



CHANGE OF RESEARCH AND DEVELOPMENT (R&D) EXPENDITURES ACCORDING TO R&D EMPLOYEES AND ITS EFFECT ON MANUFACTURING VALUE ADDED IN TURKEY

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Abstract

Aim: In this research, it was aimed to evaluate change of Research and Development (R&D) expenditures according to R&D employees and its effect on manufacturing value added in turkey.

Methods: R&D expenditures (RDEX) R&D employee (RDEMP) and manufacturing value added (MVA) series were used from the World Bank Country Report from 1996 to 2022 in the research. Spearman's rho correlations were performed for relationship analysis between research parameters.

Results: R&D expenditure range was 0.36% to 0.96% of GDP for research time interval with 0.66 ± 0.19 mean value. R&D employee value per million people range was 304.34 to 1379.41 for research time interval with 725.31 ± 364.48 mean value. MVA value mean was 17.69 ± 1.91 with 15.05-22.27 range. Spearman's rho correlation analysis results showed that MVA was negatively correlated with RDEX ($r = -0.722$; $p < 0.01$) and RDEMP ($r = -0.735$; $p < 0.01$). According to correlation coefficients, relationship between MVA and ARGEEMP was higher. This result suggests that there have been a renovation process for the country. GLM results showed that effect of RDEMP ($B = -0.966$; $p < 0.01$) was significant with the effect of year ($B = -0.966$; $p < 0.01$).

Originality: Although researches express the importance of R&D process on production, this article argues that the transformational process changes may reduce conventional production. For this reason, this research underlines the importance and control of R&D expenditures and employee in order to prevent reduces in production. The negative impact of R&D expenditures on production may be due not only to the nature of R&D expenditures, but also to production variation. Therefore, the research is important in terms of demonstrating the need to re-evaluate the effectiveness of R&D expenditures. In addition, further macroeconomic researches are needed.

Keywords: R&D Employee, R&D Expenditures, Manufacturing Value Added, Innovation, Production.

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INTRODUCTION

Technology has played an important role in all human life, technology changes the human lifestyle (Ghana & Dr M., 2021). In the past era first, we can use the barter payment systems(the exchange of goods and services between two or more parties without the use of money) (Investopedia, n.d.) after the cash method was introduced and after cheques, credit cards and debit cards was introduced and now in the recent era, electronic payment is famous in India (Ghana & Dr M., 2021). In India after the COVID 19 virus pandemic, there have been a lot of Indian people use an E-Payment, and also increase the online activities in India (Bukvic, 2021). In India's recent times the number of internet users is increasing, (Agrawal & Bansal, 2018) and e-payment systems it's only based on online systems and e-payment is one of the systems that the provides payment tools for services or goods via the Internet, so Internet users it's the most important part of the adoption of e-payment systems (Yanuar, Imam, Agus, & Indira, 2018).

In today's competitive environment, new products and services are introduced to the markets every day, and as a result, the parties that exist in the market with traditional production and marketing methods are becoming weaker in competition (Sharon and Thieerry, 2020; Anselmsson, and Johansson, 2009). In this respect, making innovations is important for increasing competitiveness and standing in the markets. In addition, innovation is also mainly related with future. Innovation is one of the most important tools in managing the future, being superior in competition on a business and country basis. Innovation makes it is possible to stand and stand out in today's competitive conditions (Leiponen and Helfat, 2010; Hinterhuber and Liozu, 2014). For this, research and development (R&D) studies need to be done continuously.

While R&D studies suggest innovations to companies or organizations, they also bring about change. Therefore, while evaluating and applying R&D and innovation studies, the positive and negative aspects of the incoming innovation should be analyzed well. Because every innovation may not bring added value, on the contrary, it may reduce the values. In this process, R&D studies are of vital importance both in order to preserve past experiences and to make innovations more effective and applicable (Bortoluzzi et al, 2018; Bartoloni and Baussola, 2016). This requires a good follow-up of R&D expenditures and employment data.

Although the main result expected in R&D studies may differ according to the product or service and the sector, it is basically related with added value. While this added value is ergonomics and consumer user friendliness on the basis of the product, it can mean an increase in production or a decrease in cost in the field of production (Farida, 2016; Moreira et al, 2012). Therefore, it is necessary to provide significant returns in production value added in R&D studies. In literature, studies on R&D suggest that R&D positively impacts production in long time. However, it may causes delays at the beginning or implementation stages (Zhang et al, 2021; Warrol et al, 2018; Ndemezo and Kayitana, 2017; Kourtit, and Nijkamp, 2012).

In this research, it was aimed to evaluate change of Research and Development (R&D) expenditures according to R&D employees and its effect on manufacturing value added in turkey.

1. Methods

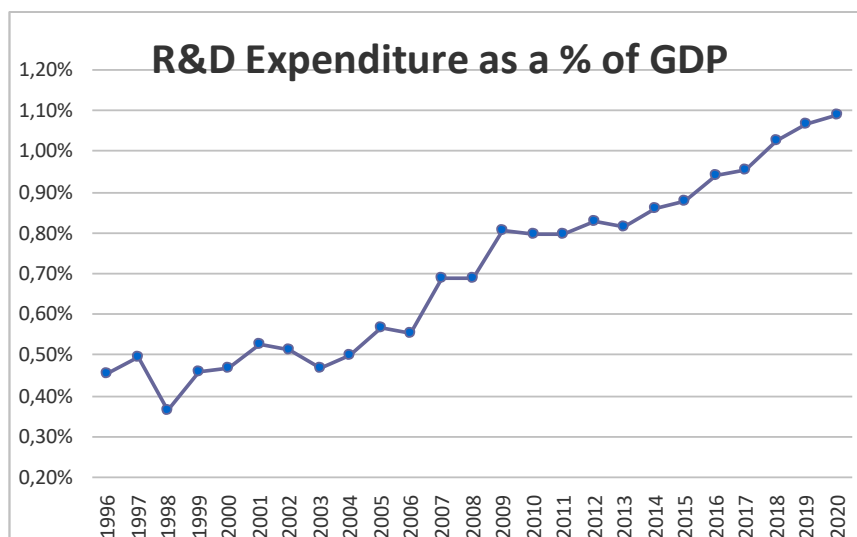
R&D expenditures (RDEX-Research and development expenditure (% of GDP)) R&D employee (RDEMP-Researchers in R&D (per million people)) and manufacturing value added (MVA-Manufacturing, value added (% of GDP)) series were used from the World Bank Country Report from 1996 to 2022 in the research. Spearman's rho correlations were performed for relationship analysis between research parameters. Since time series assumptions were not met, further effect analysis was not performed, and the research was concluded with correlational structure.

MVA, marketing value added, an indicator used by the World Bank Country Report. It describes the marketing value of the country with NV. IND. MANF. KD code. Manufacturing refers to the ISIC divisions 10-33 of industries. After summing all all outputs and deducting any intermediary inputs, value added is a sector's net output. It is estimated without taking into account the deterioration and depletion of natural resources or the wear and tear on manufactured assets. The International Standard Industrial Classification (ISIC), edition 4, identifies the source of value added. Data are presented in constant 2015 prices and are stated in USD (The World Bank, 2021). R&D expenditures and R&D employee are also indicators of the World Bank, which are given in percentage of GDP.

Mean and standard deviation values and ranges of variation were used to define the World Bank data sets used in the study. Parity analysis was used to analyze the changes of the series. Spearman's rho correlation analysis was performed for the relationship between the variables. All analyzes were performed with 95% confidence interval, 0.05 significance level and SPSS 25.0 for windows program.

2. Results

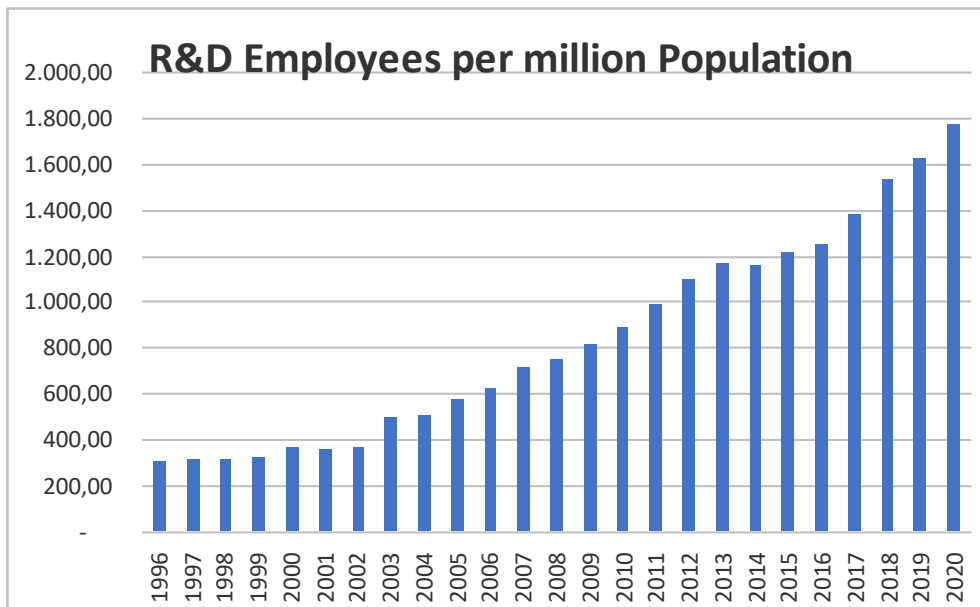
R&D expenditure changes according to years were given in the Scheme 1.



Scheme 1: R&D expenditure changes according to years (1996-2020).

R&D expenditure range was 0.36% to 0.96% of GDP for research time interval with 0.66 ± 0.19 mean value. Small decreases in 1998, 2003, 2006, 2009 and 2013 were recorded. However, parameter distribution was in increasing trend.

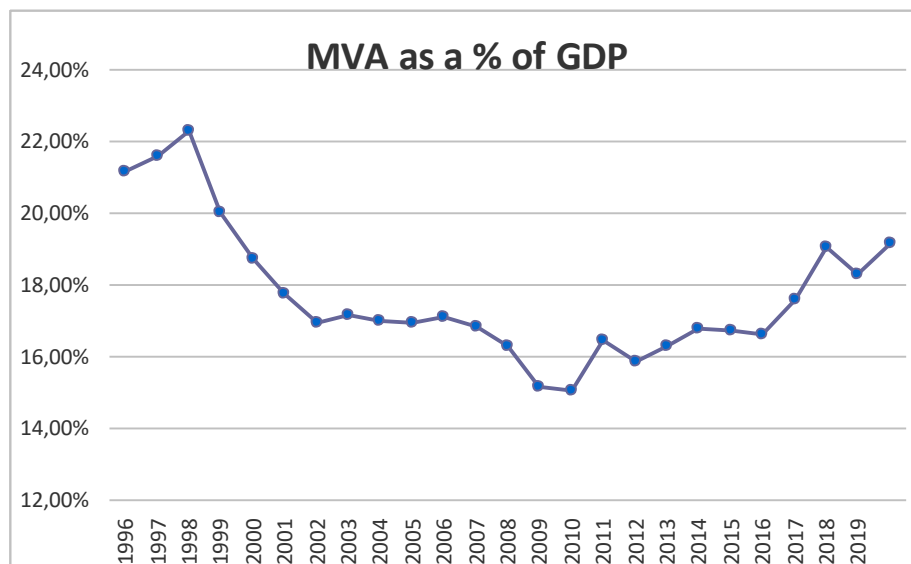
R&D employee changes according to years were given in the Scheme 2.



Scheme 2: R&D employee changes according to years.

R&D employee value per million people range was 304.34 to 1379.41 for research time interval with 725.31 ± 364.48 mean value. By the end of 2020, which is published by the World Bank after presentation, it has reached over 1.600 per million people with continuously increasing trend.

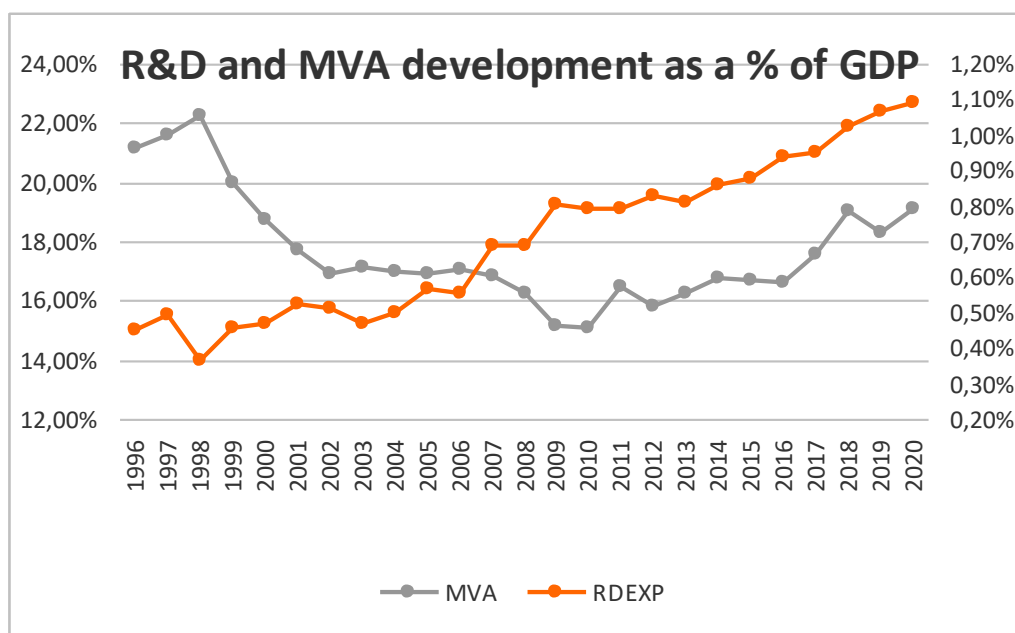
MVA changes according to years were given in the Scheme 3.



Scheme 3: MVA changes according to years.

MVA value mean was 17.69 ± 1.91 with 15.05-22.27 range. From 1998 to 2010, there was a decreasing trend with small changes. However, the trend has changed its direction to increasing except 2012 and 2019 decreases.

R&D and MVA changes according to years were given in the Scheme 4.



Scheme 4: R&D and MVA changes according to years.

Spearman's rho correlation analysis results showed that MVA was negatively correlated with RDEX ($r=-0.722$; $p<0.01$) and RDEMP ($r=-0.735$; $p<0.01$). According to correlation coefficients, relationship between MVA and ARGEEMP was higher. This result suggests that there have been a renovation process for the country. However, results of the analysis were also showed that there was a breaking point at 2007. Before 2007, the correlation was in negative direction, and it was turned to positive direction after 2007.

In addition, Spearman's rho correlation analysis was performed for the relationship between R&D and MVA for the whole world and it was seen that the relationship was not statistically significant ($r=-0.018$; $p>0.05$).

Unit root test results for research parameters were given in the Table 1.

Table 1: Unit Root Test Results for Research Parameters

	1% CV	5% CV	10% CV	t	p value
Augmented Dickey Fuller-ADF					
MVA	-3.7378	-2.9919	-2.6355	-1.8125	0.3657
RDEMP	-3.7880	-3.0124	-2.6461	1.7604	0.9993
RDEX	-3.7880	-3.0124	-2.6461	-0.1493	0.9312
Phillip Perron-PP					
MVA	-3.7378	-2.9919	-2.6355	-1.8125	0.3657
RDEMP	-3.7880	-3.0124	-2.6461	1.7604	0.9993
RDEX	-3.7880	-3.0124	-2.6461	0.1957	0.9655

Since all parameters had unit root according to both ADF and PP tests, logistic model was used for the model. In order to evaluate time series effect on research parameters and model, logarithmic transformation of all parameters were performed by using Generalized Linear Model (GLM-logit model) with year kovariance. The model was given as below:

$$\text{LnMVA} = B_0 + B_1 (\text{LnRDEMP})_t + B_2 (\text{LnRDEX})_t$$

Generalized Linear Model results for the research model were given in the Table 2.

Table 2: Generalized Linear Model Results for the Research Model

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Square	Chi-df	p
(Intercept)	1947,762	292,9158	1373,658	2521,867	44,217	1	,000
LnRDEX	-6,635	3,8916	-14,262	,992	2,907	1	,088
LnRDEMP	-,017	,0029	,011	,023	33,457	1	,000
Year	-,966	,1470	-1,254	-,678	43,154	1	,000
(Scale)	,678 ^a	,2044	,375	1,224			

Dependent Variable: MVA
 Model: (Intercept), LnRDEX, LnRDEMP, Year
 a. Maximum likelihood estimate.

GLM results showed that effect of RDEMP (B=-0.966; p<0.01) was significant with the effect of year (B=-0.966; p<0.01).

DISCUSSION and CONCLUSION

Innovation requires the introduction of a new idea or method. In the classical definition of innovation, innovation refers to the introduction of another process or operation instead of any process. In this respect, innovation is expressed as the replacement of the old processes or equipment with new ones, wholly or partially. However, this definition also means abandoning some or all of the gains from traditional production and marketing methods and processes (Sharon and Thieerry, 2020; Anselmsson, and Johansson, 2009; Jalilvand, 2017; Salojarvi et al, 2015). While innovation was a source of competitive advantage for companies and countries in the past, it has become a necessity today. Therefore, innovation has become an ongoing dynamic process. Continuous research and development activities are needed for innovation.

In the studies on R&D in the literature, it has been stated that innovation is a concept that requires a process and a cost. According to the definition, when the innovation is made in the production area or in a part of the production, the production in that part is either temporarily stopped or interrupted. Even if the innovation process is partially completed externally and then integrated, there may be a serious pause in the integration process (Akgun et al, 2017; Meroño-Cerdán and López-Nicolás, 2017; Kim et al, 2013; Simmons et al, 2013).

The findings obtained in the study revealed that both R&D expenditures and R&D employment have a serious reducing effect on production in Turkey. This shows that either there is a large-scale innovation in the areas where production is made, or there is a new understanding of production by changing the production systems altogether. Finally, it may also be an indication that the innovation processes in the production areas are carried out incorrectly or insufficiently, or that the innovations made in production are worthless. It is of great importance that all these justifications be well researched and put forward for further research.

As a result, the findings obtained in the research reveal that the relationship between production and R&D expenditure and R&D employment, which is an indicator of innovation, is negative. This may be due to a necessary total change, or it may be a waste of resources. It would be beneficial to investigate and reveal each possibility with both academic studies and field applications.

During the research analysis and presentation to the congress, the World Bank presented the data up to 2017 as the most up-to-date data. However, data for 2018, 2019 and 2020 were also published immediately after the congress date. In fact, these data are still very new and should be examined in further studies for evaluation and validation. The importance of the findings obtained in this study is that they point to the change in the relationship between R&D and MVA before and after 2007. While R&D production before 2007 is decreasing, R&D production after 2007 is increasing. For this reason, further studies are needed to include both the latest data published by the World Bank and to examine the causes of the 2007 break point.

Although both RDEMP and RDEX variables were significantly associated with MVA in univariate analysis, only the relationship between RDEMP and MVA was significant in multivariate analysis. This finding reveals that employment is more important in innovations.

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