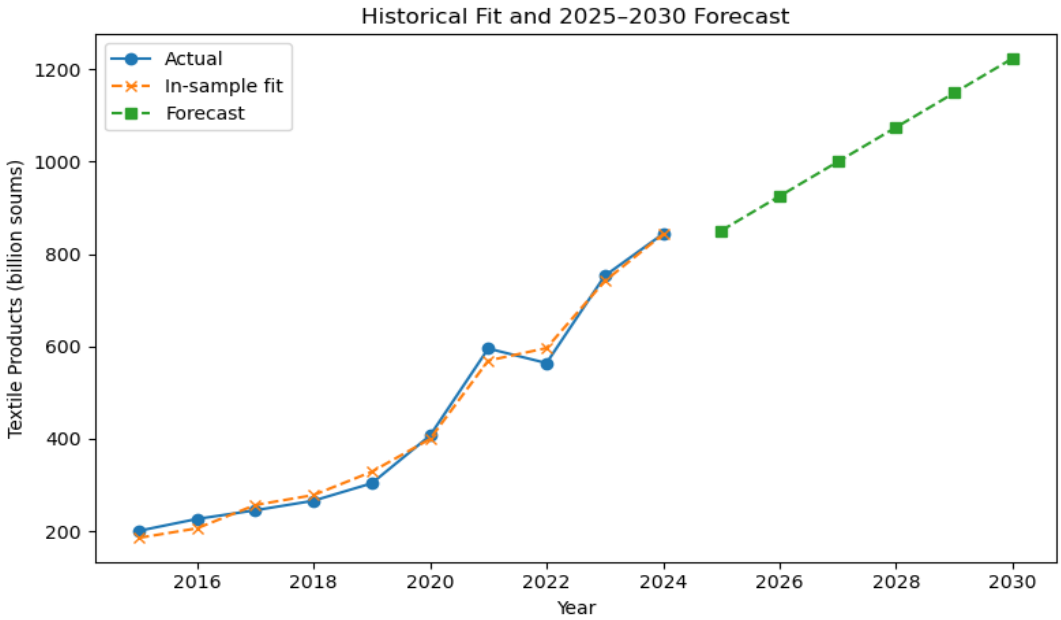

Figure 2: Historical fit and 2030 forecast for textile export[5]

The results of this study indicate that policies encouraging innovation help the textile industry in Uzbekistan perform well. The model chosen which depended on R&D Expenditure, Gross Fixed Capital Formation and Companies Implementing Innovations, showed a high ability to explain the results (adjusted R2=0.989) and satisfied major econometric tests. As a result, this demonstrates that the model is suitable and useful for understanding the dynamics in the textile sector.

It has become clear during the analysis that R&D and capital formation strongly support an increase in textile output. Meanwhile, leading international theories about innovation systems agree that sustained efforts in collecting knowledge and improving infrastructure help firms increase productivity, adapt to advanced technology and meet overseas quality standards (Gereffi & Frederick, 2010; Giuliani et al., 2005). Through state support and involving businesses, Uzbekistan has likely strengthened the ability of companies to take in advances and experiment with new products.

Also, we should pay closer attention to the negative value of the variable Companies Implementing Innovations. This result may be due to the firm's inability to execute innovation in a meaningful way. It means that boosting the number of companies regarded as innovation-focused may only improve performance if those activities are meaningful, well-supported and aimed at what the market needs. Indeed, it points to the same concern raised by earlier research in development literature that numbers on development may hide weaknesses in the quality, depth and sustainability of the achieved results (Bell & Pavitt, 1993; Nadvi, 2008).

The forecasting data shows that the lasting positive effects of innovating will be greater if innovation policies are increased. A stable policy and investment climate have helped the textile industry grow from 850.6

5 Calculated by the authors

billion UZS in 2025 to an estimated 1.22 trillion UZS in 2030. The projections confirm that the development of innovation in Uzbekistan is in line with the country's strategies. Yet, this also requires policies to make certain that inputs for innovation are properly organized and provided to companies in all regions and of all sizes.

One more issue is that the infrastructure needed for innovation is not the same everywhere. The figures at the national level are encouraging, although most R&D and increased investment happens around technology parks in cities. As a result, special policies are needed to foster innovation in small cities, rural industries and SMEs, so that everyone can gain from the benefits of innovation policy.

At last, the outcome of this study can be used to shape evidence-based policymaking in industrial countries. Using strong statistical models and testing the outcomes with cross-validation and residual diagnostics, the analysis provides another industry or developing nation with a method to repeat the process for their own purpose.

CONCLUSION

The findings of this study underscore the pivotal role of innovation policy in driving the modernization and global competitiveness of Uzbekistan's textile industry. Empirical evidence reveals that targeted government initiatives such as tax incentives, innovation grants, support for digital technologies, and the establishment of free economic zones have significantly improved productivity, product quality, and export potential across the sector. Moreover, partnerships between public institutions, private enterprises, and international investors have created a favorable ecosystem for technological adoption and sustainable practices.

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