TUJISE Turkish Journal of Islamic Economics

The Profit Rate-Interest Rate Nexus
Evidence from Machine Learning Algorithms

Mehmet Yeşilyaprak
Ali Polat
Onder Ozgur
Süleyman Şahal

Abstract: The main purpose of this study is to examine potential predictors of profit rates and dee posit rates and to examine whether these rates are affected by identical factors. This paper empirically addresses tree-based machine learning algorithms (e.g., boosting, bagging, random forest). The empirical findings of the study demonstrate participation banks' profit rates to be more influenced by industrial production due to these banks being in contact more with real economic activity. As expected, however, domestic and global interest rates appear to have great significance in how deposit banks set their rates. This study contributes to the literature in two ways. First, it determines the potential predictors of profit rates and deposit rates in a data-rich environment. Second, the study uses random forest, bagging, and boosting algorithms as methodological tools and benefits from the apparent advantages these algorithms have empirically.

Keywords: Profit, interest, participation banking, Islamic finance, bank, usury.

JEL Classification: E43, G21

@ Assoc. Prof., Beykoz University, mehmetyesilyaprak@beykoz.edu.tr, 0000-0001-8334-5191
Assoc. Prof., Ankara Yildirim Beyazit University, apolat@hotmail.com, 0000-0001-6041-5003
Assist. Prof., Ankara Yildirim Beyazit University, oozgur@ybu.edu.tr, 0000-0001-5221-4842
Manager of Insurance Analytics, Turk Eximbank, suleymansahal@gmail.com, 0000-0003-4179-8998

DOI: 10.26414/A3704
TUJISE, x(x), 202x, xx-xx
tujise.org

Submitted: 24.12.2021
Revised: 11.03.2022
Accepted: 28.03.2022
Online First: 18.04.2022

Introduction

The global pace of Islamic finance (IF) in the second half of the 21st century has not only brought a new framework for financing but also opened a theoretical scope for discussing unconventional financing methods. These theoretical discussions have shown themself in different strands of the literature, one developing strand being related to the similarities or causality between Islamic and conventional financial institutions regarding profit shares and interest rates on deposits in financial markets containing both conventional and Islamic financial institutions (IFIs).

The total global IF assets reached $2.88 trillion USD in 2019, with70% being held in Islamic Banks and 19% being held in Sukuks (Islamic Corporation for the Development of the Private Sector [ICD], 2020). Therefore, when talking about IF, one should actually bear in mind that Islamic Banking (IB) and Sukuk-related developments are being talked about rather than other IFIs, Islamic funds, or takafuls. ICD's report also forecasted that global Islamic financial assets to be expected to reach $3.69 trillion USD.

Eid and Asutay (2019) indicated IF to be the fastest growing sector in the global financial industry with a broad and sophisticated product and service range being put forward for the financial and theological needs of more than 1.5 billion Muslims. However, much research has indicated customer satisfaction to be higher among non-Muslim customers (Amin et al., 2011) who use IB services and service quality in IBs to be fundamental (Awan & Bukhari, 2011) for IB customers. Therefore, IF is attractive to everyone irrespective of religion, although the underlying reasons for providing and choosing IB services vary.

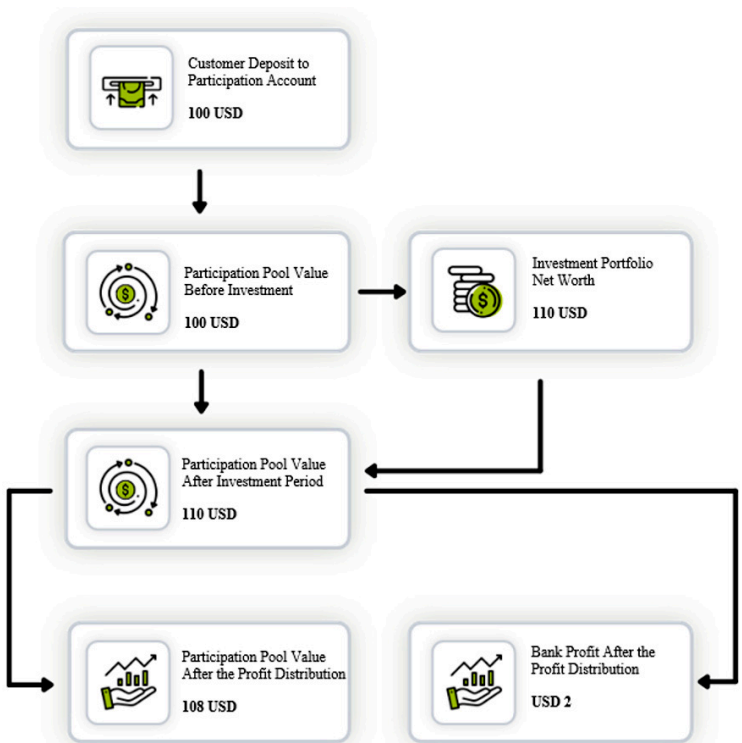
The basic business model for IBs is to collect funds from real and legal persons who have excess funds and to make these funds available for the real and legal persons requesting funds. IBs perform these activities interest-free but with and for profit. Venardos (2005) there are no clear definitions as to what these terms entail. Whereas some scholars assert that Shari'ah-compliant and Shari'ah-based products are the same, there is a need to distinguish between different nuances of Islamic finance in terms of legal and social Shari'ah requirements. In this research note (note indicated IF to have social objectives consistent with its ethical system compared to its conventional counterparts, to be equity-based and not debt-based, and to not permit *gharar* [uncertainty], among other differences. IB limits many activities that fall under the category of speculation, gambling, or activities that are harmful to society. IBs' sharia committees decide whether these limitations are permissible or not either through a general policy or on a per-basis decision.

Whether IBs act according to its theoretical requirements or have certain issues that keep them prone to Sharia non-compliance risk is important in any IFI-related discussion. Discussions on Sharia-based and Sharia-compliant instruments are also the source of discussions from which one can derive further discussions, such as this research.

Despite appearing structurally similar to conventional banking, the fundamental difference with IBs is that fund owners deposit their money at time *t* in a profit-sharing account with no return guarantee at time *t + 1*. IBs create a pool from the funds consisting of the same maturities, and all projects' profits in the same pool are calculated at the end of the maturity of the related pool. The profit or loss will be known to the parties at this time (*t + 1*), not at the time of the deposit (*t*) but at the maturity of the project (i.e., *t + x* days).

Figure 1

$100 USD Deposit and $100 US Murabaha Project (share based on 80% to 20%) at 10% Profit Sharing.



Source: Created by the authors.

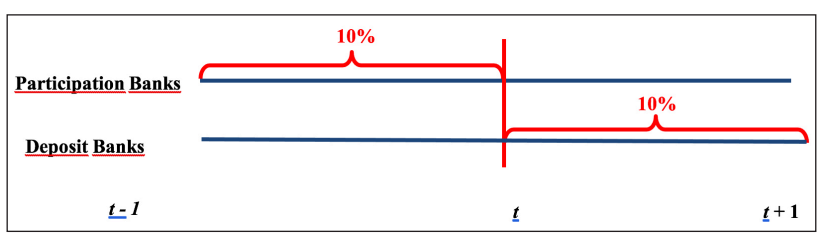
The participation banking (PB) model differentiates itself not only in fund collection but also in how it uses these funds. Creating pools and funding from these pools is at the heart of the system. Fund owners deposit the excess funds they have in the IB without any specific promise or guarantee from the IB. The only determined issue between an IB and its customer is the sharing rate/ratio upon deposit. The sharing rate shows how much of the profit will be shared with the funding customer (i.e., the real or legal person) at the end of maturity. Figure 1 assumes the investor to have deposited $100 USD in the bank at the first stage and to have received an 80% share rate. IBs pool the collected funds in participation pools, which constitute the source of the loans to be given.

In IB, funding must be related with real economic and trade activity. PBs mediate the purchase of related goods or services during funding. Thus, property ownership passes to the customer who has a contract with the IB for payment of the funds that were paid to the seller. This type of lending transaction is called *Murabaha* [production support] and is a type of loan with the highest shares in the Turkish Participation Banking system, just as in other IBs in different regions or countries. The participation pool grows with installment payments that also include a profit share.

Therefore, how much the pool will earn and the individual return rates of each of these pools are determined at the end of maturity in PBs. Upon making a deposit in a depository bank, the depositor is notified at that time of the amount of interest that will be paid to the deposit. At this point, the deposit returns for these two types of banks differ in their description. While conventional banks announce a fixed rate upon making the deposit despite the net return being unknown, PBs announce the rate of return at the maturity date of the related deposit after calculating the net rate of return for the pool. As Bashir (1984) indicated, this participation basis may be more expensive than fixed-rate deposits, but it is much safer and less risky than interest loans.

Figure 2

Timing of Profit Rates and Interest Rates: PBs versus CBs



Source: Created by the authors.

Discussing the fundamental difference of rate timing in IBs and CBs is also important. When IBs declare a rate, this rate is what they agree to pay to their customers between time *t-1* and time *t* depending on the average return of the pool. Meanwhile, the rates conventional banks declare are the rates they promise to pay their depositors between times *t* and *t+1*. The rate of return for IB customers between times *t* and *t+1* will be calculated after time *t+1*.

To rephrase this issue, PBs due to their nature do not promise a fixed return when collecting deposits from their customers. The more returns a PB gets from the loans they have provided during the relevant period, the more the profit share of a certain maturity of the return will be shared with the depositor unless the PB applies a different smoothing process to their profit distribution. An IB sharing future profits is completely in contrast with the application of a deposit interest rate as announced by a CB.

With such apparent differences, the connection between a PB's profit rates and a CB's deposit rates has long been discussed by scholars, and the literature continues to grow. These studies generally concentrate on the causal relationship between profit rates and deposit rates, with the predominant conclusion being that a causal relationship exists between these rates. Aside from a large body of literature being found to have examined the relationship between profit and deposit rates, these studies primarily focus on causality analyses. However, the causal connection may be attributable to any intermediary variable that connects deposit and profit rates. Our main argument in this paper is that the research performed over causality will not be beneficial to developing PBs unless we further investigate the real reasons behind the results of the related econometric models. The causation models are actually indicative of a correlation, and another variable or variables may exist that cause both rates (interest and profit) to increase or decrease alongside one another. Therefore, we need to examine the profit rate-deposit rate nexus with an extended set of variables instead of causality models. Room appears to exist for contributing in this context to see if any intermediary variable can be found that connects deposit and profit rates.

As a result, our study examines the predictors of profit rates and deposit rates regarding different maturities in the Turkish banking industry from January 2008 to December 2019. The Turkish banking industry provides an ideal environment with its dual banking system. Turkey's political and economic environment is very sensitive to global, regional, and domestic developments. Therefore, we assume a higher standard deviation will be seen in our time series, and this deviation will provide a greater effect over the related variables. Another reason for using the case

of Turkey is to discuss this new approach for the literature and to encourage scholars to look beyond causality by applying a larger data set using different variables.

In this context, the current research offers two forms of contributions. The first is that this study concentrates on the potential predictors of profit rates and deposit rates and examines whether these rates are affected by identical factors. As a result, the goal of this study is to see if any intermediary variable is found in action that might explain the significant link between deposit and profit rates. The second is that the study uses tree-based random forest, bagging, and boosting algorithms as a methodological tool, which offers clear advantages. To examine the relationship between variables, these machine learning algorithms do not require a predefined functional form. Furthermore, unlike traditional tools, these methods do not require *a priori* distributions for the selected variables, instead providing out-of-sample performance for the generated model.

The rest of the current study will occur as follows. The next section reviews the existing literature. The third section introduces the data and empirical methodology. The fourth section provides the empirical findings, and the fifth section discusses these findings with the last section concluding the study.

Literature Review

The literature on this issue is multi-faceted with direct and indirect connections. Studies have mainly concentrated on countries with dual banking systems. For instance, Hassoune (2002) analyzed profitability and interest rate cycles. Among the points he raised is that, even if a country chooses IB as its default model for the entire system, depositors will still compare their returns with non-Islamic markets.

Comparisons of IB and CB generally concern deposits. Exceptional research is found to have attempted to understand the relationship between these two bank types' lending rates (e.g., Lee et al., 2017; Nguyen & Manrique, 2011). Bacha (2004) compared the rate of return on deposits in both CB and IB in a study on interest rate risk. The study examined 10 years of monthly data between 1994 and 2003 for Malaysia. Bacha's study covered the falling and rising periods of interest rates and found the cost of funds and inflows (deposits) for IBs to closely correlate with those of CBs. The research indicates IBs to possibly be subject to interest rate risk in dual banking systems.

Chong and Liu (2009) investigated whether IB actually differs from CB or not. In theory, the profit-and-loss sharing (PLS) partnership paradigm appears to be the main difference distinguishing IB from CB. However, they concluded IB to

not differ much from CB in terms of the PLS paradigm in practice. For Malaysia, Ito (2013) observed similarities and claimed neither banking system to differ in regard to return rates. Ito's study employed Toda and Yamamoto's (1995) Granger causality method and determined a causal relationship to occur from profit share rates to interest rates in all maturity groups except 1-month maturity loans.

Sukmana and Ibrahim (2017) employed nonlinear methods to assess the relationship between Islamic rates and conventional rates for Malaysia using monthly data between January 1999 and November 2016. Islamic banks were found to follow consumer reactions when pricing investment products instead of pegging their rates to their conventional counterparts in Malaysia. Recently, Saeed et al. (2021) investigated the dependency of IB rates on CB rates, which violates the religiosity principle of IB, for Malaysia using monthly data from January 2009 to April 2018 alongside some deviation and causality models. They found IBs in Malaysia to have been influenced both by CB and the Bank Negara Malaysia's policy rates with regard to their deposit and loan activities.

Because the Turkish banking system also has a dual banking nature, several studies are also found there to have examined the association between profit rates and deposit rates. These studies mainly concentrated on whether a causal relationship exists between profit and deposit rates. Of these studies, Erturk and Yuksel (2013) studied the causal relationship between returns from CBs and from IBs in Turkey using the Granger causality test. They concluded no significant relationship to exist between the banking sectors. Ergec and Kaytancı (2014) investigated whether PB return rates in Turkey were effected by CB deposit rates. Their study showed CB deposit rates to Granger cause PBs' profit rates.

Avcı and Aktaş (2015) analyzed data between 2010 and 2014 in their study on Turkey. They observed PBs, to focus more on the *murabaha* method (70-75%), and less on the *mudaraba* [profit-loss partnership] method (2%). This reveals the need for PBs to support more profit-and-loss projects.

Ata et al. (2016) analyzed data between 2004-2014 using the Hacker and Hatemi (2006) causality test. They found a two-way causality relationship with 12-month maturity rates and a one-way causality relationship from interest rates to profit share rates for other term periods. Similarly, Korkut and Özgür (2017) examined the period between January 2006 to May 2015 for Turkey and found government securities' interest rates and foreign exchange rates to significantly affect PBs' profit share rates. Yüksel et al. (2017) studied the years between 2000-2016 regarding banks in Turkey. By employing the Toda-Yamamoto (1995) causality analysis, they determined a significant causal relationship to exist between the

two types of banks. They also justified this by indicating that, because both banks performed in the same market, both rates would inevitably be similar.

Ergeç (2018) study on the relationship between Islamic and conventional foreign exchange deposits of banks in Turkey between 2005-2017. That study contributed to the literature by conducting a discussion of foreign currency deposits compared to Turkish Lira deposits. The analysis used the Toda-Yamamoto (1995) causality method and determined a causal relationship in all maturity groups except the one-year or longer maturity groups. In funds collected in dollars, Ergeç found a bidirectional causal relationship between Islamic and conventional bank deposit returns, and found deposit interest rates to Granger cause profit rates for funds in Euros. Tura and Kaya (2019) also analyzed the relationship between PB profit shares and CB deposit rates for Turkey and found similar results, with interest rates Granger causing profit shares in the Turkish banking system.

Gök's (2021) recent study analyzed the period from March 2001 to June 2019 over monthly data to see if a relationship exists between CB and PB regarding CB deposit rates and PB profit-sharing rates. Gök's overall finding after identifying both unidirectional and bidirectional causality suggested neither banking sector to be independent of the other. This finding is also an indirect indication of both banking systems to actually monitor other macro-level or global variables. Çonkar and Gökgöz (2021) investigated the relationship between profit and deposit rates using S-cointegration and Fourier-Granger causality tests by considering structural breaks for different maturity groups. They found no cointegration relationship but did find a one-way causality from deposit interest rates to profit rates, as expected.

Data and Methodology

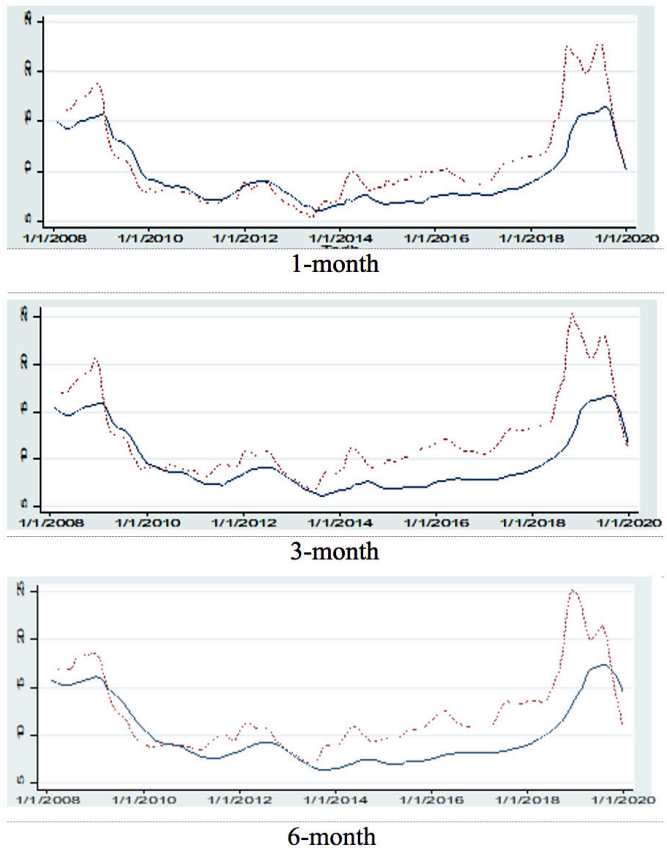
Data

The dataset used in this study covers monthly observations from January 2008 to December 2019. Our dependent (target) variables are participation bank profit rates and conventional bank deposit rates over three different maturities (1, 3, and 6 months).

Because our study concentrates on the predictors of profit rates and deposit rates regarding different maturities and focuses on whether the same indicators are critical to predicting these rates, looking at the time series graphs for participation rates and deposit rates regarding 1-, 3-, and 6-month maturities makes sense. Figure 3 displays the time-series graphs for the target variables.

Figure 3

Time Series Graphs for Profit Rates and Deposit Rates



Note: dotted graph = deposit rate, solid graph = profit rate
Source: Turkish Participation Banking Association (TKBB)

Looking at the graphs and data for the rates and profit shares, we can say that:

a. Since mid-2013, a clear distinction is found between profit rates and interest rates. The political and/or economic reasons should be investigated for this difference.

b. Interest rates in Turkish Lira (TRY) are more volatile. Conventional banking can be said to follow policies that are more responsive to market conditions.

We addressed a group of predictor variables to determine the factors critical for explaining the link between participation and deposit rates. Table 1 introduces the definitions and data sources for these variables.

Table 1
Variables and Their Sources

	Data	Acronym	Data Source	Details
Target Variables	Participation Banks Profit Rates	Profit_Rate_TRY01	Turkish Participation Banking Association (TKBB)	Newly set up Turkish Emlak Participation Bank has been excluded due to the non-availability of data.
		Profit_Rate_TRY03		
		Profit_Rate_TRY06		
	Conventional Banks Interest Rates (Stock, %)	Deposit_Rate_TRY01	Turkish Central Bank Electronic Data Delivery System	Stock data series are preferred as PBs' rates were also stock rates
		Deposit_Rate_TRY03		
		Deposit_Rate_TRY06		
Alternative Financial Instruments	Borsa Istanbul (BIST) Nominal Return (%)	BIST_Return_01	Turkish Statistical Institute (TSI)	
		BIST_Return_03		
		BIST_Return_06		
	USD Nominal Return (%)	USD_Return_01	Turkish Statistical Institute (TSI)	
		USD_Return_03		
		USD_Return_06		
	EUR Nominal Return (%)	EUR_Return_01	Turkish Statistical Institute (TSI)	
		EUR_Return_03		
		EUR_Return_06		
	Gold Nominal Return (%)	Gold_Return_01	Turkish Statistical Institute (TSI)	
		Gold_Return_03		
		Gold_Return_06		
Participation Funds	Participation Funds (% Change)	FUND_01	Turkish Central Bank Electronic Data Delivery System	
		FUND_03		
		FUND_06		
Deposits	Deposits (% Change)	DEP_01	Turkish Central Bank Electronic Data Delivery System	
		DEP_03		
		DEP_06		

Monetary Policy	Interbank Overnight (ON) Interest Rate (%)	ON	Thomson Reuters/Eikon
Economic Activity	Industrial Production Index (Annual % Change)	IPI	Turkish Central Bank Electronic Data Delivery System
Risk	Geopolitical Risk (Index)	GEO	Thomson Reuters/Eikon
Inflation	Inflation Rate (%)	INF	Thomson Reuters/Eikon
Global Factors	US Federal Funds Rate (%)	FFR	Thomson Reuters/Eikon
	Euro Short Term Repo Rate (%)	ECB	Thomson Reuters/Eikon

The Turkish Lira and Foreign Exchange funds collected by PBs were obtained from the website https://www.tkbb.org.tr/mukayeseli-tablolar. The sectoral weights of the PBs were calculated for each deposit in TRY and the three different maturities. These six different weighted values were multiplied by the individual profit rates of PBs, after which we reached a weighted average for PBs' sectoral profit rate average for each currency type and maturity.

In our model specifications, the first group of predictor variables is the nominal returns of alternative financial instruments. These variables represent whether the returns from the alternative financial tools are better able to predict participation rates and deposit rates for the various maturities. We also addressed the changes in the volume of participation funds and deposits to see the impact demand factors have over rates. Finally, we used monetary policy indicators, economic activity variables, risk measures, inflation rate, and global factors to determine better predictors for the participation and deposit rates and to clarify the association between these two financial indicators. Table 2 shows the descriptive statistics for a set of target and predictor variables.

Table 2
Descriptive Statistics

Variables	Mean	Median	Max.	Min.	*SD*	Observations
Profit_Rate_TRY01	9.55	8.22	16.52	6.02	3.08	144
Profit_Rate_TRY03	9.73	8.40	16.72	6.14	3.17	144
Profit_Rate_TRY06	10.00	8.58	17.34	6.42	3.28	144
Deposit_Rate_TRY01	10.83	9.22	22.80	5.29	4.31	144
Deposit_Rate_TRY03	12.25	10.84	25.37	6.59	4.28	144
Deposit_Rate_TRY06	12.27	10.87	25.12	7.06	4.06	144
BIST_Return_01	0.68	1.20	19.10	-24.00	6.27	144
BIST_Return_03	2.25	1.74	46.40	-38.80	12.67	144
BIST_Return_06	4.69	4.74	93.20	-39.40	20.53	144
USD_Return_01	1.20	1.15	22.01	-8.21	3.95	144
USD_Return_03	3.67	2.16	36.84	-16.20	8.20	144
USD_Return_06	7.21	5.42	63.05	-13.92	11.85	144
EUR_Return_01	1.00	0.70	20.49	-9.24	3.66	144
EUR_Return_03	3.03	1.77	36.59	-18.17	7.19	144
EUR_Return_06	6.01	5.32	54.10	-16.50	10.15	144
Gold_Return_01	1.66	1.15	17.82	-12.30	4.76	144
Gold_Return_03	5.10	5.18	30.15	-12.18	8.96	144
Gold_Return_06	10.48	10.97	56.10	-16.20	12.82	144
FUND_01	1.93	1.88	48.32	-38.57	13.67	144
FUND_03	2.59	2.59	26.61	-13.77	6.53	144
FUND_06	1.79	0.73	55.26	-26.69	10.77	144
DEP_01	1.27	0.77	27.39	-12.72	7.10	144
DEP_03	1.16	0.95	13.48	-7.00	2.65	144
DEP_06	1.93	0.31	101.31	-30.14	13.92	144
ON	11.21	10.67	25.36	4.03	4.98	144
IPI	4.49	5.10	24.21	-20.22	7.92	144
GEO	129.20	124.72	234.28	58.66	38.81	144
INF	0.78	0.62	6.30	-1.44	0.95	144
FFR	0.69	0.17	4.26	0.06	0.87	144
ECB	0.75	0.25	4.25	0.00	1.08	144

Based on basic descriptive statistics, the mean value for deposit rates is evidently greater than that for participation banks' profit rates for all maturity periods. Table 2 demonstrates longer maturities to have higher profit and deposit rates.

Methodology

Because the way PBs and CBs do business differs significantly, one might expect different input variables to influence profit rates and deposit rates. Therefore, this study conducts machine learning algorithms (i.e., boosting, bagging, and random forest) to show the importance of potential predictors for profit and deposit rates.

Machine learning algorithms offer some distinct advantages compared to traditional time series econometric methods. To begin with, machine learning methods allow for more variables to be included in the study and offer a measure of variable importance that identifies the most significant predictors of the target variable. Second, machine learning techniques do not require *a priori* functional form selection and provide model flexibility. Third, machine learning does not require the variables to follow a certain probability distribution.

Tree-based machine learning algorithms aim to explain the variation in the target variable by using a set of input variables. The algorithms use binary splits and split data repeatedly to increase the purity of the target variable in regard to prediction. Machine learning algorithms split data into mutually exclusive nodes and set a decision rule to apply to a specific input variable (Gonzalez et al., 2014).

Basuchoudhary et al. (2017) defined the standard tools and steps for performing bagging, boosting, and random forest algorithms as follows:

- These algorithms use binary splits to divide the sample into sub-samples in each node.
- Tree-based algorithms have some predetermined criteria to split data into additional nodes or to define the node as the terminal node.
- Splitting the data into new nodes aims to minimize the measure of impurity. One commonly used measure of node impurity is the mean square error (MSE), which is the average value of the squared difference between the actual output variable and the predicted output variable.
- These algorithms search for the best cutoff point in each node to minimize these errors.
- Decision rules are designed to assign a predicted value for each terminal node.

The first machine learning algorithm we address in our empirical analysis is the boosting algorithm as proposed by Freund and Schapire (1997) and modified by Friedman (2001). The algorithm employs the following steps (James et al., 2013):

- This algorithm first creates *M* different learning samples, each with *p* control variables.
- The algorithm assigns a weight to each of these samples.
- The algorithm calculates the error using the assigned weights for each learning sample in each constructed tree.
- If the error rate is unreasonable, new weights are set to get the best performance by means of a lower prediction error.
- The algorithm predicts the target variable for each tree and denotes this prediction as .
- The output of the boosting algorithm is:

$$\hat{B}_{pred}(M_i) = \sum_{i=1}^{M} \omega B_{pred}(M_i) \qquad (1)$$

We've also employed the bagging algorithm in our empirical specification. The bagging algorithm was proposed by Breiman (1996) and follows the steps below (Barboza et al., 2017):

- The bagging algorithm takes *M* samples from the learning sample using replacements.
- Using these *M* samples (note that samples might be identical since the algorithm gets the data through replacement), the algorithm creates *M* decision trees.
- The algorithm uses all *p* control variables for each decision tree and finds the best splitter in each node.
- The algorithm continues to find the best splitter until reaching the minimum node size.
- The best splitter is found using the MSE measure.

$$MSE\ (p_i) = \frac{\sum_{i=1}^{n}(b_i - b_{pred})^2}{n} \qquad (2)$$

where b_i represents the observed value of the target variable, b_{pred} is the predicted value, and n is the number of observations in the learning sample.

- The algorithm then provides M predictions of the target variable by using the decision rule in each tree. The bagging predictor is the average value of these M predictions.

Lastly, we employed the random forest algorithm as proposed by Breiman (2001). A random forest algorithm randomly selects M subsamples from the learning sample, as in the case of the bagging algorithm. The main difference between the random forest and bagging algorithms is that the random forest algorithm chooses input variables at random when constructing each decision tree without replacements. The methodological steps of the random forest algorithm are as follows (Yoon, 2021):

- From a selected learning sample, the algorithm first creates a bootstrapped sample of size N.
- The algorithm repeats the following steps until reaching the minimum node size:

1. Selects k variables among a set of p control variables,
2. Among these k variables, the algorithm selects the best split point for each node. The best split point is decided in such a way as to reduce the MSE,

$$MSE\ (k_i) = \frac{\sum_{i=1}^{n}(f_i - f_{pred})^2}{n} \qquad (3)$$

where f_i represents the observed value of the target variable, f_{pred} is the predicted value, and n is the number of observations in the learning sample.

The random forest predictor is the average of the values and is denoted as .

Each algorithm provides the specific measure and rank of the variables according to their importance measure. As noted above, the algorithm calculates the improvement in the node impurity as the splitting variable used in each node (Hastie et al., 2017).

Our empirical specification uses the variable importance measure in the boosting, bagging, and random forest algorithms based on the mean decrease in accuracy. The mean decrease in mean accuracy measure is calculated by adding up the decrease in MSE in each node where the specific variable is used as a splitter (Basuchoudhary et al., 2017).

Empirical Results

Our empirical analysis examines the most important predictors of profit rate and deposit rate; this allows us to infer the profit rate and deposit rate nexus. To this end, we've created six models and utilized the random forest, bagging, and boosting algorithms. We address 1-month, 3-month, and 6-month profit rates and deposit rates as the target variables and sets of predictors. These models can be illustrated as follows:

$$Model_k: Profit_{Rate_{TRY_i}} = f(\mathrm{BIST}_{\mathrm{Return}_i}, \mathrm{USD}_{\mathrm{Return}_i}, \mathrm{EUR}_{\mathrm{Return}_i}, \mathrm{GOLD}_{\mathrm{Return}_i}, \mathrm{FUND}_i, \mathrm{ON}, \mathrm{IPI}, \mathrm{GEO}, \mathrm{INF}, \mathrm{FFR}, \mathrm{EURO}) \quad (1)$$

where k takes values 1, 3, and 5 for the profit rate models and 2, 4, and 6 for the deposit rate models. In addition, i takes the value of 1-month, 3-month, and 6-month.

To discuss the association between profit rate and deposit rate, we provide the relative importance of variables in predicting the profit rate and deposit rate values. The random forest algorithm offers a mean decrease in accuracy measure to identify the relative importance of the predictor variables. This measure provides the decrease in prediction error through the specific variable used as the splitter in the tree. Therefore, this measure allows us to evaluate the performance of the predictor variables in predicting the target variable.

Before illustrating the results of the variable importance measures, each table is worth noting to demonstrate the relative importance of predictors as a percentage. Due to our performing three algorithms, the predictor variables are ranked according to the average of the relative importance measures. Table 3 provides the relative importance of our set of predictor variables for predicting the average 1-month profit rate offered by participation banks.

Table 3
Variable Importance Results for Profit_Rate_TRY01

Rank	Variable	Forest	Bagging	Boosting	Average
1	ON	65.460	30.274	43.860	46.532
2	IPI	21.406	21.749	27.551	23.569
3	FFR	6.121	23.311	9.510	12.980
4	ECB	2.053	15.108	7.264	8.142
5	GEO	0.387	4.422	3.104	2.638
6	USD_Return_01	0.576	1.352	1.786	1.238
7	FUND_01	1.256	0.533	1.664	1.151
8	INF	1.458	0.578	1.318	1.118
9	BIST_Return_01	0.431	1.361	1.440	1.077
10	EUR_Return_01	0.541	1.117	1.001	0.886
11	Gold_Return_01	0.311	0.196	1.502	0.669

Note: Ranking is based on the average; numbers are percentages.

Table 3 shows the most important variable in predicting the 1-month participation rate to be the overnight interbank interest rate. As we noted, the ON variable represents the prediction power of the central bank policy rate. Therefore, one can conclude monetary policy to be the most important policy tool affecting the 1-month profit rate in Turkey.

The second most important variable in predicting the 1-month profit rate is the industrial production index. Therefore, one can conclude that, due to the financing mechanism in participation banks being highly related to real economic and trade activity, the industrial production index is highly important in predicting profit rate.

The global monetary policy indicators of FFR and ECB rates also seem to be highly important for the 1-month profit rate. Therefore, the performance of domestic and global monetary policy indicators is more robust relative to the other predictors of profit rate for the very short-term profit rate. As Hassoune (2002) indicated, whenever the default financing in a specific country is based on IB, the depositors will compare their returns with conventional markets. We can say the behavioral standing of depositors in this manner supports criticisms about profit rates converging to interest rates.

Our findings demonstrate the geopolitical risk indicator to be a better predictor of the 1-month profit rate than the returns of alternative financial instruments. The amount of funds in the participation banking industry doesn't appear to be a

better predictor. Table 4 illustrates the performance of a set of predictors for the 1-month deposit rate.

Table 4
Variable Importance Results for Deposit_Rate_TRY01

Rank	Variable	Forest	Bagging	Boosting	Average
1	ON	90.591	43.390	81.516	71.832
2	FFR	5.601	30.040	1.794	12.478
3	IPI	1.916	10.535	9.537	7.329
4	ECB	0.206	10.702	0.586	3.832
5	GEO	0.770	2.290	1.031	1.364
6	EUR_Return_01	0.134	0.706	1.005	0.615
7	USD_Return_01	0.206	1.048	0.584	0.613
8	DEP_01	0.187	0.281	1.287	0.585
9	BIST_Return_01	0.201	0.694	0.597	0.497
10	Gold_Return_01	0.121	0.427	0.861	0.470
11	INF	0.065	-0.112	1.201	0.385

Note: Ranking is based on the average; numbers are percentages.

As Table 4 shows, the overnight interest rate is the most important predictor of a 1-month deposit rate. Although this is the case for Profit_Rate_TRY01, the relative importance of ON is relatively higher for Deposit_Rate_TRY01. Also, compared to the 1-month profit rate model, the relative importance of the industrial production index is relatively lower in regard to predicting the 1-month deposit rate.

Putting domestic and global monetary policy indicators together, we can conclude the more significant share of the prediction power to belong to these interest rates. Thus, the industrial production index is not a strong predictor of deposit rate. This finding might imply that, although the IPI is not the most important predictor of profit rate in the participation banking system, it is more important in regard to setting the profit rate.

The performance of the alternative financial instruments and inflation rate is not highly significant for very short-term deposit rates in the Turkish banking industry.

We also addressed other short-term rates to evaluate whether a difference is found regarding predicting the profit and deposit rates over different maturities. Table 5 illustrates the relative importance of these predictors for a 3-month maturity profit rate.

Table 5
Variable Importance Results for Profit_Rate_TRY03

Rank	Variable	Forest	Bagging	Boosting	Average
1	IPI	41.641	24.609	41.273	35.841
2	ON	32.545	33.096	15.496	27.045
3	FFR	16.287	26.594	20.864	21.248
4	ECB	1.561	7.339	5.268	4.723
5	USD_Return_03	2.213	2.795	2.421	2.476
6	GEO	1.436	1.705	2.902	2.015
7	EUR_Return_03	1.435	1.373	2.063	1.624
8	BIST_Return_03	0.811	1.812	1.908	1.510
9	Gold_Return_03	0.703	0.796	2.915	1.471
10	INF	1.101	0.396	2.633	1.377
11	FUND_03	0.266	-0.516	2.258	0.669

Note: Ranking is based on the average; numbers are percentages.

Table 5 provides evidence for the importance of economic and trade activity in the participation banking pricing of profit rates. Findings for the 3-month profit rate illustrate IPI to outperform its counterparts in predicting the 3-month profit rate in the participation banking industry. Alternative financial instruments do not appear to be good predictors of the participation rate in the 3-month maturity. Table 6 displays the relative importance measures of the set of predictors for the 3-month deposit rate.

Table 6
Variable Importance Results for Deposit_Rate_TRY03

Rank	Variable	Forest	Bagging	Boosting	Average
1	ON	93.112	39.501	73.268	68.627
2	FFR	1.594	27.152	2.730	10.492
3	IPI	2.985	11.540	15.827	10.117
4	ECB	0.347	8.865	0.761	3.324
5	EUR_Return_03	0.281	3.634	1.418	1.778
6	USD_Return_03	0.346	3.668	0.871	1.628
7	BIST_Return_03	0.365	2.058	0.884	1.103
8	GEO	0.414	1.624	0.917	0.985
9	Gold_Return_03	0.197	1.301	1.354	0.951
10	INF	0.236	0.781	1.094	0.703
11	DEP_03	0.123	-0.123	0.876	0.292

Note: Ranking is based on the average, and numbers are in percentages.

For the 3-month deposit rate, our empirical findings demonstrate the dominance of interest rates. The total significance of the relative importance shares of domestic and global interest rates in this model is greater than 80%. The economic activity measure is a weak predictor of a 3-month deposit rate compared to the profit rate for the same maturity. Finally, Tables 7 and 8 provide the relative importance measures of our predictor variables for the 6-month profit rate and deposit rate.

Table 7
Variable Importance Results for Profit_Rate_TRY06

Rank	Variable	Forest	Bagging	Boosting	Average
1	ON	46.990	27.582	34.296	36.290
2	IPI	22.721	16.812	22.222	20.585
3	FFR	17.527	29.443	11.903	19.624
4	ECB	0.649	8.988	3.003	4.213
5	EUR_Return_06	3.937	2.996	4.214	3.716
6	BIST_Return_06	4.068	4.627	2.422	3.706
7	GEO	1.011	4.421	4.850	3.427
8	USD_Return_06	1.770	3.155	3.998	2.975
9	Gold_Return_06	0.386	1.041	5.360	2.262
10	FUND_06	0.433	0.463	4.424	1.773
11	INF	0.506	0.472	3.308	1.429

Note: Ranking is based on the average; numbers are percentages.

The results from the variable importance measure for the 6-month profit rate also favor the role of participation banks being more in touch with the real sector and actual economic activity. Although the domestic monetary policy indicator has the highest predictive power, the industrial production index is highly significant in regard to predicting the 6-month profit rate. The results for Deposit_Rate_TRY06 are illustrated in Table 8, which favors the empirical findings of other short-term maturities.

Table 8
Variable Importance Results for Deposit_Rate_TRY06

Rank	Variable	Forest	Bagging	Boosting	Average
1	ON	47.721	36.232	41.218	41.724
2	FFR	44.460	35.243	33.586	37.763
3	IPI	4.423	10.574	14.127	9.708
4	ECB	0.641	7.754	0.787	3.060
5	BIST_Return_06	0.690	3.232	1.644	1.855
6	DEP_06	0.378	1.720	1.756	1.285
7	GEO	0.311	2.181	1.263	1.252
8	Gold_Return_06	0.828	1.023	1.111	0.987
9	USD_Return_06	0.182	1.637	1.093	0.970
10	INF	0.187	-0.139	2.393	0.814
11	EUR_Return_06	0.180	0.543	1.023	0.582

Note: Ranking is based on the average; numbers are percentages.

The 6-month deposit rate results demonstrate domestic and foreign monetary policy rates to have the highest predictive power compared to their counterparts. The industrial production index has one-tenth of the total reduction in the model purity. The returns from alternative financial instruments have no highly significant predictive power for the 6-month deposit rate.

Different results are found in the literature regarding the predictors of profit rates and deposit rates and whether deposit rates cause profit rates or not. For instance, Erturk and Yuksel (2013) claimed neither banking type to have significant relevance for Turkey, while Ergec and Kaytancı (2014) showed CB deposit rates to Granger cause PBs' profit rate; Yüksel et al. (2017) found the two types of banks to have a significant causal relation. While Ata et al. (2016) found a two-way causal relationship for 12-month maturity rates between the two banking groups, Korkut and Özgür (2017) found interest rates from government securities and foreign exchange rates to affect PBs' profit share rate.

Discussion

This research has investigated the profit rates of PBs and interest rates of CBs for funds collected and attempted to answer whether PBs' profit rates are determined by the same variables or not. Our main findings indicate PBs' profit rates to be more influenced by industrial production, due to these banks being more in

contact with real economic activity. Our contribution to both the literature and to modelling is the addition of the industrial production index and our attempt to transform the discussion to another perspective beyond Granger causality. Rather than discussing the real sector variables, prior research had concentrated on the output variables (i.e., interest rates and profit rates) and conclusions based on the differences between these two variables was somehow misleading as it only revealed conditional causality. Meanwhile, similar research to ours using different variables may show how participation banking differs. At least with this study, our contribution to the literature is that the industrial production index is not a strong predictor of deposit rates but is a strong predictor for profit rates. With regard to predicting 6-month profit rates, the industrial production index is also highly significant. As long as we can prove profit rates to be related to the real sector and some other macroeconomic variables, the criticism that the end result in terms of pricing the product is the same will become a weaker argument. For the time being, a big strand of the literature involves these criticisms' use of Granger causality which just shows that, if two end results follow each other without looking at any other variable, it will appear to lead the movement of both.

Meanwhile, the importance of domestic and global interest rates appears to be undeniably significant in regard to how PBs set their profit rate. One of the practical challenges that PB faces is their requirement to operate under conventional legal and financial frameworks and institutional arrangements (Iqbal & Molyneux, 2005). Interest rates being applied in 95% of the economic activities including all banks effect IFIs, directly and indirectly. Therefore, interest rates may be expected to be one of the most important predictors of profit rates. Still, different perspectives are found that have yet to be investigated in the literature. For instance, leasing as a financial instrument is acceptable in IB. However, conventional banks and IB provide this in almost the same manner. Just because leasing operations are carried out by conventional banks does not make the instrument Islamically unacceptable. If one ignores the pricing mechanism of the leasing, the instrument itself can be Islamically acceptable, and some conventional banking activities are Islamically acceptable as a result.

Another reason might be that all IB does business under conventional legal and financial frameworks at a country or global scale. Therefore, the global macro-economic conditions will affect PB unless they have a different benchmark that is used in a mainly Islamic economic environment. For IB that operates globally, their rates being able to decouple from the global benchmarks like LIBOR is highly unlikely (Azad et al., 2018). Therefore, arbitrage possibilities force Islamic rates to converge with global benchmark rates.

Furthermore, country-specific or institution-specific reasons may exist for the similarity between IB and CB rates. More research needs to be done regarding finding these reasons. For instance, some IBs apply a kind of income smoothing to balance the income distribution in order to be competitive. As such, market-related conditions may also be present.

Another reason may be that, when considering a causality to exist between deposits and profit rates, even if not strict, this may be result from things such as overuse of *murabaha*, rate smoothing, certain regulations, customer behavior, or whether IB policy prefers Sharia compliance or Sharia-approved.

Other dimensions may also exist that could have important in a close relationship between PBs and CBs. For instance, PBs are known based on surveys made with PB employees to employ certain types of pool management techniques that can result in smoothing the pool returns in order to minimize the volatility from one maturity bucket to another because of seasonal fluctuations in return rates or other reasons. This may even be a tool that allows marketing to state PB rates are competitive with CB rates.

Many reasons for the criticism are found among the above-mentioned issues, such as operating in a conventional legal and financial framework, applying global interest rates as a benchmark (whether willingly or unwillingly), and competition-related income smoothing for customers. Çonkar and Gökgöz (2021) provided another perspective where whether the deposit and loan interest rates in traditional banks under strict government regulation and control actually qualify as interest in terms of IB rules.

As can be seen, the literature on this topic is mainly a collection of Granger causality analyses; this needs to be addressed and criticized before jumping to any conclusion that states "conventional banks and participation banks are the same" just because of the result of the Granger causality test. Some authors have used IB rates' dependence on conventional rates to support the argument that PB is a form of masked CB. Islamic scholars who claim Islamic finance to be different from conventional finance need more objective support and empirical evidence (Lee et al., 2017). We argue the historically insanitary conventional basis upon which IB activities are performed to be unable to reveal its power, and this a very hard paradox to solve. In terms of some of the global macro consequences, CBs and PBs can parallel one another due to the lack of necessary and sufficient conditions being available. However, if one concentrates on the differences, these differences can also be seen. If one needs to answer the question "Does any indicator exist that is a determinant of Islamic Bank profit rate but that is unrelated or weakly related

with conventional banking interest rates?", we can say that industrial production index is just such a variable. Future studies can concentrate on some other variables for seeing these differences under very unfavorable conditions for IB institutions.

Conclusion

Research on IB is currently going on in several strands, and whether they really are different than conventional counterparts or not is an important part of this discussion. Islamic economics theoretically claims to be different than conventional economics in terms of its values, applications, and results. As a part of Islamic economics, IB activities are also under investigation in term of whether they are similar or not to conventional banking. In order to test this, different research in various strands of the literature is required.

Our study has examined the most important predictors of profit rates and deposit rates over different maturity periods (1-, 3-, and 6-month) in the Turkish banking industry between January 2008 and December 2019. Our study contributes to the existing literature through its use of machine learning and its focus on whether identical sets of predictors are highly significant in predicting profit and deposit rates in the Turkish banking system.

Our main findings have indicated an apparent distinction between PB and CB. These findings from the machine learning algorithms indicate the industrial production index, being a measure of real economic activity, to be a more significant variable in predicting profit rates regarding PB. However, deposit rates also appear to be highly influenced by domestic and foreign monetary policy rates. Our findings therefore provide evidence showing PBs to have a closer relationship to the real sector and real economic activity compared to CBs.

Unlike conventional banks, one of the leading points of IB is that it is more concerned with the financial capacity and profitability of a project than customers' collateral status. Good projects rejected by traditional banks due to lack of collateral can be financed through the profit-loss sharing structure of IB. Thus, Islamic banks can play an important role in promoting economic development. In any case, this topic's discussion is beyond the scope of this research paper. For example, using an Islamic benchmark rate instead of LIBOR or any other conventional rates remains to be discussed. IBs were born in the conventional system and carry the burden of certain undesired regulations, standards, and market practices of the conventional system. In order for any country to see the expected social and economic benefits of IB, a better regulatory environment under Islamic standards should be set alongside educated market participants at both the supply and demand sides of funds.

References

Amin, M., Isa, Z., & Fontaine, R. (2011). The role of customer satisfaction in enhancing customer loyalty in Malaysian Islamic banks. *The Service Industries Journal*, *31*(9), 1519–1532.

Ata, H. A., Buğan, M. F., & Çiğdem, Ş. (2016). Kar payı oranları ile mevduat faiz oranları arasındaki nedensellik ilişkisi. *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *25*(1), 17–28.

Avcı, T., & Aktas, M. (2015). Katılım bankalarının kar payı ödemeleri ile mevduat bankalarının faiz ödemelerininin birbirlerine yakın olmasının nedenlerinin araştırılması. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *8*(4), 41–51.

Awan, H. M., & Bukhari, K. S. (2011). Customer's criteria for selecting an Islamic bank: Evidence from Pakistan. *Journal of Islamic Marketing*, *2*(1). doi: 10.1108/17590831111115213

Azad, A. S. M. S., Azmat, S., Chazi, A., & Ahsan, A. (2018). Can Islamic banks have their own benchmark? *Emerging Markets Review*, *35*, 120–136. doi: 10.1016/j.ememar.2018.02.002

Bacha, O. I. (2004). Dual banking systems and interest rate risk for Islamic banks. *The Journal of Accounting, Commerce, & Finance – Islamic Perspective*, *8*(1), 1-42.

Barboza, F., Kimura, H., & Altman, E. (2017). Machine learning models and bankruptcy prediction. *Expert Systems with Applications*, *83*, 405–417.

Bashir, B. A. (1984). Successful development of Islamic banks. *Journal of Research in Islamic Economics*, *1*(2), 1–8.

Basuchoudhary, A., Bang, J. T., & Sen, T. (2017). *Machine-learning techniques in economics: New tools for predicting economic growth*. Springer.

Breiman, L. (1996). Bagging predictors. *Machine Learning*, *24*(2), 123–140.

Breiman, L. (2001). Random forests. *Machine Learning*, *45*(1), 5–32.

Chong, B. S., & Liu, M. H. (2009). Islamic banking: Interest-free or interest-based? *Pacific Basin Finance Journal*, *17*(1), 125–144. doi: 10.1016/j.pacfin.2007.12.003

Çonkar, M. K., & Gökgöz, H. (2021). Katılım bankaları kar payı oranlarını etkileyen faktörler: Mevduat faiz oranları ve kar payı oranlarının yakınlığıyla ilgili bir değerlendirme. *İşletme Araştırmaları Dergisi*, *13*(1), 235–251.

Eid, W. K., & Asutay, M. (2019). Introduction. In *Mapping the Risks and Risk Management Practices in Islamic Banking.* John Wiley & Sons. doi: 10.1002/9781119156505.ch1

Ergeç, E. H. (2018). Relationship between rate of returns on foreign exchange Islamic and conventional deposits in Turkey. *Optimum Ekonomi ve Yönetim Bilimleri Dergisi*, *5*(2), 147–162.

Ergec, H., & Kaytanci, G. B. (2014). The causality between returns of interest-based banks and Islamic banks: The case of Turkey. *International Journal of Islamic and Middle Eastern Finance and Management*, *7*(4), 443–456. doi: 10.1108/IMEFM-07-2014-0072

Ertürk, M., & Yüksel, S. (2013). Causal link between Islamic and conventional banking: Evidence-from Turkish banking sector (Working Paper 6). Istanbul:Research Department of Borsa Istanbul.

Friedman, J. H. (2001). Greedy function approximation: A gradient boosting machine. *Annals of Statistics*, *29*(5), 1189–1232. doi: 10.1214/aos/1013203451

Freund, Y., & Schapire, R. E. (1997). A decision-theoretic generalization of on-line learning and an application to boosting. *Journal of Computer and System Sciences*, *55*(1), 119–139.

González, C., Mira-McWilliams, J., & Juárez, I. (2015). Important variable assessment and electricity price forecasting based on regression tree models: Classification and regression trees, bagging and random forests. *IET Generation, Transmission & Distribution*, *9*(11), 1120–1128.

Gök, R. (2021). On the causal relationship between deposit rates in conventional banks and profit-sharing rates in Islamic banks in Turkey. *Doğuş Üniversitesi Dergisi*, *22*(1), 21–37. doi: 10.31671/dogus.2021.459

Hacker, R S. & Hatemi-J, A. (2006). Tests for causality between integrated variables using asymptotic and bootstrap distributions: Theory and application. *Applied Economics. 38*, 1489–1500.

Haron, S., & Ahmad, N. (2000). The effects of conventional interest rates and rate of profit on funds deposited with Islamic banking system in Malaysia. *International Journal of Islamic Financial Services*, *1*(4), 1–7.

Hassoune, A. (2002). Islamic banks' profitability in an interest-rate cycle. *International Journal of Islamic Financial Services*, *4*(2), 1–13.

Hastie, T., Tibshirani, R., & Friedman, J. (2017). *The elements of statistical learning: Data mining, inference, and prediction*. Springer.

Iqbal, M., & Molyneux, P. (2005). Challenges facing Islamic banking. In *Thirty years of Islamic banking* (pp. 105–122). Springer.

Islamic Corporation for the Development of the Private Sector. (2020). ICD-REFINITIV: Islamic finance development report: Progressing through adversity. Retrieved from https://icd-ps.org/uploads/files/ICD-Refinitiv IFDI Report 20201607502893_2100.pdf

Ito, T. (2013). Islamic rates of return and conventional interest rates in the Malaysian deposit market. International Journal of Islamic and Middle Eastern Finance and Management, 6(4). doi: 10.1108/IMEFM-11-2012-0113

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning* (Vol. 112). Springer.

Korkut, C., & Özgür, Ö. (2017). Is there a link between profit share rate of participation banks and interest rate?: The case of Turkey. *Journal of Economic Cooperation and Development*, *38*(2), 135–158.

Lee, S. P., Auzairy, N. A., Isa, M., & Choong, C. K. (2017). Dynamic relation between Islamic & conventional lending rates in Malaysia. *Afro-Asian Journal of Finance and Accounting*, 7(1), 65–83. doi: 10.1504/AAJFA.2017.082929

Nguyen, C. V., & Manrique, J. (2011). Behavior of lending and deposit rates in the economy where conventional and Islamic finance systems coexist: The case of Malaysia. *Banks and Bank Systems*, *6*(2), 15–22.

Saeed, S. M., Abdeljawad, I., Hassan, M. K., & Rashid, M. (2021). Dependency of Islamic bank rates on conventional rates in a dual banking system: A trade-off between religious and economic fundamentals. *International Review of Economics & Finance*, in press. doi: 10.1016/j.iref.2021.09.013

Sukmana, R., & Ibrahim, M. H. (2017). How Islamic are Islamic banks? A non-linear assessment of Islamic rate – Conventional rate relations. *Economic Modelling*, *64*, 443–448. doi: 10.1016/j.econmod.2017.02.025

Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, *66*(1-2), 225–250.

Tura, Ü., & Kaya, F. (2019). Katılım bankaları tarafından katılım hesaplarına uygulanan kar payı ödemeleri ile geleneksel bankalar tarafından mevduatlara uygulanan faiz oranları arasındaki ilişkininin analizi. *Econder International Academic Journal*, *3*(2), 187–202. doi: 10.35342/econder.653208

Venardos, A. M. (2005). Islamic financial products. In *Islamic banking and finance in South-East Asia* (pp. 62–91). World Scientific Book. doi: 10.1142/9789812569394_0005

Yoon, J. (2021). Forecasting of real GDP growth using machine learning models: Gradient boosting and random forest approach. *Computational Economics*, 57(1), 247–265.

Yüksel, S., Canöz, İ., & Özsarı, M. (2017). Causality relationship between interest rate of deposit banks and profit share rate of Islamic Banks in Turkey. *IKONOMIKA, 2*, 131–148. doi: 10.24042/febi.v2i2.189