An empirical model for bank branch planning: the case of a Turkish Bank

Türkay Dereli[*1], Alptekin Durmuşoğlu[1], H. Ali Ata[2], Furkan Gür[2]

[1]*University of Gaziantep, Faculty of Engineering, Department of Industrial Engineering, 27310, Gaziantep, Turkey*

[2]*University of Gaziantep, Faculty of Economics and Administrative Sciences, Department of Business Management, 27310, Gaziantep, Turkey*

Abstract

This paper addresses the relationship between the factors (including socioeconomic and demographical factors) and the total deposits that each of bank branches is able to collect. A multiple regression model is established in order to explain the variability in total deposit, in other words, to determine the dependency of the *total deposit* to other selected factors. The empirical model has proved to be a suitable tool for predicting the total deposits to be collected by the bank branches. A case study is also given in which, future values of the model predictors forecasted by a Turkish commercial bank (it is called as "Bank X" throughout the paper, since the bank wants to be kept secret) are plugged into the regression model. Based on the forecasted values of total deposits, the numbers of bank branches for years 2004-2010 are then projected by using the two different *deposit efficiency* scenarios. This paper demonstrates that the regression models explaining the total deposit along with the forecasted values of the predictors can be used as a decision-support tool to establish a long-term branching policy of the banks.

Keywords: Deposit forecasting; Bank branch planning; Regression analysis

[*] *Corresponding Author:* dereli@gantep.edu.tr; turkay.dereli@gmail.com

1. Introduction

Bank branches are considered to be the entities which fulfill the primary role of distributing financial products and services. Therefore, number of bank branches and *their distribution and focus* (branches of commercial, individual and institutional) with the corresponding numbers of employee, are regarded as critical factors which influence the overall profitability of the banks. Thygerson (1991) has reported that little academic search has been done on the subject of branch performance. Avkiran (1995) has also underlined the same issue in his PhD thesis. The determination of a branching policy has been generally based upon *the forecast of deposit demand* in the literature. Academic research into branch performance has been studied as subject of marketing research and operations research. Those studies investigated the relations between *demographic and socio-economic factors* and *branch performance* pointers like deposit.

Soenen (1974) described three methods for projecting deposit potential in a defined site (location, province). The first of these three methods is the *"statistical method"* including the set up of a regression equation. The second method is the *"summary and relative method"* which estimates the deposit per family and multiplies it with the total number of families. The third method is the *"analysis of market by type of deposit"* which calls for individual deposit, commercial deposit, industrial deposit and public deposit, and finally adds them up. In the third method, the deposits are estimated by the interviews with local business and by investigation of financial statements of local actors.

Doyle et al. (1979) employed *stepwise regression* to explore branch potential to support branch location decision. They suggested that data belonging to a new site can be entered into regression equation to measure the potential of the site. In their work, independent variables are selected as percentage of self-employed and population aged over 65 years under the trade area characteristics; number of major retailers within x meters under location features and etc. They also used several dependent variables as measures of potential such as average value of personal current accounts, number of personal current accounts and new personal loans each year.

Olsen and Lord (1979) hypothesized that seven *market era characteristics* are effective on the branch performance. These characteristics were; purchasing power (number of households x mean household income), employment in area, retail square footage, median household income, percentage of housing-units renter occupied, external competition (number of branches of other commercial banks), internal competition (presence of another branches of the same bank). They employed regression analysis using these variables. Dependent variables were selected as *checking-account* deposits and *saving account* deposits. The greatest part of the variation was explained by median household income. Negative coefficients (external competition) show the inversely proportion of independent variable. Result of their analysis is presented in Table 1.

Table 1. Results of stepwise regression on market era (Olsen and Lord, 1979)

Model	**Variables in the equation**	**Regression coefficient**	**Cumulative R^2**
Checking Account Deposits	Median household income	1.2706	0.55
	Retail square footage	0.2365	0.72
	External competition	-8.6889	0.77
Saving Account Deposits	Purchasing power	0.0021	0.57
	Employment	0.0375	0.77
	Percent renter	-1.2973	0.81

Several studies has employed different variables to explain the variability in branch performance of the banks. Table 2 summarizes the variables used by previous studies reported in the literature.

The determination of structured and effective branching policies is becoming a more attractive research area due to increasing competitiveness in the banking sector in many countries as well. The effects of bank branches on market size in Norway was discussed by Kim and Vale (2001). They found that a bank specific branch-network does not confer externality on other banks. As a result, branch network affects only market shares but not market size. Calcagnini at al. (1999) focused on the determinants of the bank branch expansion in Italy. The principal findings were: (i) variables describing existing market structure and recent past branch expansion by the bank and its rivals strongly influence *de novo* branching, (ii) banks seek targets of opportunity when siting branches in provinces where they have a presence, where many communes in a province are unserved, and where branches per capita is low, (iii) there is only a weak relation between a province's level and change in per capita GDP and *de novo* branches, (iv) banks which merge are more likely to have *de novo* branches in a province than other banks, and (v) profitable banks with large number of workers per branch and large amounts of loans relative to deposits are likely to have more *de novo* branches. Cohen and Mazzeo (2005) investigated the relationship between branch networks and competition in a cross-section of rural banking markets, distinguishing among single market (or community) banks, thrift institutions, and multi-market banks. Carlson and Mitchener (2005) has recently explored the characteristics that made a bank a more likely target of a takeover, how competing unit banks responded to the presence of branch banks and how branching networks affected the probability of survival of banks during the great depression.

In this study, a multiple regression model is set up in order to explain the variability in total deposit, in other words, to determine the dependency of the *total deposit* to other selected factors. The model has proved to be a suitable tool for predicting the total deposits to be collected by the bank branches. A case study is also presented to check the effectiveness of the model. For the case study, future values of the model predictors forecasted by a commercial bank in Turkey (it is called as "Bank X" throughout the paper, since the bank wants to be kept secret) are substituted into the developed regression model. Based on the forecasted values of total deposits, the numbers of bank branches for years 2004-2010 are then projected by using the two different *deposit efficiency* scenarios.

The remainder of the paper is organized as follows. Section 2 provides the information about Turkish banking industry and branching problems. Data conversion and linear regression model are described in Section 3. Forecasted values of predictors and branch location planning are presented in Section 4. Section 5 discusses the limitations of the model and presents the concluding remarks.

Table 2. Summary of the variables to explain the variability in branch performance of the banks (Avkiran, 1995)

Variable	**Work**
Age of Branch	Clawson (1974), Doyle et al.(1979), Frerichs (1990), Rose (1986)
Average Account Balances	Doyle et al.(1979), Olsen and Lord (1979)
Competition	Clawson (1974), Olsen and Lord (1979), Doyle et al.(1979), Chelst et al. (1988)
Convenience	Heald (1972), Clawson (1974), Soenen (1974)
Household Income	Soenen (1974), Olsen and Lord (1979), Rose (1986), Min (1989), Frerichs (1990)
Managerial Competence	Rose (1986)
Number of New Accounts	Doyle et al.(1979), Rose (1986)
Population	Heald (1972), Clawson (1974), Soenen (1974), Doyle et al.(1979), Clawson (1974), Min (1989)
Population Growth Rate	Soenen (1974), Min (1989)
Privite Dwellings Rented (%)	Clawson (1974), Soenen (1974), Olsen and Lord (1979), Rose (1986)
Quality	Davenport and Sherman (1987), Eccles (1991), McDonell and Rubin (1991)
Staff Numbers	Heald (1972)

2. Branching policy in Turkish banking industry

Banking industry forms a dominating part of the Turkish financial system in which *branching policy* is a critical decision for the profitability of the banks. It is obviously required to use some analyses, regulations and procedures for building and managing a proper and working branching scheme. In the past, the banks operating in Turkey did not have a *"road map"* to establish their branching policies. However, the need of urgent change in banking including their branching policies showed itself in recent banking and economic crises. Some of the banks went bankruptcy, some were taken over by government funds, many branches of the banks were closed down and some of them were merged. Privatization of the state banks was also promoted during the past 5 years. In addition, foreign banks were encouraged to operate in Turkey. The Turkish banking sector has undergone dramatic changes in last several years fostered by mergers and acquisitions, expansion and the arrival of new foreign players. Table 3 summarizes the changes in the number of banks and their branches in Turkey. For the time being, there are a total of 47 banks operating with 6162 branches in Turkey. As can be seen from Table 3, while the number of private banks decreases, the number of their branches increases. (This result is also consistent with the information given in a study of Portuguese banks by Barros (1995) who reported that privatized banks were more likely to expand than other banks and that existing (incumbent) banks did not respond to branches opened by new entrants). It has been recognized that there has been a strong need for more research on the determination of the branching policy in Turkish banking industry.

Table 3. Number of commercial banks and branches in Turkey

	Year 2000		**Year 2005**	
	# of banks	**# of branches**	**# of banks**	**# of branches**
Banks owned by State	4	2.834	3	2.035
Private Banks	28	3.783	17	3.799
Banks Taken Over by Government Funds	11	1.073	1	1
Foreign Banks	18	117	13	393
Total	61	7.807	34	6.228

In order to resolve the factors effective on the branching policies, the authors communicated with the general managers of commercial banks operating in Turkish banking sector. It has been recognized from these special communications and survey that there has been no distinguishing factor as well as no structured frameworks are generally used. Although there are many factors mentioned, these are generally classified into five groups which are; *socio-economical indicators of sites (provinces or locations where branches operate), missions of the banks, environmental issues, status (prestige)* and *cost considerations*. Among these factors, socio-economical indicators are considered in the model proposed in this study since they are considered to be the *"general factors"*. Therefore, the model proposed can be used as a preceding decision aid in the determination process of branching policy, and the other specific factors can also be considered for the final decision.

3. Model

The "deposit" is one of the main interests in banking industry. Branching decision (i.e., locating/closing a branch) is made upon the possible collectable deposit amounts of a candidate site (city). In order to establish a promising branching policy, it is required to have a simple and reliable empirical model which estimates collectable deposit amounts of each site. Multiple linear regression models have been extensively used to predict the potential total deposit amounts (Avkiran, 1995). This paper presents a multiple linear regression model based on historical data provided by Bank X and explains the total deposit collected by Bank X for 72 sites (cities). The values of the regressors (which are estimated by the Bank X's information office) are inserted into the regression model to forecast possible *"collectable deposit amounts"* of each site.

3.1 Statistical Design

Regression analysis focuses on the form of the relationship between variables (Krzanowsk, 1988). The purpose of regression analysis is to assess the relative impact of a predictor variable on a specific outcome such as total deposit. The linear regression is a straight line through the data that predicts *Y* based on X *or* X_i*'s.* Multiple linear regression analysis creates an equation to predict the scale of the dependent variable, given the values of independent variables.

In the social sciences, multiple regression analysis is very widely used in research (Elinor and Eric, 1998). The critical question before implementing the multiple regression is "what should be the best predictor of ...". In this study, the question is replaced with "what is the best predictor of total deposits collected by a commercial bank in a certain location?" Several different techniques can be used for the determination of true predictors in regression models. Using "expert ideas" is one of the most widely used methods for determination of the predictors. In this study, ten top-managers of Bank X were asked to prepare a list of possible predictors of the total deposit amounts. They provide a list of predictors on which they had a consensus. *Population (number of individuals living in each site), number of firms in the manufacturing sector, number of employees, number of flats, number of tax payers, gross domestic product per capita, public investment amounts* are the predictors proposed in their list. Some other predictors (efficiency and productivity of the bank branches) are not considered due to the problems about the accessibility of the data. It should also be noted that Table 2 lists the previous studies which use the same/similar predictors proposed in this study for the total deposit estimation.

3.2 Selection of true variables

The predictors determined by the managers of Bank X are still called as *"Candidate"*. It is required to check some assumptions before naming them as: "True Predictors". Predictability of a multiple linear regression model increases when the independent variables are not linearly correlated (colinearity) among themselves. The Pearson Correlation Coefficient (PCC) or coefficient of correlation (Neter and Wasserman, 1990) was introduced by Galton in 1888 and developed later by Pearson (1896). PCC measures the linear strength of relations.

Correlation matrix of the candidate predictors are shown in Table 4. Correlation values in this matrix are all significant for $p<0.05$. *"Number of firms in the manufacturing" (X2)* is strongly correlated with *"Public investment amount" (X7).* Inserting both "X2" and "X7" into the model will be a duplication of the predictors and will decrease the reliability of the model. Therefore, the one which is more correlated with the dependent variable (total deposit amount) should be included in the model.

Table 4. Correlation matrix of candidate predictors

PCC	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*
X1	1	0,141	0,105	0,201	0,138	0,223	0,245
X2	0,141	1	0,124	0,203	0,154	0,32	0,967
X3	0,105	0,124	1	0,04	0,217	0,301	0,08
X4	0,201	0,203	0,04	1	0,103	0,182	0,312
X5	0,138	0,154	0,217	0,103	1	0,204	0,147
X6	0,223	0,32	0,301	0,182	0,204	1	0,182
X7	0,245	0,967	0,08	0,312	0,147	0,182	1

Where:

X1: *Population (number of people living) in each site (city);*

X2: *Number of firms in the manufacturing sector in each site;*

X3: *Number of employees in each site,*

X4: *Number of flats in each site;*

X5: *Number of tax payers in each site;*

X6: *Gross domestic product per capita in each site (New Turkish Lira, YTL);*

X7: *Public investment amount spent in each site (New Turkish Lira, YTL).*

Before setting the model, it is required to check linearity between the predictors and the dependent variable ("total deposit"). That is because of two reasons. The first reason is about the linearity of the model. Each predictor should be linearly correlated with the "total deposit". The second reason is the necessity for elimination of the duplicating predictors ("X2-X7"). The calculated PCC values of the predictors with the "total deposit" are shown in Table 5.

Table 5. PCCs of the candidate predictors versus the total deposit

Candidate predictor	PCC	*p*
Population (X1)	+0.919	0
Number of Firms in Manufacturing (X2)	+0.967	0
Total Number of Employees (X3)	+0.336	0.204
Total Number of Flats (X4)	-0.242	0.271
Number of Tax Payers (X5)	+0.284	0.213
GDP per capita (X6)	+0.700	0
Public Investment (X7)	+0.740	0

P-value shows the probability of rejecting the null hypothesis (indicating there is not a linear relation) although the null hypothesis is true. P-values which are tabulated in Table 5 are significant to reject ($p<0.3$) the null hypothesis.

In this study, *"rules of thumb for the range of coefficients"* (Hair, 2000) are used to classify relations of the predictors like *"none"*, *"weak"*, *"moderate"*, *"strong" and "very strong"*. According to the strength of relations described, the total deposit is weakly correlated with the "number of flats" (X4), "number of tax payers" (X5) and "number of employees" (X3). The total deposit is correlated with the "GDP per capita" (X6) and "population" (X1). Therefore "number of flats" (X4), "number of tax payers" (X5) and "total number of employees" (X3) are excluded from the model due to very low degrees of correlation. The comparison between "number of firms in manufacturing" (X2) and "public investment" (X7) shows that X2 is more correlated (0.967>0.740) with the dependent variable. Therefore, "Public investment" (X7) excluded to avoid duplication.

3.3 Regression Model

Ordinary least square (OLS) multiple linear regression is used to evaluate the influence of "population" (X1), "number of manufacturing firms" (X2) and "GDP per capita" (X6) on "total deposit (Y)". Steps in the regression analysis are as follows:

Step 1 - Linear regression is run for independent variables (true predictors) versus "total deposit" separately.

Step 2 - The squares and cubes of each independent variable are calculated. Step 1 is then repeated for the predictors (for the transformed data) versus "total deposit" to see whether linearization improves the model, or not (see Table 6).

Step 3 - R values of each model with the transformed variables is compared with the linear model. The one with the higher R value is selected to be employed in the model.

Table 6. Models with the transformed variables

Model Number	**Model Variables**	**R^2 Value**
Model 1	{X1, X2, X6}	0.725
Model 2	{$X1^2$, X2, X6}	0.803
Model 3	{$X1^3$, X2, X6}	0.811
Model 4	{X1, $X2^2$, X6}	0.698
Model 5	{X1, $X2^3$, X6}	0.672
Model 6	{X1, X2, $X6^2$}	0.702
Model 7	{X1, X2, $X6^3$}	0.705

As can be seen in Table 6, R value of the *Model-1* is 0.725. R value can only be increased by using "square" or "cube" of the population variable as in the case of *Model 2* and *Model 3*, respectively. It is found that the *"Model-1"* explains 72.5% of the variability and *"Model 3"* explains of 81.1 % of variability in the "total deposit". Therefore, the *"cube of population"* is employed instead of "population" variable in the regression model. Results of the multiple linear-regression analysis of the *Model-3* are given in Table 7.

Table 7. Output of the regression analysis

Variables in the model	Coefficients of variables
GDP per Capita (X6)	0.00045190 ($ß_1$)
Public Investment (X7)	0.00011672 ($ß_2$)
Cube of Population ($X1^3$)	0.00020187 ($ß_3$)
Constant Term	-121.46

Source	D.F	Sum of Squares	Mean Square	F Value	Prob < F
Model	3	6688728	2229576	1234.934	**<0.001**
Error	716	1292682	1805.42		
Total	719	6861410			

Total Deposit = (0.00045190) X6 + (0.00011672) X7 + (0.00020187) $X1^3$ – 121.46

R^2 = 0.811
R^2 Adjusted= 0.810

Three variables *(GDP, public investment and cube of population)* are used as "true predictors" of the "total deposit" in the regression model. The variables GDP, public investment and cube of population explain 81% of the variability in the "total deposit". The *"F critical value"* for 3 as numerator and 716 as denominator degrees of freedom is 5.4803, which captures an upper-tail area of 0.001. This proves that the overall model can be used as a suitable tool for predicting the total deposits to be collected by the bank branches of Bank X.

Following hypotheses are used for testing the necessity for predictors of the model.

H_0: $ß_1 = ß_2 = ß_3 = 0$
H_1: $ß_J \neq 0$ for at least one j

Where; **$ß_1$**, **$ß_2$** and **$ß_3$** are the coefficients of the predictors (X6, X7, X1 respectively).

A *t-test* is employed to see whether the observed regression coefficients come from a population in which the true regression coefficients are equal to zero, or not. At the significance value associated with the t-tests (%95 for this case), null-hypothesis that the observed sample regression coefficients come from a population can be rejected. Both regression coefficients, the intercept and the slope, differ significantly from zero. There are also some other certain assumptions related with the residuals. Residual, is the difference between the calculated mean value of Y (this is also the fitted value as determined by the regression line) and the actual observed value of Y for a given value of the explanatory variable. It is assumed that the residuals are distributed normally in multiple regression. The normality plot for the fitted model is presented in Figure 1. Ryan-Joiner test result appears 0,989. The critical value for α=0.10 is 0.9847. The test statistic value captures lower-tail area 0.10. Since 0.989>0.9847, the null hypothesis of normality cannot be rejected.

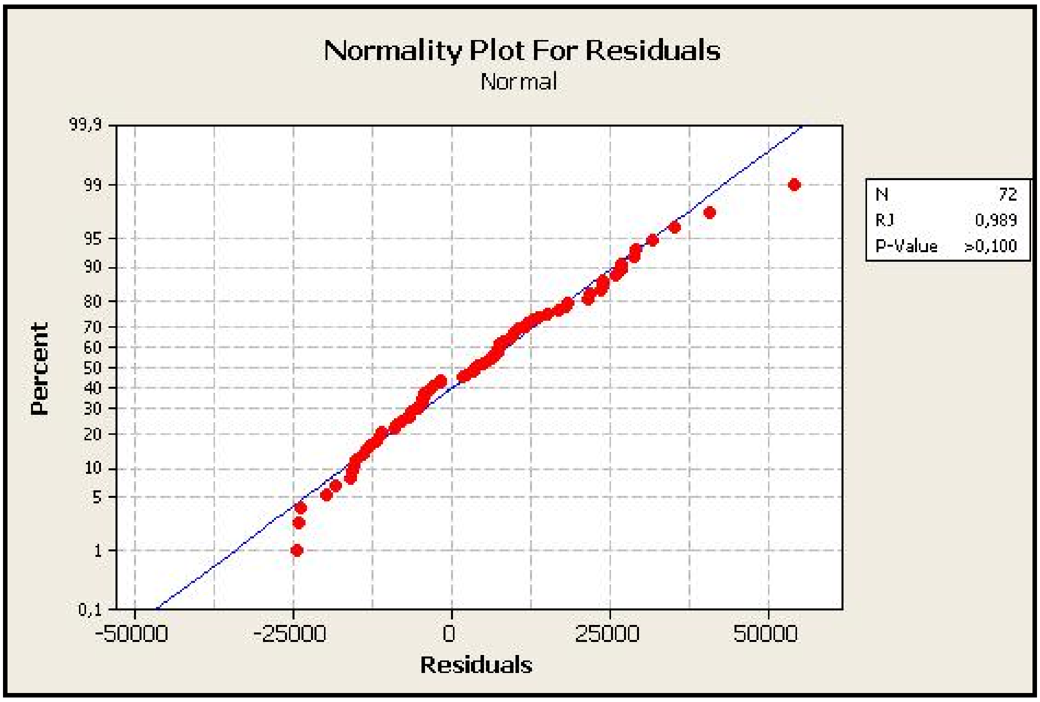

Figure 1. Ryan-Joiner test for residuals

A plot of residuals versus fitted values by the order *in which the data were entered* helps to identify abnormal data points. Figure 2 shows that there is not a certain pattern which violates the assumptions.

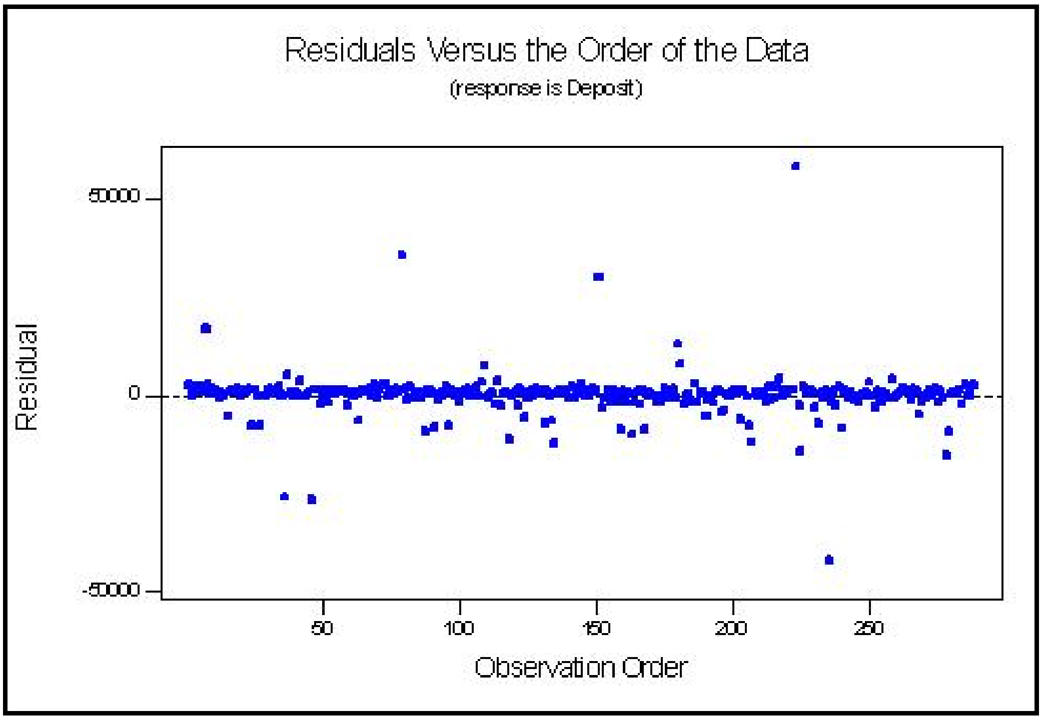

Figure 2. Residual versus order of the data

3.5 Data

Data used in this study covers the total deposit amounts collected by the Bank X during the years 1995-2004 for 72 sites (720 cases; n=720). Data were supplied by Bank X's own headquarter. Collected amount of total deposit is considered to be *strategic data*; therefore it is not allowed to be published completely. In Table 8, a section of the corresponding total deposit values are presented for year 2005. Since the inflation is highly effective on the related years (1995-2004), all monetary terms deflated (1995's Turkish Lira). The *"Inflation rate"* obtained from *State Institute of Statistics of* Turkey for deflation.

Table 8. Collected total deposit amounts of cites (cities) for year 2005

Site	Total Deposit *	Site	Total Deposit *
İstanbul	12.137.530,48	Zonguldak	177.748,2
Ankara	5.056.703,24	Çorum	77.614,92
İzmir	1.647.603,12	Elazığ	80.962,68
Konya	292.675,68	Ağrı	11.238,92
Bursa	748.162,44	Giresun	74.683,26
Adana	476.564,52	Isparta	92.762,04
Antalya	654.296,08	Çanakkale	91.095,96
Mersin	353.624,52	Osmaniye	34.034,04
Şanlıurfa	56.242,32	Batman	17.747,16
Diyarbakır	75.126,6	Muş	11.594,64
Gaziantep	222.535,36	Edirne	102.771,48
Manisa	190.026,92	Aksaray	74.955,48
Hatay	212.701,92	Bitlis	8.379,84

* Unit of Total Deposit Amounts: Thousand YTL (New Turkish Lira)

Note: 1 YTL (New Turkish Lira) = 1000000 TL (Turkish Lira) = 1.4131 US Dollars, The Exchange Rate of Central Bank of The Republic of Turkey, http://www.tcmb.gov.tr/yeni/eng/, December 25th, 2006.

4. Bank branch planning

Bank X strategically traces several local variables including "GDP", "public investment", and "population" of each site. They calculate the future projection of these variables using *trend analysis* method. The forecasted values by Bank X were plugged into the *regression model* established in this study (See Table 7) in order to calculate "total deposit" of each site between the years 2004-2010. Bank X has a branch classification system according to *deposit performance* of the branches. For example, "Class A" branch is expected to collect an average of 50.000.000 YTL (New Turkish Lira) deposit per year (THE BEST CASE SCENARIO), whereas "Class C" branch is expected to collect an average of 25.000.000 YTL deposit per year (THE WORST CASE SCENARIO). These expected amounts were determined by the headquarter office of Bank X. The classification scheme of the Bank X is used to estimate the number of branches for each site in between the years of 2005-2010. The forecasted total deposits are divided by 50.000.000 YTL to determine the best case scenario. Similarly, the forecasted total deposits are divided by 25.000.000 YTL to determine the worst case scenario. The forecasted values of *number of branches* which belongs to one of the major city of Turkey are presented in Table 9. Bank X has been well-satisfied with the use of the *regression model* established in this study to predict the number of bank branches.

Table 9. Forecasted number of branches

Year	**Actual**	**Total number of branches in "the best case scenario"**
2005	54	58
2006	60	61
2007	X	64
2008	X	67
2009	X	72
2010	X	77

5. Discussion and concluding remarks

The Turkish banking industry has undergone dramatic changes in last several years due to privatization, amalgamation of the banks, acquisitions, expansion and new entrants, etc., as well as the new regulations of the government of Turkey which goes through the EU (European Union) membership process. This has significantly changed the market structure and therefore, determination of effective bank-branching policies has been a critical issue. For instance, banks have to operate with *both effective and lower number of branches*.

The relationship between "total deposit" and the factors (including socioeconomic and demographical factors) is investigated in this paper. A multiple regression model is established in order to explain the variability in total deposit, in other words, to determine the dependency of the *total deposit* to other selected factors. In view of the fact that the determination of branching policies of the banks is a strategic matter, the regression model presented in this paper is intended to provide a decision support tool for the managers of the commercial banks as well as it can be used for the reorganization of the bank branches. It has been found that *public investment* amounts, *GDP* and *population* are statistically meaningful to explain the "total deposit" using multiple regression analysis, where the greatest fraction of the variation was explained by the GDP. Trial of linearization of the independent variables has shown that *cube of the population variable* improves the regression model. One other distinguishing feature of this study has been the elimination of the *inflation effect* on the monetary values. Future values of the model predictors forecasted by a commercial bank (it is called "Bank X" throughout the paper) are plugged into the developed regression model. Based on the forecasted values of total deposits, the numbers of bank branches for years 2004-2010 are then projected by using the two different *deposit efficiency* scenarios. The model has proved to be a suitable tool for predicting the total deposits to be collected by the bank branches. Bank X has been well-satisfied with the use of *regression model* established in this study to predict their number of branches. The proposed model can be used to improve the bank branching decisions. However, they should have more sophisticated databases to increase the validity of models.

The proposed model can be adapted to changing market conditions using several other case scenarios. This model can be improved by releasing some of the limitations in future studies. For example, this model is not expected to be sensitive to the changes in *customer behavior* like *quality perception*. Moreover, some other factors like external/internal competition and cost considerations can also be employed in future. Some of the variables may loose its validity by the time and employment of some new variables may be required in case of paradigm shifts. Hence, periodic review of the model may be essential to keep the model up to date.

References

Avkiran NK (1995) A multivariate model of integrated model of branch performance and potential focusing on personal banking. PhD Thesis. Victory University of Technology

Barros PP (1995) Post-entry expansion in banking: the case of Portugal. International Journal of Industrial Organization 13:593-611

Calcagnini G, Riccardo DR, Hester DD (1999) Determinants of bank branch expansion in Italy. Working Paper, University of Wisconsin, Madison. Available at www.ssc.wisc.edu/econ/archive/wp9932

Carlson M, Mitchener KJ (2005) Branch banking, bank competition, and financial stability. Finance and Economics Discussion Series. Board of Governors of the Federal Reserve System (U.S.) 20:5-10

Chelst K, Schultz J, Sanghvi N (1988) Issues and decision aids in designing branch networks. Journal of Retail Banking 10:5-17

Clawson CJ (1974) Fitting branch locations, performance standards, and marketing strategies to local conditions. Journal of Marketing 38:8–14

Cohen A, Mazzeo M (2005) Investment strategies and market structure: an empirical analysis of bank branching decisions. Working paper

Davenport TO, Sherman HD (1987) Measuring branch profitability. The Banker's Magazine 17:34-38

Doyle P, Fenwick I, Savage GP (1979) Management planning and control in multi branch banking. Journal of Operation Research Society 30:105-111

Eccles RG (1991) The performance measurement manifesto. Harvard Business Review; 69:131-137

Elinor S, Eric T (1998) Research Strategies in the Social Sciences. Oxford University Press

Frerichs GR (1990) The decision matrix maps branch profit potential. Bank Marketing; 22:29-32

Galton F (1888) Correlations and their measurements, chiefly from anthropometric data. Proc R Soc London

Hair J (2000) Marketing Research, McGraw-Hill, Singapore

Heald GI (1972) The application of the automatic interaction detector (AID) programme and multiple regression techniques to assessment of store performance and site selection. Operational Research Quarterly 23:445-57

Kim M, Vale B (2001) Non-price strategic behavior: The case of bank branches. International Journal of Industrial Organization 19:1583–1602

Krzanowsk WJ (1988) Principles of multivariate analysis: a user’s perspective. Oxford, England: Clarendon

McDonell ED, Rubin MJ (1991) A scorecard for branch performance. Financial Managers’ Statement 13:46-56

Min H (1989) A model-based decision support system for locating banks. Information and Management 17:207-215

Neter J, Wasserman W, Kutner MH (1990) Applied linear models: regression, analysis of variance, and experimental designs. Homewood, Ill: Irwin

Olsen LM, Lord JD (1979) Market area characteristics and branch bank performance. Journal of Bank Research pp.102-110

Pearson K (1896) Mathematical contributions to the theory of evolution: III. Regression heredity and panmixia. Phil Trans R Soc Lond Series A

Rose PS (1986) The bank branch: which way to the future? Canadian Banker 93:42-50

Soenen LA (1974) Locating bank branches. Industrial Marketing Management 3:211-228

Thygerson KJ (1991) Modeling branch profitability. Journal of Retail Banking 13:19-24