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The Logit Model: A Prediction of Future Economic Events

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Abstract

Financial crises are recurrent events with profound economic and social implications. Accurately predicting these crises is of paramount importance for policymakers, financial institutions, and investors. This abstract provides an overview of a study that explores the utility of Logit models in predicting financial crises and their ability to provide insights into the factors contributing to these crises and the value of Logit models in predicting financial crises and gaining insights into their underlying drivers. Such predictive models can enhance risk management strategies and help prevent or mitigate the devastating consequences of financial crises. Future research could focus on refining the model by incorporating additional data sources and improving predictive accuracy further.

Keywords

Logit Mode, Early Warning System, Logistic Regression

1. Literature Review of the Logit Model

Following the episodes of severe financial crisis in United States of America (2007-2009), economists are concerned about the factors that could help them predict future economic anomalies. Early warning systems (EWS) aim to recognize vulnerable situations in an economy, because certain variables behave differently before and during a specific period of time. The aim of using EWS is not to predict, but rather to signal an increased likelihood of a crisis to occur in the short run. Therefore, using the logit models has received a lot of attention from economists and researchers around the globe; they use important indicators to predict the financial crisis of a specific country or industry in the future. The logit approach is logical to predict a binary outcome (1 = economic crisis, 0 = no

economic crisis). Note that financial crises are not limited to a one-country level, but they are easily transmitted to another country due to globalization (Hamdaoui, 2016) [1].

Borio and Drehmann (2008) [2] rely on indicators to quantify financial disorders (based on property prices, and equity prices).

Rose and Spiegel (2012) [3] discover that the only indicator to estimate the 2008 financial crisis is the size of the equity market prior to the crisis.

Demerigüc-Kunt and Detragiache (1998) [4] used a logit model to compute the probability of occurrence or not of a financial crisis using explanatory variables. The probability of a crisis occurring is one.

Davis and Karim (2008) [5] evaluate whether it was possible to predict the financial crisis of 2008 using EWS based on logit models.

Frankel and Saravelos (2012) [6] predict the 2008 crisis using existing literature on leading indicators to understand which of them were the most reliable in explaining the incidence. They discovered that real GDP growth is one of the most reliable indicators to predict the financial crisis.

Finally, Wong *et al.* (2010) [7] states that an economy with slow economic growth and high interest rates will likely drown the country into banking distress.

This section proposes a logit model to predict whether a recession is going to occur in the near future or not because:

1) Logit model is widely used and taught.

2) Logit model is easy to understand and available in many software applications. It clearly explains the reasons why a crisis will occur.

3) The Logit model has been put into practice and assessed in the banking sector.

4) The Logit model is more accurate than any other model.

2. The Model

This section further explores our a-priori economic knowledge to see if the current economic, financial, and political factors are signaling an economic downturn in the United States of America. A logistic model is based on the cumulative probability function. After studying the parameters of the model through the maximum likelihood model, the probability of occurrence of the corresponding sample can be obtained. If $p < 0.5$, the probability of a crisis to occur is relatively low, if $p > 0.5$, the probability of a crisis to occur is relatively high.

As mentioned above, the 2008 financial crisis started in the housing sector, so, our model is going to include a variable based on the housing sector. The model used is the logistic regression model which shows the probability of an event to occur as a function of a set of explanatory variables. The equation for this model is:

$$P_r\left(crisis=1\right)=F\left(x\right)$$

where:

$P_r\left(crisis=1\right)$: the probability of a recession to occur.

$F(\ )$: logistic function that combines the independent variables into an equation that explains the occurrence of a crisis.

X: vector of explanatory variables that may influence the probability of a crisis.

In this model, X will include the following variables:

- Housing Prices (X_1): a measure of the level of housing prices in the economy.

The data used are based on the Housing Price Index (HPI): quarterly, seasonally adjusted data (base year = 1991Q1)

- GDP Growth Rate (X_2): a measure of the growth rate of the economy.

GDP in percentage change from preceding period, quarterly, seasonally adjusted data

- The stock market index is represented by the S & P (500) (X_3), which is a stock market indicator reflecting the whole market.

S & P monthly seasonally adjusted data (took the average of 3 months to make out the quarterly data)

- Federal Fund Rate (X_4) is the rate at which banks lend from each other overnight. This rate is used because it is the benchmark for all types of interest rates in the market.

Some of the data are monthly data; however, they will be set quarterly (by averaging out 3-months) to match the other variables.

Through the model, the coefficients of this equation will be estimated using data from 2000 till 2022 to compare and analyze the economic trend during this interval. This equation is useful for understanding the important elements that led to the financial crisis, and for evaluating the likelihood of future crises based on changes in these variables. The financial data were retrieved from many sites: HPI from FHFA (Federal Housing Finance Agency), GDP Growth Rate from Fred St. Louis Fed, S & P from Yahoo Finance, and Federal Fund Rate from the Fed's website.

The logit model will be as follows:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4$$

where p is the probability of the country going into a crisis in 2023.

x_1, x_2, x_3, x_4 are the explanatory variables.

To make the model more accurate and significant, some lags were included. The Federal Fund Rate was lagged for four quarters (12 months). This rate is a lagging indicator and takes approximately 12 - 18 months for the full effect of the change in the Federal Fund Rate to appear (Miller, 2011). In addition, the GDP Growth rate records a lag value of 1 quarter since it is used as a measure of the health of the economy, and it always shows past performances of the total production of the country (Baumohl, 2012, p. 146) [8].

Using EViews program and the data collected from different reliable websites, the following was found (see **Table 1**).

Since all the variables above are important to predict the existence of a crisis, none of them will be dropped from the equation (level of significance = 10%).

Table 1. Regression results.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
S_P	−0.001380	0.000874	−1.579381	0.1142
IR_LAG4	105.4892	27.50215	3.835671	0.0001
HPI__BASE_YEAR___1991_	0.042238	0.017107	2.469120	0.0135
DPG_LAG1	−8.846621	6.338738	−1.395644	0.1628
C	−10.88600	3.301222	−3.297567	0.0010

So, the equation would be as follows:

$$\ln\left(\frac{p}{1-p}\right) = -10.886 + 0.042x_1 - 8.846x_2 - 0.001x_3 + 105.489x_4$$

And the estimated probability of occurrence would be the odd function:

$$pr\left(1 = recession\right) = \frac{e^{-10.886+0.042x_1-8.846x_2-0.001x_3+105.489x_4}}{1+e^{-10.886+0.042x_1-8.846x_2-0.001x_3+105.489x_4}}$$

In 2008 Q1,

$$x_1 = 210.88$$

$$x_2 = 0.042$$

$$x_3 = 1343.96$$

$$x_4 = 0.0525$$

$$pr\left(1 = recession\right) = \frac{e^{1.793641}}{1+e^{1.793641}} = \frac{6.011297}{7.011297} = 0.85737$$

The *probabilty* of a crisis to occur, according to this equation, is 0.85737 which is greater than 0.5. This means that the probability of a crisis occurring is relatively high. Furthermore, the historical data show that in 2008 there was a crisis; hence, this probability matches what really happened in the past.

For more verification, the data of 2015Q1 were put in the equation to check whether this formula reflects the true economic situation in every year (in 2015 there was no crisis):

$$x_1 = 209.96$$

$$x_2 = 0.025$$

$$x_3 = 2055.793$$

$$x_4 = 0.0025$$

$$pr\left(1 = recession\right) = \frac{e^{-4.0809}}{1+e^{-4.0809}} = \frac{0.016892}{1.016892} = 0.016612$$

The *probabilty* of a crisis to occur, according to this equation, is 0.016612 which is less than 0.5. Keeping everything else constant, there is no evidence that a crisis occurred in 2015 based on these variables.

3. Findings

Based on the variables provided in the model above, this section will forecast the occurrence of a crisis in the United States of America in 2023.

In 2023 Q1:

$$x_1 = 393.9$$

$$x_2 = 0.066$$

$$x_3 = 4052.02$$

$$x_4 = 0.001667$$

$$pr(1 = recession) = \frac{e^{1.197759}}{1 + e^{1.197759}} = \frac{3.312685}{4.312685} = 0.768126$$

The *probabilty* of a crisis to occur, according to this equation, is 0.768126 which is relatively greater than 0.5. Hence, the probability of a crisis occurring is high. This is justified by the analysis of the data gathered:

- The HPI shows an upward trend from 2017, reaching its highest level in 2023 (393.9). This increase in the price level of houses will negatively affect the purchasing power of an individual to buy a house. Since housing prices are part of the CPI, there might be a chance that this increase in the index will increase the CPI and therefore will increase the inflation rate in the USA.
- From 2022Q2 till 2023Q1, the GDP Growth rate decreased from 8.5% to 5.1%, showing a slowdown in the economic activity in the United States. Since the effect of the interest rate is not immediate, GDP will be affected later by a decrease in its values (GDP = lagging indicator).
- S & P reacts spontaneously to an immediate change in the interest rate. Therefore, the data of S & P in 2023, and the low-level of the unemployment rate, indicate that the policy makers expect a soft-landing in the economy. To accurately analyze the S & P, one year should be awaited revealing a past hike of the interest rate.
- As mentioned before, the interest rate should be lagged at least four quarters to show the full effect on an economy. So, even if the interest rate in 2022Q1 (0.17%) was too low, the contractionary monetary policy initiated by the Fed this year (2023Q1) might be a signal for a further decrease in the level of output. In 2023, the interest rate reached a range between 5% and 5.25%.

All of these factors combined in an equation offer a glimpse of what is going to happen in the economy in the near future.

4. Conclusion

The 2008 financial crisis started in the housing market, but it had a spillover effect on the whole economy of the United States and the whole world. It is important to note that there was no collateral on the traded financial instruments, which made the default risk high. America was the fastest to get out of its recession even though it was the one that caused it. Moving 15 years forward, many economists are worried that the same scenario will recur. Hence, this model was

built to show the relationship between the probability of an occurrence of a financial crisis and some financial and economic variables that might cause a similar crisis to that of 2008; results came out as pro-crisis with a high probability of occurrence. So, any current events that might cause a domino effect on the economy are being managed at a fast pace. After the Covid-19 pandemic and the Ukraine-Russian war, can people afford another crisis?

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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