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THE IMPACT OF SUBSIDIES AND INCENTIVES ON FIRMS' INNOVATION PERFORMANCE

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ABSTRACT

Purpose- The purpose of this study is to investigate the impact of government incentives on firm innovation performance in Turkiye, with the aim of providing an evidence-based framework for evaluating the effectiveness of these policies. By examining how various incentive mechanisms influence firms' research and development (R&D) investments, product innovations, and process improvements, the study seeks to identify the key factors that drive innovation performance across different sectors and firm sizes. This research will contribute to the academic literature by addressing the ongoing debate surrounding the efficiency and effectiveness of government incentives. It will also provide strategic insights for policymakers, enabling the design and implementation of more targeted and efficient support mechanisms. Ultimately, the findings aim to enhance the alignment of government policies with Turkiye's broader goals of fostering innovation, improving global competitiveness, and achieving sustainable economic growth.

Methodology- The methodology of this study is designed to analyze the impact of government incentives on firm innovation performance in Turkiye using a quantitative research approach. The primary dataset utilized is sourced from the World Bank's Enterprise Survey (WBES), which covers over 150 countries and provides comprehensive information on various aspects of the business environment, such as financial access, corruption, infrastructure, competition, and firm performance. For Turkiye, six separate surveys conducted between 2002 and 2019 were utilized. These surveys include data from firms of varying sizes, sectors, and regions, capturing both those that received government incentives and those that did not. Based on a thorough literature review, a model tailored to the dataset was developed. The dependent variable is the presence of innovation within firms, measured as a binary outcome, while government incentives serve as the primary independent variable. Firm-specific characteristics frequently highlighted in the literature, such as firm size, age, export intensity, and sectoral distribution, are included as control variables to ensure a comprehensive analysis. The statistical analysis was conducted using the Logit regression technique in Python, chosen for its suitability in estimating the probability of binary outcomes. Diagnostic criteria such as Pseudo R-squared, log-likelihood, LL-Null, and the likelihood ratio test (LLR p-value) were employed to evaluate model fit and statistical significance. The results reveal that government incentives have a statistically significant effect on the likelihood of firm innovation, alongside other firm-specific factors. This methodological framework provides a robust basis for understanding the relationship between government support and innovation performance, offering valuable insights for policymakers.

Findings- The study reveals that R&D expenditures have the most significant impact on innovation, while the effect of firm size is relatively smaller. Government incentives and export ratios positively influence innovation likelihood, consistent with literature. Over time, firm age has shown a growing positive effect on innovation. In Turkiye, the probability of innovation for incentivized firms reached 19% in 2019, compared to 6% for non-incentivized firms, though the overall impact of incentives remains limited. International comparisons highlight Turkiye as having the lowest innovation probability among non-incentivized firms, with incentives providing modest improvements compared to other countries.

Conclusion- The findings highlight the limited effectiveness of government incentives in Turkiye compared to other countries with stronger incentive mechanisms, such as Slovenia and the Czech Republic. To address this, more strategic and targeted policies are needed to enhance the impact of incentives, reverse the declining innovation trends, and align incentive mechanisms with broader innovation strategies. These steps are critical for improving Turkiye's innovation performance, fostering competitiveness, and driving sustainable economic growth.

Keywords: Innovation performance, incentive, subsidies, logit regression, enterprise surveys, R&D expenditure.
JEL Codes: O31, O32, O38

1. INTRODUCTION

The economic growth and global competitiveness of countries largely depend on their ability to innovate. Innovation adds dynamism to economic structures by developing new and improved products, processes, and services, playing a critical role in achieving sustainable

development goals. Moreover, innovation enables companies to adapt quickly to changing market conditions, enhancing their competitiveness in international markets. In this process, government incentives accelerate technological progress and increase economic growth potential by encouraging firms to invest in R&D and innovation activities (Romer, 1990). Examining the impact of government support on firm innovation performance is of strategic importance for designing more effective support mechanisms. Governments employ various policy tools to promote innovation, including direct financial support, tax incentives, grants, and subsidies. However, there is ongoing debate in academic and policy circles regarding the effectiveness of these incentives. While some studies indicate that government support strengthens firms' R&D activities, others argue that these incentives fail to deliver the expected outcomes or lead to misallocation of resources (Jones & Williams, 1998). These conflicting findings suggest that the effectiveness of incentives may vary depending on factors such as industry, firm size, and technological intensity (Guellec, 2003). The primary objective of this study is to analyze the effects of government incentives on firm innovation performance in depth. The research aims to evaluate the impact of incentives on firms' R&D investments, product innovations, and process improvements through analyses conducted on firms across different industries and scales. Analyzing other variables influencing firm innovation performance and comparing all results with selected international countries constitute the secondary objectives of this study. This study aims to provide a framework for understanding and evaluating the effects of government incentives on firm innovation performance in Turkiye. By offering an analytical basis for assessing the effectiveness of incentive programs at the firm level, this framework seeks to contribute to both academic discourse and policy-making.

2. LITERATURE REVIEW

Government support programs play a crucial role in fostering innovation and economic growth. Assessing the performance of these programs requires the use of various metrics, which can be broadly categorized into input, output, and outcome indicators. Input metrics focus on the resources allocated to R&D activities, such as funding, personnel, and infrastructure. These metrics provide insights into the scale and intensity of innovation efforts. However, some scholars argue that input metrics alone may not accurately capture the effectiveness of R&D support programs, as they do not measure the actual outcomes and impacts of innovation activities (Cohen & Levinthal, 1990).

Output metrics, on the other hand, measure the tangible outputs generated from R&D investments, such as the number of patents, publications, and prototypes developed. While output metrics provide valuable information about the immediate results of R&D efforts, they may not fully capture the long-term impacts and benefits of innovation (Mansfield, 1991). Outcome metrics assess the broader socio-economic impacts of innovation activities, including job creation, economic growth, and societal welfare. These metrics aim to evaluate the ultimate effectiveness and value of government support programs in achieving their intended objectives. However, measuring outcomes can be challenging due to the complex and long-term nature of innovation processes (Hall et al., 2010). Despite the importance of outcome metrics, some scholars argue that attributing socio-economic impacts solely to R&D support programs can be problematic, as other factors, such as market conditions and policy environment, also influence innovation outcomes (Mowery & Rosenberg, 1998).

Historically, the origins of R&D incentives date back to the late 19th and early 20th centuries. Particularly, in countries like the United Kingdom and Germany, the first R&D incentives were provided to promote industrial and military innovations (Smith & Johnson, 2010). Numerous studies indicate that technological progress and R&D activities enhance a country's competitiveness (Keller, 1997). Research demonstrates that as R&D expenditures increase, countries become more innovative and efficient, consequently enhancing their competitiveness (Branstetter, 2001). Research findings on the nature of the relationship between R&D expenditures and economic growth and country development vary. Some studies argue that R&D expenditures positively influence economic growth and country development (Eid, 2012).

There is a wide range of academic research on factors affecting innovation performance. Some scholars, such as Hottenrott and Lobes-Bendo (2016), highlight the critical role of financial resources in innovation. Others argue that the relationship between resources and innovation is complex (Çolpan et al., 2017). Human resource competency plays a critical role in the execution of innovative projects (Damanpour & Schneider, 2006). Among the factors influencing innovation performance, the importance of technological infrastructure is increasingly recognized (Wu & Wang, 2019). However, some studies suggest that its role in influencing innovative activities may be limited (Gölgeci & Kuşakçı, 2016). Carayannis and Campbell (2012), as well as Etzkowitz (2003), emphasized that university-industry collaboration in the United States enhances innovation and R&D performance and contributes to economic growth. Export activity has long been recognized as a factor influencing innovation and R&D performance for firms in Turkiye and worldwide (Wagner, 2008). In the literature, there are studies that favor small firms, those that favor large firms, and those indicating that innovation outputs are independent of firm size (Yılmaz & Ekinci, 2018). Aerts and Czarnitzki (2016) conducted research showing that firm size does not determine R&D outputs. Similarly, another study from Turkiye by Demir and Ustun (2018) found no significant difference in innovative outputs among firms of different sizes.

Academic research examining the impact of firm age on innovation performance constitutes an important area of study both in Turkiye and globally (Özdemir & Ekinci, 2018). Innovation culture, management practices, market conditions, and competitive factors are also key elements influencing innovation performance (Kim & Park, 2018). The literature suggests that the response of industrial sectors to incentive performance on innovation varies widely and is influenced by factors such as industry structure, technological complexity, and market conditions (Dechezleprêtre et al., 2017). Academic studies in Turkiye on government incentives and subsidies focus on various areas such as economic growth, export performance, and technological advancements. These studies emphasize the importance of promoting R&D activities while analyzing the impacts of government policies on the economy. Kalay and Kızıldere (2015), who conducted research with TUIK data, found that innovation performance is dependent on various factors. Studies such as Çetin and Gedik (2017), who found a strong relationship between firm age, number of employees, and innovation, as well as Ela (2019), who identified a correlation between tax incentives and innovation, also support this view. Furthermore, Canbay (2020a) concluded that there is a positive relationship between R&D expenditures and export performance. Mercan and Çetin (2019) highlighted that different institutions' incentives have varying effects on innovation.

3. DATA AND METHODOLOGY

In this study the data form the World Bank's Enterprise Survey conducted at the firm level across 150 countries worldwide were used. The World Bank conducted this survey for Turkiye in the years 2002, 2005, 2008, 2013, 2015, and 2019. Since the effect of incentives on innovation was intended to be examined in the econometric model; innovation (binary) was used as the dependent variable, incentives (binary) were used as the main independent variable and variables mentioned in the literature were used as control variables (Table 1). Model:

$$Inovation\_statusit = \beta 0 + \beta 1.Firm\_sizeit + \beta 2.Firm\_ageit + \beta 3.Export\_ratioit + \beta 4.R\&D\_expenditure\_ratioit + \beta 5.Incentive\_ratioit + \beta 6.Number\_of\_emp + \beta 7.Incentive\_statusit + \varepsilon it$$

β0 is the intercept. β1, β2, β3, β4, β5, β6, β7 is the slope coefficient. ε is the error term. i and t represent firm (i) data at the end of year t. While comparing the innovation performance of treated and untreated firms, the performance of firms treated and untreated in the same year has been compared due to changing economic conditions over the years (Hud and Hussinger, 2015, p. 1847). Logistic regression (Logit) is used to estimate the probability of an event occurring, such as the likelihood of innovation. It is used when the dependent variable is binary (0 or 1).

Calcutating Log-odds (Logit):

$$Log - odds = \beta 0 + \beta 1\, x\, X1 + \beta 2\, x\, X2 + \ldots + \beta n\, x\, Xn$$

Calculating Probability (p):

$$p = \frac{e^{log-odds}}{1 + e^{log-odds}}$$

Actual Probability in Logit Technique; The above probability calculations were made to show the effect of variables individually. To calculate the actual probabilities, it is necessary to combine the effects of all variables.

Table 1: Variables and Descriptions

Variables	Descriptions	Survey Question Number by Year					
		2002	2005	2008	2015	2013	2019
INOV	If innovation = 0; 0, else; 1	Q60a1	Q60a	Q1	H1-5	H1-5	H1-5
CSIZE	Size by number of employees	S4a2	S4b	A6b	A6b	A6b	A6b
AGE	Age of the company at the time of the survey	S1a	S1a	B5	B5	B5	B5
TSALE	Firm's annual total sales	Q82a	Q57a	D2	D2	D2	D2
EXPO	Percentage of Firm's annual direct and indirect export	Q14	Q7	D3	D3	D3	D3
RD	Total annual R&D expenses of the company	Q83b	Q58b	ECAo4	ECAo17 ECAo19	H8	H9
EMPX	Number of permanent full-time workers	Q91a1	Q66a	L1	L1	L1	L1
SUBS	During the last two years, did this establishment receive any direct or indirect government grant? (binary)	Q79a1 Q79a2 Q79a3	Q53a1 Q53a2 Q53a3	Q53	ECAq53	TU_h.4	BMk5a

5. FINDINGS AND CONCLUSION

In this study, seemingly unrelated regression (SUR) is used to define the relationship between social media sentiment and cryptocurrency volatility. Below the tables, we explained the relationship among variables. Logit refression results of Turkiye are shown in Table 2.

Table 2: Logit Regression Results of Turkiye

Variables	2002	2005	2008	2013	2015	2019
	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)
Const.	-1,4533	-0,6874	-0,8163	-1,5558	-2,7788	-3,1727
	(0,000)	(0,004)	(0,000)	(0,000)	(0,000)	(0,000)
RD/TSALE	15,5922	35,3256	21,6824	30,072	19,4432	46,3369
	(0,184)	(0,029)	(0,000)	(0,011)	(0,000)	(0,000)
EXPO	1,4557	2,017	-0,2943	0,2478	0,9082	1,2231
	(0,000)	(0,000)	(0,176)	(0,309)	(0,000)	(0,000)
CSIZE	0,4354	0,2948	0,1597	0,0780	0,4228	0,0101
	(0,004)	(0,059)	(0,114)	(0,533)	(0,000)	(0,942)

SUBS	0,5469	0,5827	0,8266	1,0273	1,1758	1,2970
	(0,232)	(0,357)	(0,001)	(0,000)	(0,000)	(0,000)
AGE	-0,0038	-0,0029	0,0096	-0,0021	0,0034	0,0163
	(0,644)	(0,591)	(0,116)	(0,769)	(0,304)	(0,007)
EMPX	-0,0002	-9,15E-02	2,44E-03	0,0006	0,0001	5,83E-02
	(0,270)	(0,618)	(0,987)	(0,030)	(0,468)	(0,880)

The analysis reveals that the intercept terms are statistically significant (p-value < 0.05) and consistently negative across all years, indicating a low baseline probability of innovation (<50%) when all independent variables are zero.

Among the independent variables, RD/TSALE stands out as the most influential factor, with a high coefficient (>15) and near-zero p-values, suggesting a nearly guaranteed likelihood of innovation with increased R&D investments. Additionally, the Export Ratio (EXPO) significantly and positively impacts innovation (p-value < 0.05), except in 2008 and 2013. Its effect has grown over time, increasing innovation probability by 77.26% in 2019. Government incentives (SUBS) also demonstrate a strong positive relationship with innovation, with p-values close to zero in most years. By 2019, these incentives boosted innovation probability to 78.53%. Conversely, firm size (CSIZE) and number of employees (EMPX) show large coefficients but remain statistically insignificant (p-value > 0.05). Firm age (AGE), previously insignificant, became statistically significant in 2015 and 2019, indicating a growing positive influence on innovation in recent years.

These findings emphasize the dominant role of R&D and government support in driving innovation while highlighting the evolving significance of firm age and the limited impact of size and employee numbers.

Figure 1: Probability Graph based on Median and Mean Values of Firm Variables in Turkiye

To calculate the country average; the probabilities of firms in Turkiye innovating before and after treatment have been evaluated based on the mean and median values of the data for the relevant years (Figure 1). The analysis highlights that firms receiving government incentives exhibit higher innovation probabilities than non-incentivized firms in both median and mean calculations. Based on median data, incentivized firms in 2019 had an innovation probability of 19.16%, compared to 6.08% for non-incentivized firms, with a steady decline in probabilities for non-incentivized firms over time. The mean data further supports this trend, showing that treated firms consistently outperform untreated firms, though the innovation probability gap of 7-16% narrows over time. While government incentives significantly enhance innovation performance, the effect weakens as years progress. Notably, the elevated probabilities in 2002, particularly in the mean data, suggest potential data irregularities that require further investigation.

Same calculations repeated for selected international countries and the results is shown in Table 3.

Table 3: Rogit Regression Results for Selected International Countries

Variables	Turkiye	Azerbaijan	Georgia	Slovenia	Lithuania	Portugal	Italy	Russia	Malaysia	Poland	Czech Rep.	Romania	Hungary
	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)
Const.	-3,1727 (0,000)	-2,6988 (0,000)	-0,8622 (0,035)	0,3054 (0,457)	-1,4569 (0,003)	-1,6594 (0,000)	-1,8105 (0,000)	-2,3909 (0,000)	-1,5290 (0,000)	-0,9294 (0,012)	-2,489 (0,000)	-0,9298 (0,001)	-1,5042 (0,000)
RD/TSALE	46,3369 (0,000)	14,1306 (0,333)	-0,6407 (0,741)	-1,3218 (0,492)	402,3668 (0,159)	9,0296 (0,099)	-7,2907 (0,472)	29,0114 (0,000)	77,8864 (0,000)	70,1906 (0,015)	3,2145 (0,422)	23,0054 (0,002)	23,2172 (0,000)
EXPO	1,2231 (0,000)	0,1718 (0,855)	-0,0624 (0,821)	0,0411 (0,915)	-0,5885 (0,108)	-0,1601 (0,488)	2,5601 (0,000)	0,7721 (0,133)	0,1566 (0,489)	0,1633 (0,000)	-0,324 (0,332)	1,6741 (0,000)	0,2085 (0,447)
CSIZE	0,0101 (0,942)	0,7851 (0,039)	0,1912 (0,242)	0,3792 (0,160)	0,5579 (0,005)	0,3090 (0,010)	-0,3985 (0,026)	0,0802 (0,453)	0,3140 (0,003)	-0.1957 (0,165)	1,0217 (0,000)	-0,0270 (0,807)	0,1901 (0,160)
SUBS	1,2970 (0,000)	0,3099 (0,512)	0,3602 (0,323)	20,0331 (0,999)	-0,9406 (0,319)	-0,2162 (0,649)	2,0860 (0,063)	1,3370 (0,003)	0,7132 (0,069)	1,4163 (0,001)	1,5008 (0,052)	0,9418 (0,048)	0,3322 (0,260)

AGE	0,0163 (0,007)	0,0225 (0,184)	0,0035 (0,740)	0,0039 (0,651)	-0,0106 (0,258)	0,0052 (0,145)	0,0081 (0,069)	0,0347 (0,000)	-0,0031 (0,590)	0,0066 (0,303)	-0,003 (0,578)	0,0056 (0,555)	-0,0089 (0,362)
EMPX	-5,83E-02 (0,000)	0,0018 (0,575)	0,0033 (0,039)	0,0029 (0,364)	-0,0003 (0,857)	0,0003 (0,598)	0,0009 (0,197)	4,60E-03 (0,966)	1,38E-02 (0,937)	-0,0003 (0,630)	-0,001 (0,094)	-2,73E-02 (0,940)	-0,0002 (0,758)

According to the analysis results, among the variables, the highest impact on innovation performance is the ratio of R&D expenditures to total revenue, except for Georgia, Slovenia, and Italy. The second highest impact is from incentives and subsidies. Although the export impact varies across countries, there is a significant positive relationship with innovation. No significant relationship was found between firm age and size with innovation performance.

Table 4: **Probability Results based on Mean and Median Values of Selected International Countries**

Countries	**Mean**		**Median**	
	SUBS=0	SUBS=1	SUBS=0	SUBS=1
Turkiye	11,46%	32,13%	6,09%	19,17%
Malaysia	43,51%	61,12%	34,71%	52,03%
Poland	24,61%	63,64%	22,36%	54,28%
Czech Rep.	62,73%	88,30%	59,09%	86,63%
Romania	36,67%	65,97%	24,92%	51,86%
Hungary	29,67%	37,03%	24,93%	31,65%
Azerbaijan	32,25%	39,35%	32,17%	39,26%
Georgia	48,70%	57,64%	46,22%	55,20%
Slovenia	81,34%	100,00%	78,00%	100,00%
Lithuania	93,26%	84,38%	44,57%	23,89%
Portugal	33,19%	28,58%	30,89%	26,48%
Italy	10,98%	49,83%	11,95%	52,23%
Russia	16,41%	42,77%	16,39%	42,74%

According to the results of the study, Turkiye ranks among the lowest in performance compared to the countries being analyzed. While outliers boost the success of incentives, the impact of incentives remains limited compared to other countries. In countries that show 50% performance even without incentives, Turkiye stands at around 10%. In the Czech Republic, Azerbaijan, Portugal, Slovenia, and Russia, the impact of outliers on performance was negligible.

The results of this study indicate that government incentives and subsidies have a positive effect on firm innovation performance. Additionally, the impact of firm R&D expenditures and export ratios is also positive. However, no significant effect was found for firm age and size. The results are consistent with the literature review. If the study is further enriched with different variables from the literature and updated, and if in-depth case studies and concrete firm data are tested, it is believed that the likelihood of success for firms applying for incentives could be predicted by the incentive provider.

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