

## VI. Data Considerations

The Bank of Japan provided a time series of monthly estimates of non-performing loans for the period January 1980 through May 2001. The non-performing loans are given in 100 Million Yen. Both bank specific and macroeconomic data were utilized for the regressors in the model.

Here non-performing loans represent total non-performing loans for the Bank of Japan.

The Bank of Japan includes following banks:

- a) City Banks
- b) Trust Banks
- c) Regional Banks I
- d) Regional Banks II
- e) Long Term Credit Banks

Real GDP (Billion Yen) are provided by the Economic and Planning Agency of Japan. The growth rate of real GDP has been calculated as a percentage change from the previous month.

The central bank discount rate, long term lending rate and unemployment rate are in percents (%). The overall wholesale price index (all commodities) is based on 1995=100. The figures for the central bank discount rate, long term lending rate, unemployment rate and overall wholesale price index come from the Economic and Planning Agency of Japan.

In time series setting, a common problem is auto-correlation or serial correlation of the disturbance term across periods. A source of auto-correlation could be the smoothing procedures used by the government agencies that often build autocorrelation into series that might otherwise be non-auto correlated.<sup>12</sup> When auto-correlation is present, OLS is not efficient.

The second problem associated with time series data is heteroscedasticity. Regression disturbances whose variance is not constant across observations are heteroscedastic.<sup>13</sup>

These problems can make the Ordinary Least Square inefficient. The OLS can be adjusted by AR(1)<sup>14</sup>, Hilderth-Lu and Generalized Least Squares (GLS).

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<sup>12</sup> See William H. Green, "Econometric Analysis" (2000), Ch-13 *Autocorrelation Disturbance* pp.525-530

<sup>13</sup> See William H. Green, "Econometric Analysis" (2000), Ch-12 *Heteroscedasticity* pp.499

<sup>14</sup> See William H. Green "Econometric Analysis" (2000), Ch-13 *Autocorrelation Disturbance*, pp.528-536, *Forecasting in presence of Auto-correlation*, pp.553-555

## **Overview of economic variables included in the model before and during the banking crisis:**

The model is based on the following five independent variables:

- 1- economic growth rate in real GDP (%)
- 2- central bank discount rate (%)
- 3- long term lending rate (%)
- 4- unemployment rate (%)
- 5- and overall wholesale price index based on all commodities (1995=100).

The subsequent discussion is about these variables and the relationship between each of them and the banking crisis. My research on the banking crisis shows that these selected independent variables were severely affected during this period. Later in this section, we will observe in the graphic presentation the remarkable change in these variables before and after the banking crisis.

### **1-GDP**

A weak financial system affected the growth of the economy for most of the 1990's. The bad loan problem inherited from the bubble years continued to fester throughout the decade, contributing to unprecedented bank failures in late 1997 and a sharp loss in confidence. After a short-lived recovery in 1996, the economy moved back into recession in early 1997.

For the years 1998, 1999, 2000 and 2001 GDP growth rate was -1.1, 0.8, 1.5 and -0.2 percent.<sup>15</sup> According to the survey reported in The Economist, "The Bank of Japan forecasts a contraction of 0.9-1.2% for the year 2002."<sup>16</sup>

The growth rate of GDP before and during the banking crisis is given in Table-2(a) and Table-2(b) respectively. Similarly, Fig-2(a) and Fig-2(b) are the graphic representation of the data for growth rate of GDP before and during the banking crisis.

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<sup>15</sup> Source: International Monetary Fund (IMF), "*Japan: Selected Economic Indicators*", IMF Staff Estimates, 2001

<sup>16</sup> Survey: "*What Ails Japan?*", The Economist Newspaper Ltd., London, (Apr 20, 2002), pp.2

**Table-2(a)**  
**GDP Growth Rate (%)**  
**Before the banking crisis (1980-1990)**

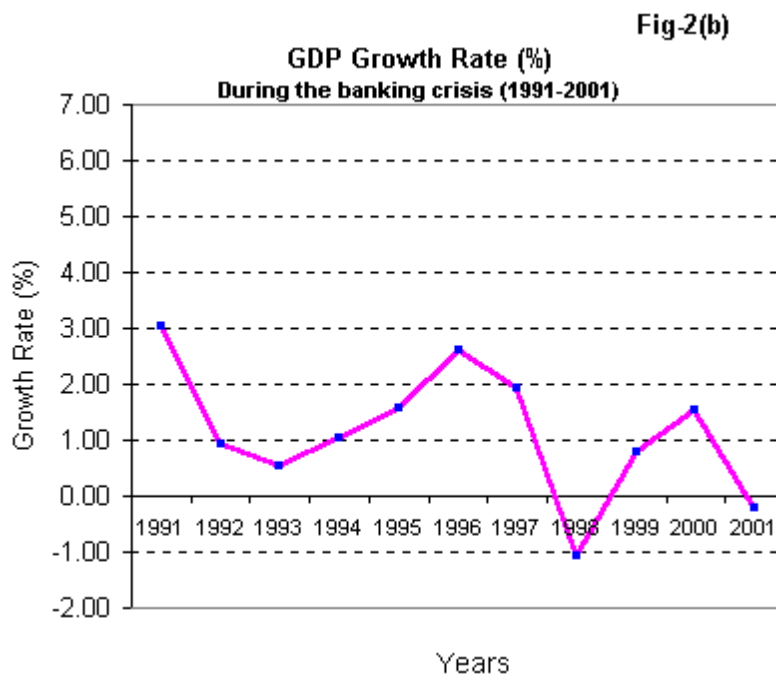
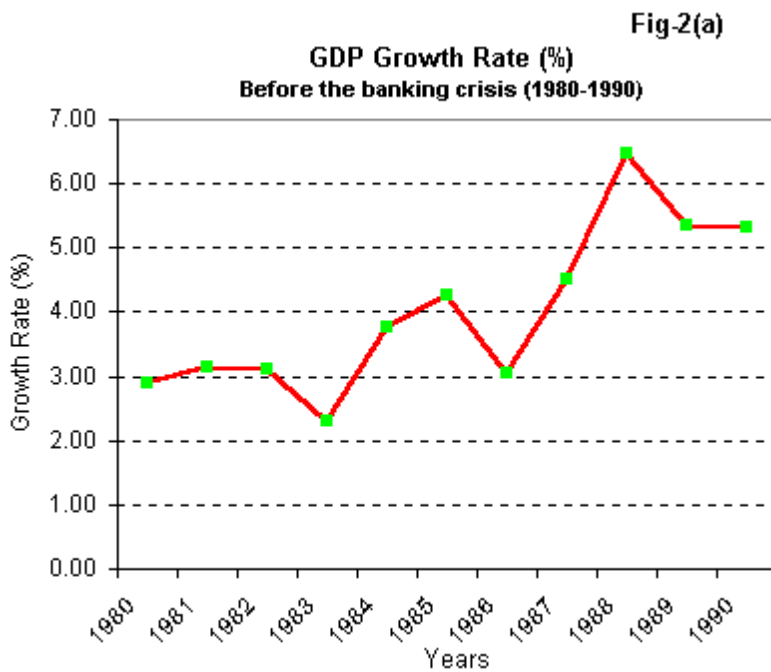
Years	Growth Rate
1980	2.90
1981	3.15
1982	3.11
1983	2.30
1984	3.77
1985	4.26
1986	3.06
1987	4.51
1988	6.47
1989	5.36
1990	5.31

**Source:** Bank of Japan,  
Economic and Planning Agency of Japan.

**Table-2(b)**  
**GDP Growth Rate (%)**  
**During the banking crisis (1990-2001)**

Years	Growth Rate
1991	3.04
1992	0.92
1993	0.53
1994	1.02
1995	1.57
1996	2.60
1997	1.92
1998	-1.06
1999	0.79
2000	1.54
2001	-0.20

**Source:** Bank of Japan,  
Economic and Planning Agency of Japan.



## 2- Interest Rate

Interest rate regulation, based on the "Temporary Interest Rate Adjustment Law" of 1947, aimed at controlling all interest rates in order to provide low-cost funds to designated industrial sectors. This single law is the basis and institutional framework for "cartellized" or "collusive cooperation" in all layers of the financial system.

The bubble had its origin in the enormous amount of liquidity available to borrowers implicit in such low interest rates. The structure of the ensuing bubble revolved around the practice of using the rising value of property as collateral for speculative borrowing. Much of this speculation was directed towards equity and property markets, thus creating a vicious circle that intensified the problem.<sup>17</sup>

The target rate in the overnight call market was steadily eased and by March 1999 had been reduced to virtually zero. In April 1998, the bank of Japan announced that this "zero interest rate policy" would be sustained until deflationary concerns were dispelled. The long-term interest rate, partly due to the market view of concerns over economic prospects, has been on a downward trend since the fall of 2000.

“Further, the Bank of Japan reduced interest rates to zero in March 2001 to revive its economy, which has suffered a long-term recession since the early 1990s. Short-term interest rates declined to virtually zero percent in February 2002.”<sup>18</sup>

In this situation, aggregate demand may "consistently fall short of productive capacity despite essentially zero short term nominal interest rates". Low interest rates are usually not considered good news for the banking sector, which makes its profits from the "spread", the difference between the interest rates banks charge on loans, and the rates they have to pay out on deposits. These spreads are usually higher when rates are high than when they are low, as banks are reluctant to offer very low savings rates.

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<sup>17</sup> See Pdraig Dixon - Senior Sophister, "*Banking Sector: Roots of Recession In Japan*", Student Economic Review, 1999, University of Dublin, Trinity College

<sup>18</sup> Source: Bank of Japan, "*Monetary Policy Meetings*", (February 28, 2002)

According to estimate of the Economist Intelligence Unit (EIU) Country Profile, the central bank interest rate for the years 1998, 1999, 2000 and 2001 was 0.6,0.5,0.5 and 0.1 respectively.<sup>19</sup>

Japanese banking authorities were driven by the fear that a number of banks would go under because companies who borrowed money would default. To ease these fears they kept interest rates low in order to keep these companies solvent, thereby building confidence in the heart of the economy.

Lending rates before and during the banking crisis are given in Table-3(a) and Table-3(b) respectively. Similarly, Fig-3(a) and Fig-3(b) are the graphic representation of the data for lending rates before and during the banking crisis.

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<sup>19</sup> Source of data: The Economist Intelligence Unit (EIU), Country Profile, (1996-2000)

**Table-3(a)**

**Long Term Lending Rates (%)**  
**Before the banking crisis (1980-1990)**

Years	Lending Rate
1980	8.65
1981	8.61
1982	8.57
1983	8.35
1984	7.87
1985	7.29
1986	6.47
1987	5.32
1988	5.58
1989	5.9
1990	7.85

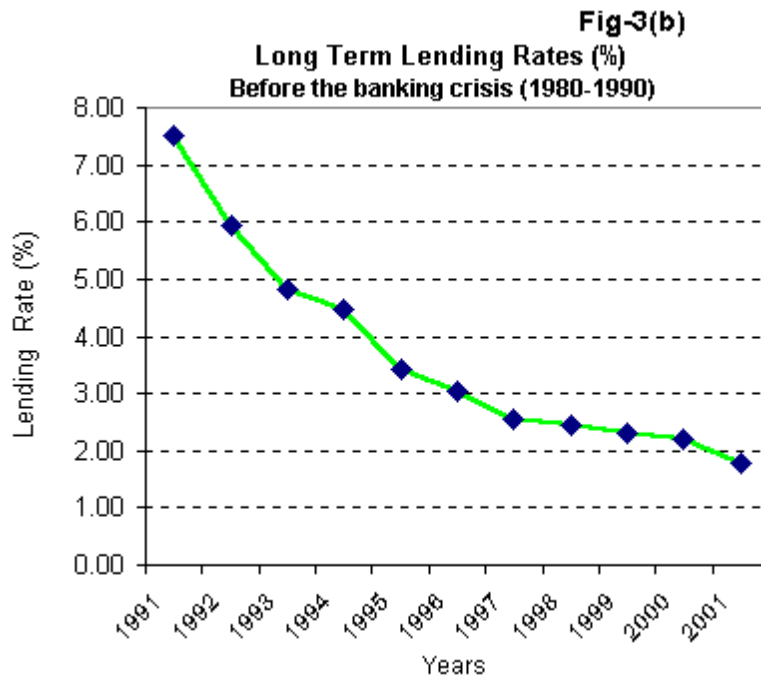
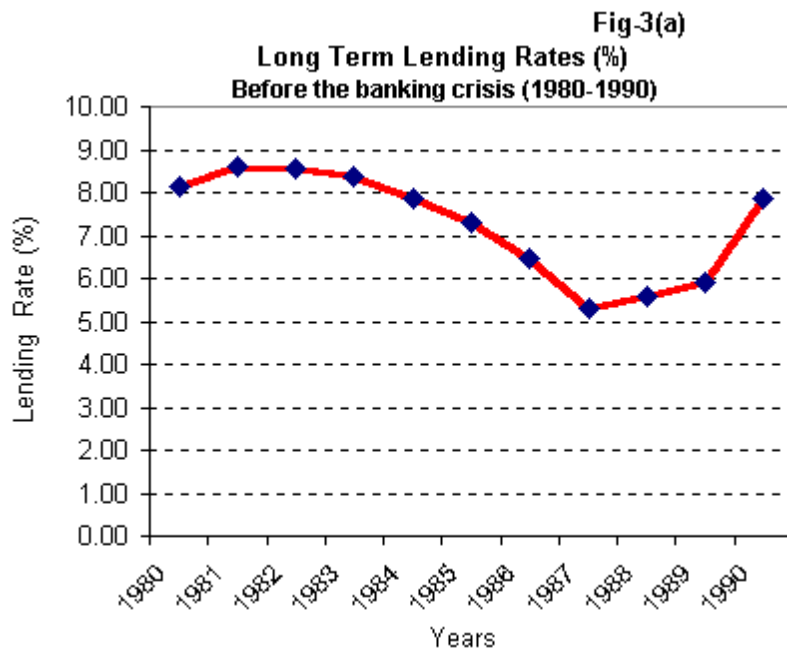
**Source:** Bank of Japan,  
Economic and Planning Agency of Japan.

**Table-3(b)**

**Long Term Lending Rates (%)**  
**During the banking crisis (1991-2001)**

Years	Lending Rate
1991	7.5
1992	5.95
1993	4.83
1994	4.46
1995	3.43
1996	3.05
1997	2.56
1998	2.44
1999	2.32
2000	2.2
2001	1.77

**Source:** Bank of Japan,  
Economic and Planning Agency of Japan.



Discount rates before and during the banking crisis are given in Table-4 (a) and Table-4(b) respectively. Similarly, Fig-4(a) and Fig-4(b) are the graphic representation of the data for discount rate before and during the banking crisis.

**Table-4(a)**

**Central Bank Discount Rates**

**Before the banking crisis (1980-1990)**

Years	Discount Rate
1980	8.14
1981	6.35
1982	5.50
1983	5.30
1984	5.00
1985	5.00
1986	3.60
1987	2.54
1988	2.50
1989	3.10
1990	5.39

**Source:** Bank of Japan,  
Economic and Planning Agency of Japan.

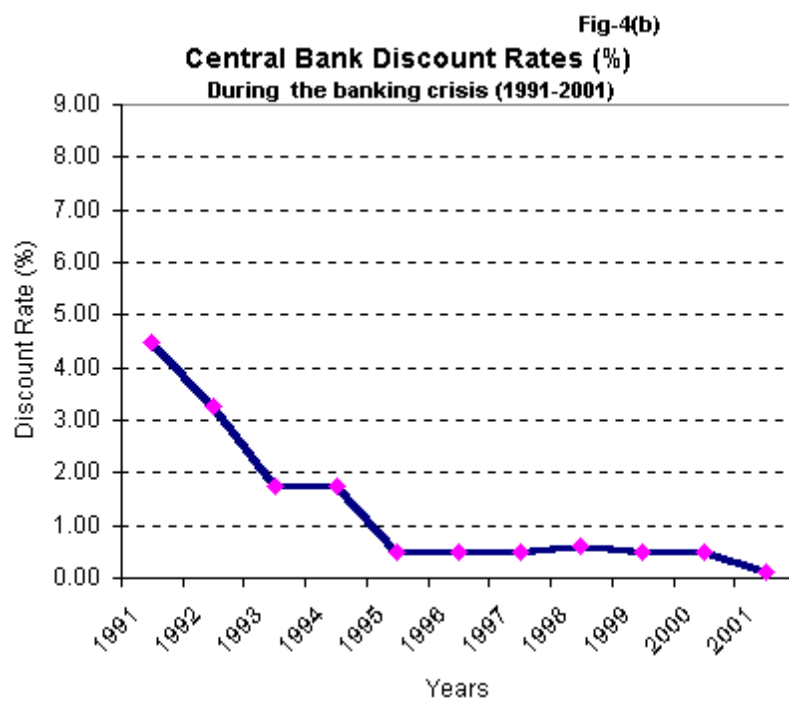
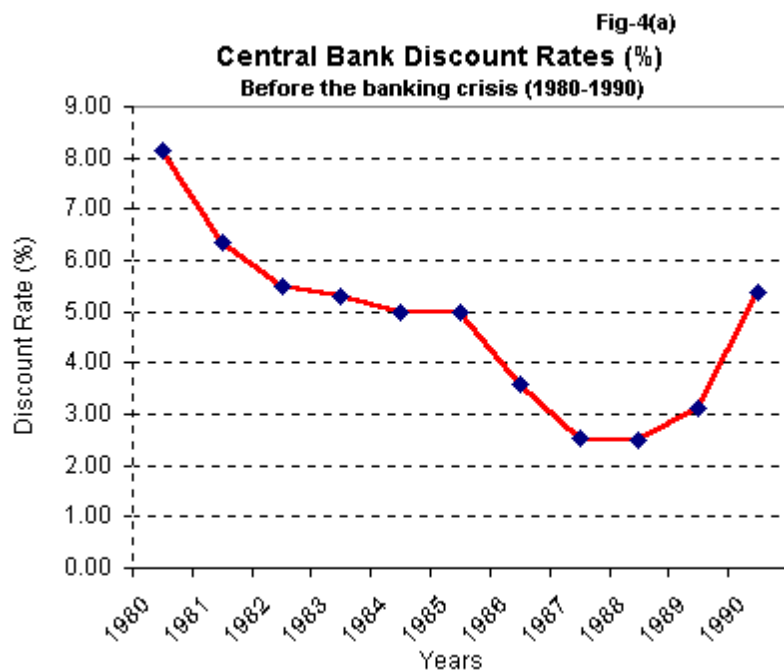
**Table-4(b)**

**Central Bank Discount Rates**

**During the banking crisis (1991-2001)**

Years	Discount Rate
1991	4.50
1992	3.25
1993	1.75
1994	1.75
1995	0.50
1996	0.50
1997	0.50
1998	0.60
1999	0.50
2000	0.50
2001	0.10

**Source:** Bank of Japan and  
The Economist Intelligence Unit Limited  
(EIU) Country Profile, 1996-2000.



### 3-Prices:

The long, slow decline in property prices since 1990 has reflected the Bank of Japan's reluctance, implicitly supported by a policy of regulatory forbearance, to recognize the full extent of these problem assets. The bad loan problem inherited from the bubble years has continued to fester, contributing to unprecedented bank failures in late 1997, a sharp loss in confidence, and a tightening in credit availability despite record low interest rates.

Deflationary pressures have so far remained moderate. Excluding the impact of falling commodity prices, the 12-month rate of decline of the WPI has been about 1½ percent, not very different from the average rate of decline during the 1990s. The 12-month change in the core CPI (excluding fresh food and energy) has been slightly negative for the years 1998 and 1999. With regard to prices, wholesale prices were on a downtrend, and consumer prices are lower than the level in 1998.<sup>20</sup>

The downward pressure from domestic factors is unlikely to weaken considerably, reflecting the already large output gap, despite the expected effects of the comprehensive economic stimulus package. Prices are likely to be weak for the near future.

Prices have been continuously dropping, mainly because of weak domestic demand further compounded by the effects of deregulation. A mild deflationary trend emerged, with domestic wholesale prices dropping slightly by 1.0 percent in fiscal 1999 and staying almost unchanged in fiscal 2000 (an increase of 0.1 percent in calendar year 2000). Since the beginning of 2001, renewed downward pressure was felt as the prices of electric machinery and steel softened.<sup>21</sup>

Higher oil prices and economic recovery have reduced the downward trend in domestic wholesale prices. According to the estimate of the Economist Intelligence Unit (EIU) Country Profile, the overall price index for the years 1998, 1999, 2000 and 2001 was recorded as 100.03, 96.07, 96.6 and 97.0 respectively.<sup>22</sup>

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<sup>20</sup> International Monetary Fund (IMF) "*Consultation with Japan (August 4, 1999)*", Public Information Notice (PIN) NO: 99/75

<sup>21</sup> Source: "*Economy Report –Japan*", *Economic Outlook*, (2001)

<sup>22</sup> The Economist Intelligence Unit (EIU) *Country Profile*, (1996-2000)

The overall wholesale price index before and during the banking crisis is given in Table-5(a) and Table-5(b) respectively. Similarly, Fig-5(a) and Fig-5(b) are the graphic representation of the data for the overall wholesale price index before and during the banking crisis.

**Table-5(a)**  
**Overall Wholesale Price Index**  
**(All Commodities) 1995=100**  
**Before the banking crisis (1980-1990)**

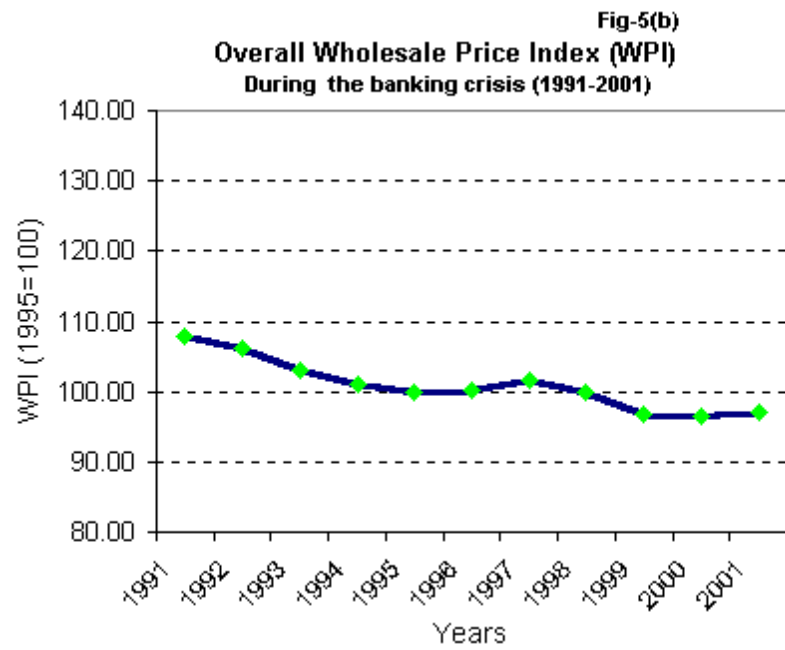
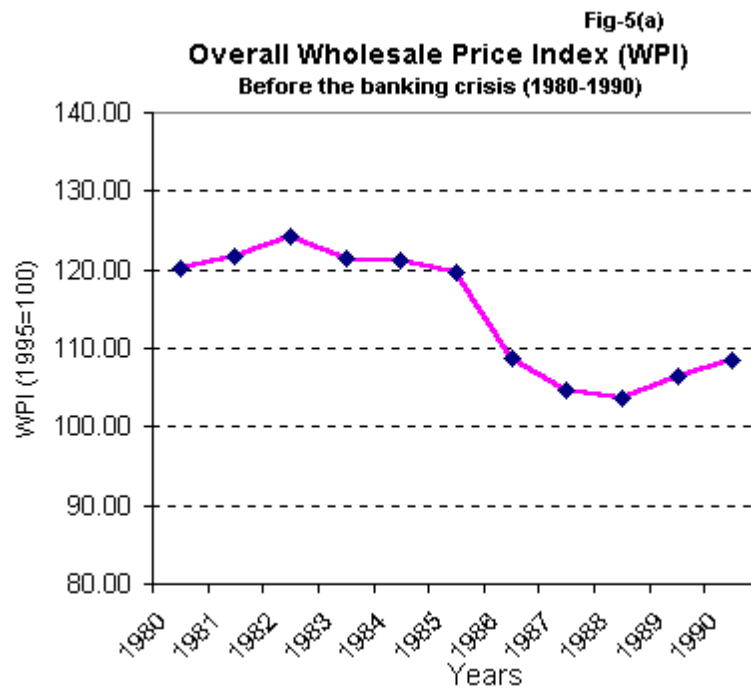
Years	WPI
1980	120.28
1981	121.80
1982	124.16
1983	121.41
1984	121.08
1985	119.69
1986	108.78
1987	104.69
1988	103.64
1989	106.33
1990	108.47

**Source:** Economic and Planning Agency of Japan.

**Table-5(b)**  
**Overall Wholesale Price Index**  
**(All Commodities) 1995=100**  
**During the banking crisis (1991-2001)**

Years	WPI
1991	107.84
1992	106.11
1993	103.03
1994	100.95
1995	99.99
1996	100.10
1997	101.61
1998	100.03
1999	96.70
2000	96.60
2001	97.00

**Source:** Economic and Planning Agency of Japan.



#### **4- Unemployment:**

The unemployment rate has more than doubled since 1991. Employment and household income conditions are still deteriorating as the unemployment rate continues at a historically high level.

The unemployment rate is remarkably high for the years 1998, 1999, 2000 and 2001 estimated as 4.10, 4.7, 4.75 and 5.6 respectively.<sup>23</sup>

The unemployment rate before and during the banking crisis is given in Table-6(a) and Table-6(b) respectively. Similarly, Fig-6(a) and Fig-6(b) are the graphic representation of the data for unemployment rate before and during the banking crisis.

The data and graphs from 1991 through 2001 show a significant decline in the GDP growth rate, discount rate, long term lending rate and overall wholesale price index and an increase in the unemployment rate.

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<sup>23</sup> The Economist Intelligence Unit (EIU), Country Profile, (1996-2000)

**Table-6(a)**  
**Unemployment Rate (%)**  
**Before the banking crisis (1980-1990)**

Years	Unemployment Rate
1980	2.61
1981	2.36
1982	2.62
1983	2.63
1984	2.64
1985	2.64
1986	2.69
1987	2.8
1988	2.88
1989	2.93
1990	2.97

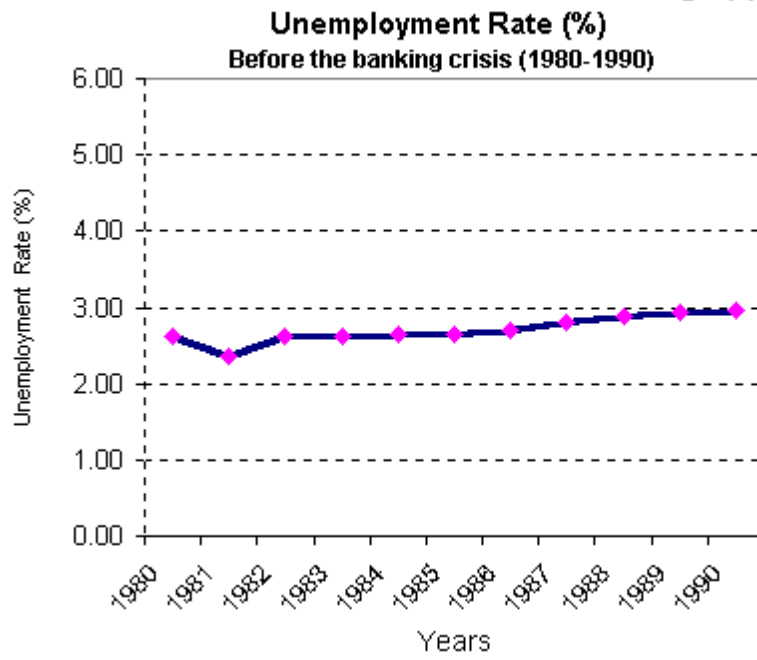
**Source:** Bank of Japan,  
Economic and Planning Agency Japan.

**Table-6(b)**  
**Unemployment Rate (%)**  
**During the banking crisis (1991-2001)**

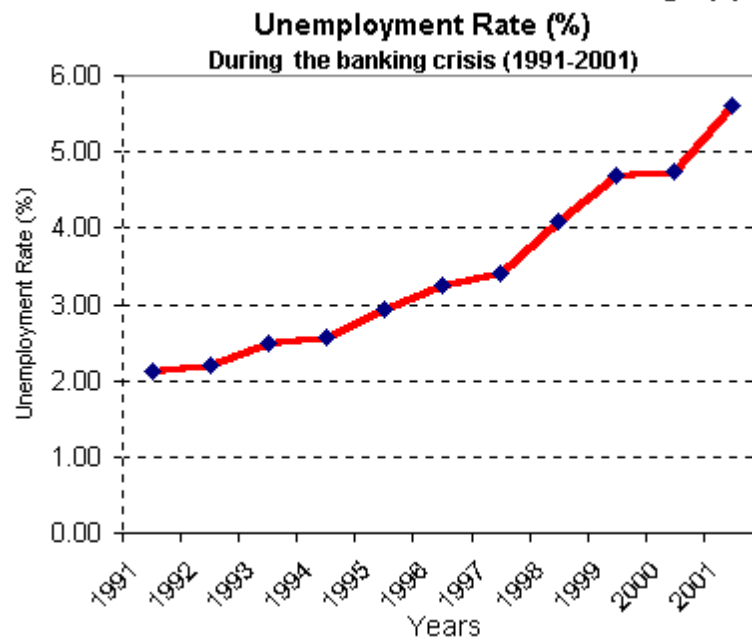
Years	Unemployment Rate
1991	2.13
1992	2.20
1993	2.50
1994	2.58
1995	2.93
1996	3.24
1997	3.40
1998	4.10
1999	4.70
2000	4.75
2001	5.60

**Source:** Bank of Japan and  
The Economist Intelligence Unit Limited  
(EIU) Country Profile, 1996-2000

**Fig-6(a)**



**Fig-6(b)**



## VII. Discussion on the results of the model:

The Hildreth-Lu Procedure is applied to equation (2) with  $\rho=0.998$ . The results are shown in Table-7.

**Table-7**  
**Non-Performing Loans**  
**Regression Results: Hildreth-Lu (HL), 1980:03-1990:12**  
**(rho)=0.998**

Variables	Coefficients	Standard Errors	T Ratios
Intercept	547.9149	750.8837	0.7297
diff r=(lending rate-discount rate) <sub>t-1</sub>	2311.7056	2507.6769	0.9219
Unemployment rate <sub>(t-1)</sub>	8507.7679	10271.7407	0.8283
Real GDP growth <sub>(t-1)</sub>	-153.4741	302.3778	-0.5076
Wholesale Price Index <sub>(t-1)</sub>	-1646.2301	992.0806	-1.6594

R-Square (R <sup>2</sup> )	0.6648
Adjusted R-Square(R <sup>2</sup> )	0.6539
F-test	59.5496
Durbin Watson Test	2.5034

### Interpretation of Coefficients for the equation:

The coefficient sign associated with  $(\Delta R_{it-1})$  states that non-performing loans increase as the difference between the lending rate and discount rate  $(\Delta R_{it-1})$  increases. However, the t-statistic is not significant.

The coefficient sign associated with the unemployment rate  $UE_{t-1}$  states that non-performing loans increase as the unemployment rate rises. However, the t-statistic is not significant.

The coefficient sign associated with the real GDP growth rate  $GDP_{t-1}$  states that non-performing loans decrease as the real GDP growth rate increases. However, the t-statistic is not significant.

Similarly, the coefficient sign associated with the overall wholesale price index  $P_{t-1}$  states that non-performing loans decrease as the overall wholesale price index  $P_{t-1}$  increases. The t-statistic for  $P_{t-1}$  is significant.

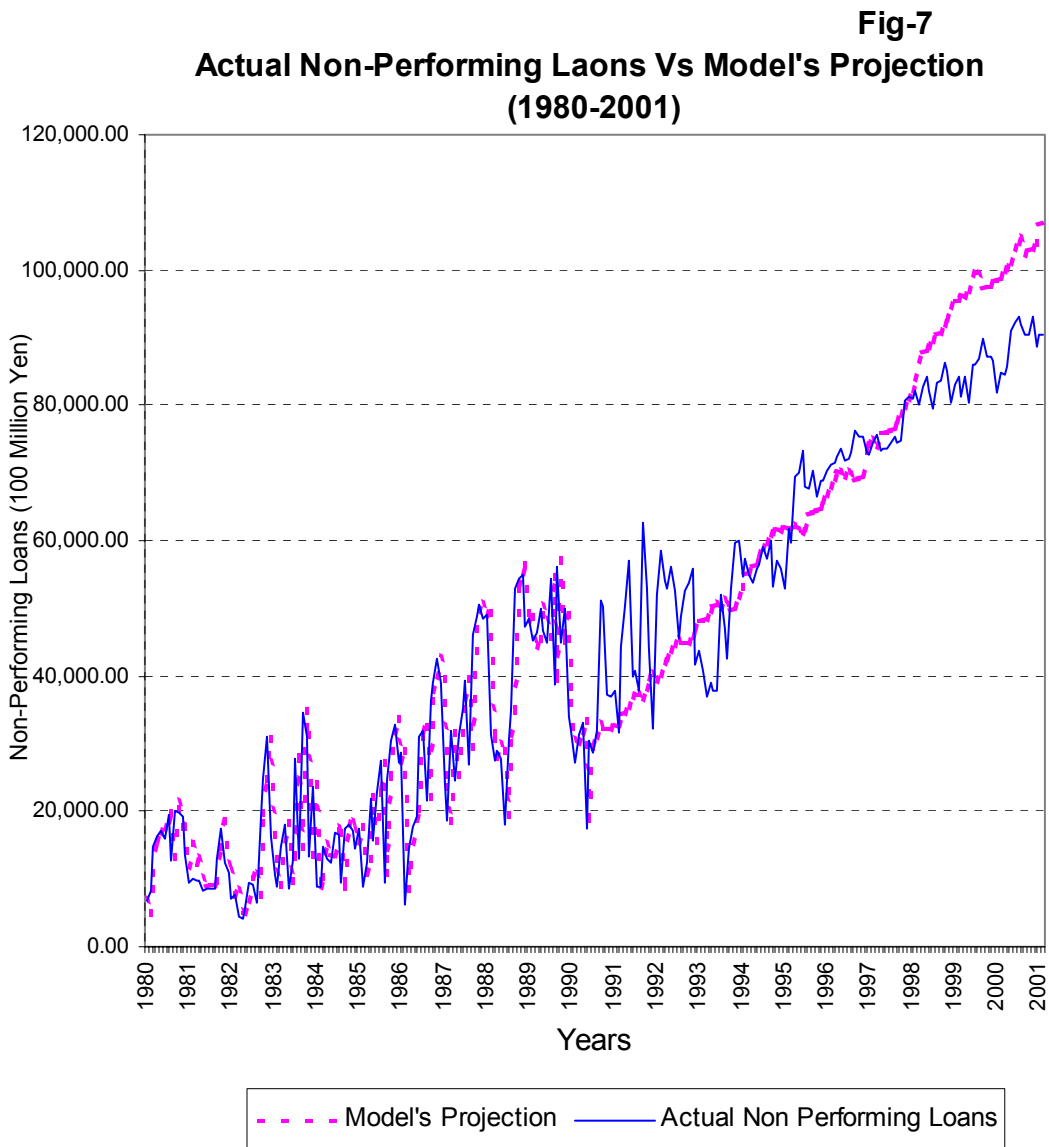
The 95 percent critical value for t-distribution with degree of freedom (124) is +/- 1.645. One of the independent variables price index is statistically significant although the other three independent variables have low statistics. Since the purpose of the model is forecasting, the low t-ratio can be ignored. The reasons for the low t-ratio are:

1- These variables individually could be not significant because of the high value of ( $\rho=0.998$ ) used for the model estimation. According to the assumption of Hilderth-Lu Procedure (the value of  $\rho$  lies between  $-1$  and  $+1$ ) as the value of  $\rho$  is increased the t-ratio are decreased. Different values of  $\rho$  have been tried for the model. The model is selected by determining the one with the highest R-Square the most plausible coefficients signs, all of which were produced with a value of  $\rho$  0.998.

2- The F- test has a significant value (59.55). The variables included in the model are jointly significant although three of the variables are not significant individually. The low t-ratios may be due to multicollinearity.

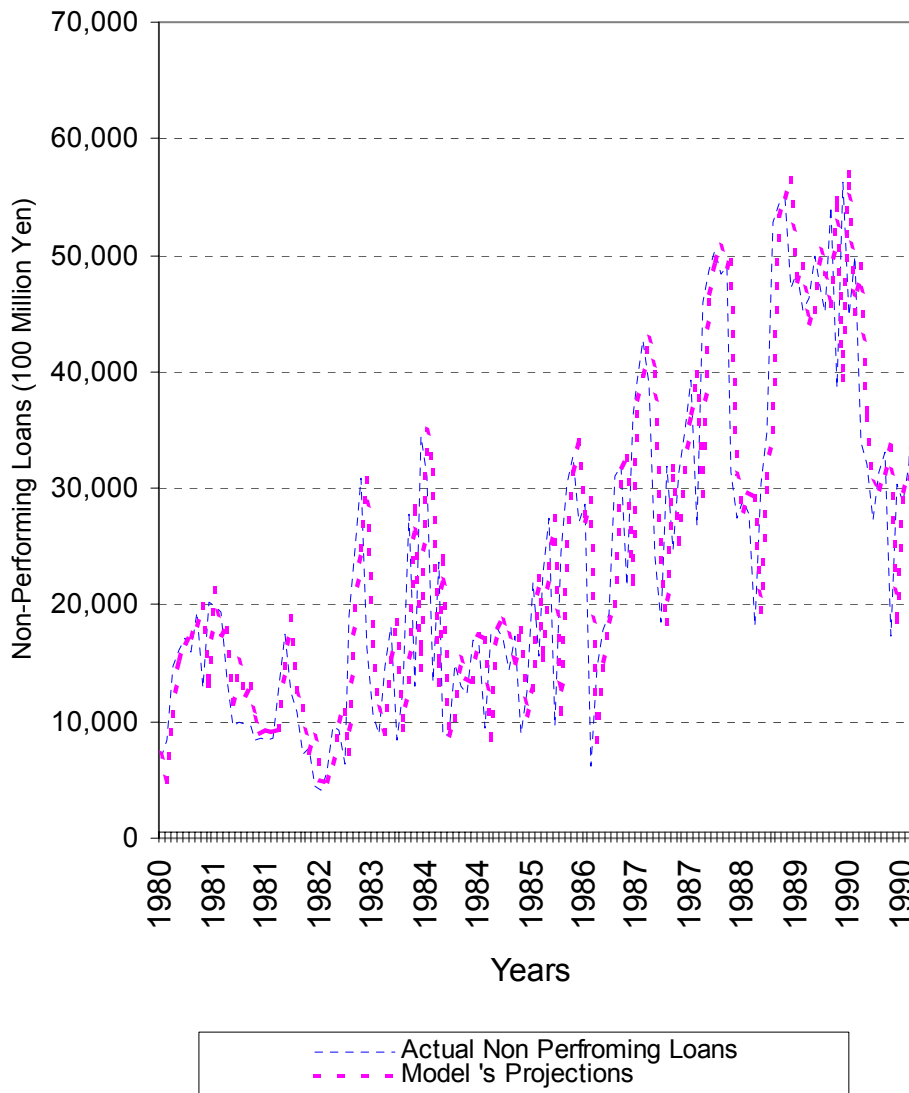
The Durbin Watson Test (D.W=2.50) shows no auto-correlation.

Fig-7 represents the model's projection for the period (1980-03 to 2001-05). By looking at the period 1980-1990, we can see how the model estimated non-performing loans on data spanning the period March 1980 through December 1990. This model appears to explain non-performing loans during this period in-sample period quite well. Could it have been used to predict non-performing loans during the 1990's? By looking at the out-of-sample period from 1991-2001, we can say the model seems to predict the non-performing loans for the decade fairly well, though it consistently over-predicted the peak-time crisis of 1998-2001.



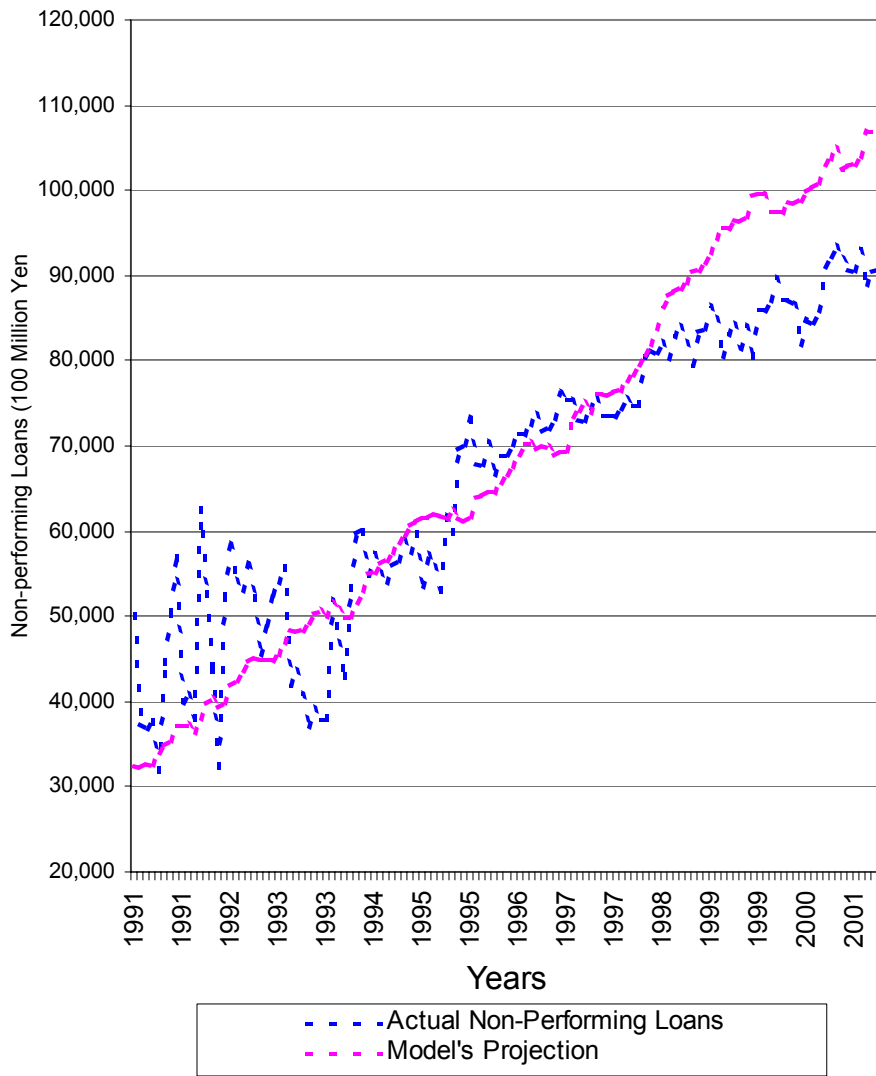
The in-sample fit for the 1980-1990 estimation period is shown in greater detail in figure 8.

**Fig-8**  
**Actual Non Performing loans Vs Model's Projection**  
**Historical Period (1980-90)**



The estimated model's out-of-sample forecast for the 1991-2001 banking crisis years is shown in figure 9.

**Fig-9**  
**Actual Non Performing Loans Vs Model's Projection**  
**Forecast Period (1991-2001)**



To measure the accuracy of forecast; the Root Mean Square<sup>24</sup>, the Mean Absolute Error<sup>25</sup> and the Theil U<sup>26</sup> statistic for the model for the historical period and as well as for the forecast period have been estimated. The results are given in Table-8.

**Table-8**  
**Prediction of Non-Performing Loans**  
**(rho)=0.998**

**Accuracy of Forecast Error**

<b>Historical Period (1980-90):</b>	
Root Mean Squared Error (RMSE)	8,162.67
Mean Absolute Error (MAE)	5,998.08
Theil U	0.29
<b>Forecast Period (1991-2001):</b>	
Root Mean Squared Error (RMSE)	9,114.01
Mean Absolute Error (MAE)	7,360.66
Theil U	0.13

The Mean Absolute Error has the smallest value as compared to the Root Mean Square Error for both cases. The computed value of the Root Mean Square Error (8162.67) and the Mean Absolute Error (5998.07) for the historical period can be compared to the computed value of the Root Mean Square Error (9114.01) and the Mean Absolute Error (7360.66) for the forecast Period.

The computed value for the Theil U is 0.2896 for the historical period and 0.1323 for the forecast period. The value of the Theil U close to zero indicates a good forecasting performance of the model.

<sup>24</sup> Root mean square is a measure of deviation of the simulated variables from its actual time path.  $RMS = \sqrt{1/n \sum_i (y - y^{\wedge})^2}$   $0 \leq RMSE \leq \infty$ . The magnitude of the RMSE can be evaluated only by comparing it with the average size of the variable in the equation. See William H. Green 2000 "Econometric Analysis" Ch-7 Inference and Prediction pp.310

<sup>25</sup> Mean Absolute Error is a measure of simulation error and is computed as  $MEA = 1/n \sum_i |y - y^{\wedge}|$ . See William H. Green 2000 "Econometric Analysis" Ch-7 Inference and Prediction pp.310

<sup>26</sup> A useful simulation statistics related to the RMS simulation error and implied to the evaluation of historical simulation or ex-post forecast is Theil's U. It is computed as  $Theil\ U = \sqrt{1/n \sum_i (y - y^{\wedge})^2 / 1/n \sum_i y^2}$ . This measure is related to  $R^2$  but not bounded by 0 and 1. Large values indicate a poor forecasting performance. See William H. Green 2000 "Econometric Analysis" Ch-7 Inference and Prediction pp.310-311

## **VIII. Conclusion**

The empirical results of the model support and affirm the hypothesis: it was quite possible to construct an econometric model that could have been used as an early warning system thereby enabling analysts to recommend measures to ward off the impending banking crisis. Had the banking regulators anticipated the incidence of “bad loans”, they could have acted to insulate the banks and the economy by spreading the risk.

The analysis demonstrates that non-performing loans for the 90s, could have been predicted by constructing a simple model over the historical period that included the following variables; central bank discount rate, long term lending rate, growth rate of real GDP, unemployment rate and overall wholesale price index.

With careful observation and monitoring plus reliable data, forecasting can be improved. By improving forecasting techniques, analysts and policy makers could help the world economy’s future prospects and growth.

The establishment of a new financial supervisory agency with the capacity to take prompt corrective action may help Japan avoid future bank crises. Moreover, if the corrective action measures are fully implemented more quickly. The mere existence and promulgation of this model should make it almost impossible for the banking data and the economy.

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## VITA

### **Saira Sultana White**

Saira Sultana White was born in 1967 in Mandi Bahawal Din, Pakistan. She achieved her Bachelor's of Arts in Economics and Statistics from Queen Mary College Lahore, Pakistan in 1989 and received her Masters of Arts in Economics from University of the Punjab, Lahore in 1992. In 2002, she earned the degree of Masters of Arts in Economics from Virginia Polytechnic Institute and State University.

The author worked during 1992-93 as an economic analyst with CADCAM Consulting Engineering Ltd. Lahore, Pakistan. From 1993-1996, she worked as an economist with National Engineering Services of Pakistan (NESPAK) Lahore. Her responsibilities in this period included cost benefit analyses of agricultural, highways and Water and Sanitation Projects.

In 1996, she came to the United States of America. In the following year, she married to Kevin White and they had a son Caleb White, and two daughters Ruth White in 1998, and Emily White in 2001. After three years of study, she will receive her masters degree in Economics from Virginia Polytechnic Institute and State University. She intends to seek a career in international banking.