EYD

*Ekonomik Yaklaşım Derneği / Association*

***Ekonomik Yaklaşım* 2021, 32(119): 89-101**

www.ekonomikyaklasim.org
*doi: 10.5455/ey.18000*

# Economic Determinants of Foreign Direct Investment in Middle-Income Countries: Fuzzy Regression Analysis[1]

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28 Mart 2021'de alındı; 15 Mayıs 2021'de kabul edildi.
29 Mayıs 2021'den beri erişime açıktır.

Received 28 March 2021; accepted 15 May 2021.
Available online since 29 May 2021.

*Araştırma Makalesi/Original Article*

**Abstract**

*In this study, the economic factors determining foreign direct investment inflows for the 84 countries in the middle-income group of the World Bank were explored using 2019 data. The significant factors were gross domestic product per capita, trade openness rate, and current balance. As a result of the fuzzy regression analysis applied with these variables, it was seen that the effect of trade openness ratio and the current balance on FDI inflows of any country in the middle-income group is fuzzy both in size and in sign. In other words, this effect can be sometimes negative and sometimes positive depending on the values of the other variables such as financial, political, organizational, etc. In addition, it was revealed that countries with higher GDP per capita attract more foreign direct investment.*

***Keywords:*** *FDI, Economic determinants, Fuzzy regression analysis.*
***JEL Codes:*** *C10, F21.*



[1] *This study is an enhanced version of the paper previously presented at the MIRDEC-6th International Academic Conference on Social Sciences Multidisciplinary, Economics, Business and Finance Studies symposium.*

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**Özet**

## *Orta Gelir Grubu Ülkelerinde Doğrudan Yabancı Yatırımın Ekonomik Belirleyicileri: Bulanık Regresyon Analizi*

*Bu çalışmada, Dünya Bankasının sınıflamasında orta gelir grubunda yer alan 84 ülke için doğrudan yabancı yatırım girişlerini (DYY) belirleyen ekonomik faktörler, 2019 yılı verileri kullanılarak araştırılmıştır. Literatüre ve veri olanaklarına dayanarak çok sayıda ekonomik gösterge arasından üç faktör belirlenmiştir. Bunlar, kişi başı GSYİH, ticari dışa açıklık oranı ve cari denge'dir. Bu değişkenlerle uygulanan bulanık regresyon analizi sonucunda görülmüştür ki orta gelir grubundaki herhangi bir ülkenin DYY girişleri üzerinde ticari dışa açıklık oranının ve cari dengesinin etkisi hem büyüklük hem de işaret olarak bulanıktır. Yani diğer ekonomik, politik, kurumsal vb. değişkenlerin değerlerine bağlı olarak bu etki bazen negatif bazen ise pozitif olabilmektedir. Buna ilaveten kişi başı GSYİH büyük olan ülkelerin ise daha fazla DYY çektikleri ortaya çıkmıştır.*

***Anahtar Kelimeler:*** *DYY, Ekonomik Belirleyiciler, Bulanık Regresyon Analizi.*
***JEL Kodları:*** *C10, F21.*



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*Economic Determinants of Foreign Direct Investment in Middle-Income Countries: Fuzzy Regression Analysis* https://doi.org/10.5455/ey.18000

## 1. Introduction

Foreign Direct Investment (FDI) is realized when a company establishes a production facility in a different country or purchases an existing production facility and is generally defined as international capital flows created by multinational companies. The FDI inflow for a country is expressed as inward FDI. FDI provides benefits such as increasing employment, efficient use of resources, technological development, reducing the foreign trade deficit, and increasing economic growth for the invested (host) country. In terms of foreign investors (the guest country), it provides advantages such as the use of cheap inputs, proximity to raw material resources, and taking advantage of the opportunities offered by new markets. Factors affecting FDI inflows to a country are categorized under three main headings: economic, political, and investment climate.

One of the first theoretical studies investigating the factors of FDI belongs to Ohlin (1933). According to Ohlin (1933), the main factor attracting investments to a developing country is the high profitability in these countries and the opportunity to finance these investments with lower interest rates. Moreover, the scarcity of trade barriers and the possibility of accessing raw material resources are important factors (Nonnemberg and Mendonça, 2004: 3). Additionally, FDI inflows have positive contributions to economic variables such as economic growth, reduction of unemployment, financial development, meeting foreign exchange needs, opening up to new foreign markets, transfer of knowhow, and increasing competitiveness (De Mello, 1997; Asiedu, 2002).

In this study, the economic factors determining foreign direct investment inflows for countries included in the middle-income group classification of the World Bank were investigated using fuzzy regression analysis with 2019 data. One of the reasons for selecting the middle-income group countries in this study is because Turkey is in this group and another important reason is the case of the middle-income trap. For the countries in the middle-income trap, which can be described as the per capita income level of the country not going beyond a certain level and therefore the country not being able to move to a higher income group, the foreign investments to be made are considered extremely important.

The literature on FDI is discussed after the introduction part of the study. Then, the analysis findings are given by introducing the dataset and method used in the application. The study is finalized by evaluating the results.

## 2. Literature review

There are many studies in the literature to reveal the determinants of foreign direct investments. In a study conducted by Dunning (1981), market size, unit labor cost, service sector productivity and inflation rate were shown as the main factors determining FDI.

Another study belongs to Schneider and Frey (1985). Schneider and Frey (1985) stated that the most important determinants of FDI for the 1976, 1979, and 1980 periods were GNP and balance of payments.

Tsai (1994) analyzed the determinants of FDI in his study. According to the analysis results of the study in which FDI inflows was dependent variable, the coefficients of the growth rate and per capita income were found to be positive, while that of the foreign trade deficit was negative.

Gastanaga et al. (1998), using cross-section and time-series data for 49 underdeveloped countries for the period 1970-1995, found that political and institutional factors had significant effects on FDI.

Chakrabarti (2001) examined the determinants of FDI for 135 countries by cross-sectional analysis. He used net FDI inflows per country as the dependent variable. As a result of the analysis, he revealed that the market volume variable was the most important. He also determined that the variables of trade openness, growth rate and real exchange rate were positively correlated with FDI, while the foreign trade deficit variable negatively correlated with FDI.

Another study was conducted by Onyeiwu and Shrestha (2004). In the study in which the panel data analysis was used for 29 African countries, economic growth, inflation, international reserves, economic openness and accessibility to natural resources were determined as the main factors of FDI. It was observed that the infrastructure level and political rights in the country did not affect FDI.

Janicki and Wunnava (2004) tried to determine the determinants of FDI for the European Union member countries and 8 European countries, which were candidates for the union, by using a cross-section analysis. They determined that unit labor cost, market size and trade openness were the main factors determining FDI.

Ang (2008) found that the most important determinants of FDI for Malaysia were real GDP per capita, financial development, and trade openness. As a result of the analysis, he stated that the real exchange rate and GDP per capita were the variables

that had the greatest impact on FDI inflows. Moreover, the effects of the financial development, economic growth, and foreign trade deficit on FDI were also found to be positive.

Demirhan and Masca (2008) found that the variables of growth rate per capita, the opportunity to communicate by phone, and degree of trade openness were positively signed and significant, while the variables of the inflation rate and tax rate were negatively signed and statistically significant. Additionally, workforce cost and risk variables were found to be insignificant.

Vijayakumar et al. (2010) examined the determinants of FDI inflows of BRICS countries with panel data analysis for the period 1975-2007. They revealed that market size, labor cost, infrastructure, exchange rate, and gross capital formation were the potential determinants of FDI. Whereas, economic stability measured by the inflation rate and growth expectation measured by industrial production, and trade openness were found to have no effect on FDI.

Ozcan and Ari (2010) examined the determinants of FDI for 27 OECD countries with the data of 1994-2006 with the GMM technique using the dynamic panel data analysis. As a result of the study, it was seen that growth rate, infrastructure level, and inflation positively affected FDI. Trade openness and current account balance variables were found to be negatively related to FDI contrary to expectations.

Blonigen and Piger (2011) used Bayesian statistical techniques to determine the variables that affects FDI, and found that the most important factors were cultural distance, GDP, cheap labor opportunity, and regional trade agreements.

In the study of Antonakakis and Tondl (2011), the determinants of the FDI of the United States, Germany, France and Holland, as four major investor countries, to developing countries located in different parts of the world were examined. In the study, 129 countries that received FDI in five different geographical regions between 1995-2008 were discussed using the Bayesian model approach. According to the findings

obtained, a qualified workforce, low wages, attractive tax rates and natural resources were found to be significant factors determining FDI.

Hong and Ronne (2012) used regression analysis to determine the determinants of FDI in the Brazil for the period 1970-2010. According to the analysis results, market size, inflation rate, and the Bolivia-Brazil pipeline were the positive determinants of FDI. Trade openness and Sao-Paulo metro line 5 did not affect FDI.

Ibrahim and Hassan (2013) analyzed the determinants of FDI for Sudan using cointegration and error correction techniques in the 1970-2010 period. According to the findings of the study, market volume, inflation rate, exchange rate, and investment incentive policy variables were put forward as the main determinants of FDI.

Xaypanya et al. (2015) investigated the important factors determining FDI for the Asian trio consisting of Cambodia, Laos, and Vietnam and the Asian quintet consisting of Indonesia, Malaysia, Philippines, Thailand, and Singapore between 2000-2011. It was found that infrastructure opportunities and trade openness affected FDI positively and that the inflation rate negatively affected FDI, in the Asian trio. In addition, it was observed that real exchange rate, GDP, and net development incentives had no effect. For the Asian quintet, market size and infrastructure opportunities were the important factors for attracting FDI.

Economou et al. (2017) examined the determinants of FDI in 24 OECD and 22 developing (non-OECD) countries with a dynamic panel approach for the years 1980-2012. According to the analysis findings, the factors affecting FDI were past FDIs, market size, gross capital formation and corporate taxation in OECD countries, while past FDIs, market size, labor cost, and institutional variables were the factors affecting FDI for 22 developing countries.

Jaiblai and Shenai (2019) examined the factors affecting foreign direct investment for the African countries Liberia, Sierra Leone, Cote d'Ivoire, Ghana, Nigeria, Mali, Mauritania, Niger, Cameroon and Senegal for the period 1990-2017 with the ARDL model. While GDP, GNP per capita, inflation rate, and infrastructure level

were found to be effective on FDI, trade openness and exchange rate variables were found to be insignificant.

Soo and Kueh (2020) analyzed the macroeconomic determinants of FDI inflows in Cambodia, Laos, Myanmar and Vietnam with the panel data analysis for the period 2000-2016. According to the findings, it was determined that there was a significant and positive relationship between FDI and market size, inflation rate, exchange rate, trade openness, and total workforce.

## 3. Data and Methodology

In this study, the main economic factors affecting the FDI inflows to the countries in the middle-income group classification of the World Bank were attempted to be determined. For this purpose, of the 106 countries, the 2019 data of 84 countries with complete data were used. When the literature is examined, it can be seen that many economic indicators affect the FDI inflow. However, as a result of the univariate and stepwise regression analyzes made among the variables of gross domestic product per capita, current balance, trade openness ratio, inflation rate, exchange rate, economic growth rate, labor wage, the data of which could be obtained, only three economic factors were found to be strongly correlated with the dependent variable (FDI). These are gross domestic product per capita (GDP), trade openness ratio (CO), and current account balance (CAB). The data on these variables were compiled from the World Bank and the fuzzy regression analysis was applied to them.

The fuzzy regression analysis, which is based on the fuzzy logic approach that has attracted great attention with its ability to take into account the uncertainty of real life, is an estimation method that can be used in cases where the relationships between variables or data are not clear. Although the fuzzy regression model has many solution methods, the method developed by Tanaka, H., Uejima, S., and Asai, K (1982) was used in this study.

The main feature that distinguishes the fuzzy regression model from the classical regression model is that all or some of the model coefficients are fuzzy. In the method of Tanaka et al. (1982), the model coefficients are determined with the help of a linear programming model that minimizes the classical regression model error-squares summation.

The fuzzy regression equation can be expressed in its simplest form as follows:

$$\hat{y}=\tilde{A}_0 + \tilde{A}_1 X_1 \qquad (1)$$

Fuzzy coefficients are shown as $\tilde{A}_i = (c_i, s_i)$ where:

$c_i$, shows the center of the triangular fuzzy symmetric coefficient, and

$s_i$, shows the length of one wing of the triangular fuzzy symmetric coefficient

Model (1) is first solved with the least-squares method as the classical regression model and the following linear programming model is created by using the obtained error terms $(e_i)$.

$$Z_{min} = n.s_0 + \sum_{j=1}^{n}\left(s_j \sum_{i=1}^{m}|x_{ij}|\right) \qquad (2)$$

$$\sum_{j=0}^{m} c_j\, x_{ij} + (1-H)\sum_{j=0}^{m} s_j|x_{ij}| \geq y_i + (1-H)e_i \qquad \text{i=1,…..,n} \qquad (3)$$

$$\sum_{j=0}^{m} c_j\, x_{ij} - (1-H)\sum_{j=0}^{m} s_j|x_{ij}| \leq y_i - (1-H)e_i \qquad \text{i=1,…..,n} \qquad (4)$$

Here *m* is the number of variables and *n* is the number of observations. Also, H is the degree of belief, and the larger it is, the larger the prediction range, that is, the rate of belonging to the fuzzy cluster. Although the recommended value for H is 0.50, the most suitable value is determined by trial and error.

In the application part of the study, the SPSS 23 statistical program was used first to obtain a good model with the classical regression analysis. The fuzzy model was obtained using Microsoft Excel Analytic Solver.

## 4. Empirical Findings

The classical regression analysis results obtained as the first step of the fuzzy regression analysis by Tanaka et al. (1982) are presented in Table 1.

**Table 1** Summary of the Regression Model

| | β | Standard Error | t | P-value | VIF |
|---|---|---|---|---|---|
| **Constant** | $-4136.46*10^6$ | | -1.220 | 0.054 | |
| **$GDP_{pc}$** | $1.23*10^6$ | 0.187 | 2.198 | 0.031 | 1.059 |
| **LnOP** | $-15351.83*10^6$ | -0.353 | -4.265 | 0.000 | 1.002 |
| **CAB** | 0.497 | 0.515 | 6.064 | 0.000 | 1.058 |
| **$R^2$** | 0.6577 | | | | |
| **Adjusted $R^2$** | 0.6449 | | | | |
| **F statistics** | 51.2377 | | | | |
| **P-value** | 0.000 | | | | |
| **Durbin-Watson** | 1.987 ($d_{L=}$ 1.434 $d_{U=}$1.577) | | | | |
| *Determinant: (Constant), CAB, LnOP, $GPD_{pc}$*<br>*Dependent Variable: FDI* | | | | | |

According to Table 1, approximately 65% of the FDI can be explained by the variables used in the analysis. At the 5% significance level, all regression coefficients were found to be significant. Moreover, the F statistics also showed that the model coefficients as a whole were significant at the 1% significance level. Besides, Durbin Watson and VIF values revealed that the regression assumptions were met.

After the classical regression analysis, a fuzzy regression model was created to obtain more flexible and realistic results. As a result of solving the linear programming model established at this stage in Excel Analytical Solver, the belief degree (H), which gives the lowest error sum of squares, was determined as 0.45. According to this belief degree, the dispersion widths obtained for the regression coefficients of $GDP_{pc}$, LnOP, CAB are $2.42*10^6$, $17.01*10^6$, and 1.69, respectively. The fuzzy regression model coefficients are shown in Table 2.

**Table 2** Fuzzy Regression coefficients (H=0.45)

| **Fuzzy parameter** | **$\beta_0$** | **$\beta_1$** | **$\beta_2$** | **$\beta_3$** |
|---|---|---|---|---|
| **Center ($c_i$)** | -4136.46*$10^6$ | 1.23*$10^6$ | -1535.18*$10^6$ | 0.497 |
| **Width ($s_i$)** | 6501*$10^6$ | 1.21*$10^6$ | 8510*$10^6$ | 0.847 |

According to the fuzzy regression analysis results, all coefficients were fuzzy. While GDP positively affected FDI, the influential aspects of the trade openness ratio and the current account balance were not certain. According to the coefficient values, an increase of $ 1 in GDP per capita can increase FDI inflows between $20,000 and $2,440,000. A 1% increase in trade openness can increase FDI inflows by up to $6,970,000, or decrease by down to $10,040,000. Finally, an increase of $1 in the current account balance can increase FDI inflows by up to $1.34, or decrease by down to $0.35.

## 5. Conclusion

Since many things in real life are not as precise as is thought, more or less uncertainty can be mentioned in almost every case. Since fuzzy logic takes this uncertainty into account and models it, it can produce much more realistic results than other methods. For this reason, the fuzzy regression method based on fuzzy logic was preferred in this study to determine the economic factors affecting FDI inflows. In empirical studies conducted on the determinants of FDI inflows, various findings are encountered in compliance with or in the opposite direction to theoretical expectations for the influential aspects of these factors. Based on this, in this study, the economic factors and their impact aspects were handled with a more skeptical approach, and as a result of the analysis, fuzzy values were obtained in terms of both coefficient sizes and coefficient signs.

Considering the findings obtained as a result of the analysis, it is seen that all variable coefficients were fuzzy. In terms of the impact direction, the effect of the GDP per capita variable on FDI inflows was definitely positive, unlike other variables in the

analysis. Accordingly, it can be said that countries with higher GDP per capita receive more FDI inflows.

The coefficient of the trade openness ratio variable was fuzzy in terms of both magnitude and sign. The fuzziness of the sign means that this variable can affect FDI inflows negatively or positively. Although the finding that trade openness negatively affects FDI seems contrary to expectations, this situation, which has previously been encountered in the literature, can be explained as follows. The direction of the effect here may vary depending on the type of FDI[3]. Foreign trade restrictions, which reduce the level of foreign trade openness, may have a positive effect on FDI in direct investments to the market. In other words, according to the tariff-skipping hypothesis, when foreign companies that want to increase their shares in other countries' markets encounter difficulties in exporting their products, they may decide to produce in this country through the subsidiaries they will establish in the host country (Asiedu, 2002: 111). As a result, a country with a low trade openness rate may sometimes attract more FDI, contrary to expectations.

As in trade openness, the coefficient of the current account balance variable was found to be fuzzy in terms of both magnitude and sign. When the literature is reviewed, it is seen that the effect of the current account balance on FDI is mostly positive but sometimes negative. The improvement in the current account balance is accepted as one of the indicators of a reliable and well-functioning economy. Therefore, the current account balance is generally expected to be positively associated with FDI. However, the increased need for foreign capital and foreign investments to correct this situation, especially in countries with poor current account balances, can encourage the entry of foreign investors in the country by increasing the efforts to attract FDI.

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[3] Foreign direct investments can be realized when a company opens a branch in a foreign country, establishes a facility, merges with or purchases an existing local company, or establishes a joint venture with a local company.

In summary, FDI can sometimes be negatively or positively affected by various economic, political, institutional factors, etc. For this reason, it is concluded that very precise statements about whether any economic factor affects FDI inflows positively or negatively will not be appropriate. It can also be said that economic factors alone will not be decisive for attracting foreign direct investment to the country, and many other factors should be considered together. In fact, there are statements that the effects of factors such as political stability, security and freedoms are more important than economic factors in attracting FDI. Therefore, it would also be appropriate to consider political, structural, cultural factors, etc. in further studies.

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