Investigation of Potential Indicators for Recession Prediction

Name: Hamza Khan
Student Number: *500715594*

I. Introduction

The threat of a looming recession worries many citizens. There always seems to be some level of growing concern and dread that a recession is coming. Multiple news and finance outlets will at times warn citizens of any economic decay and the possibility of an upcoming recession. There is an abundance of economic data that has been gathered in the last century that should help economists and experts determine when a recession may occur. However, there is no real reliable way to predict a recession.

By definition, a recession occurs when there are two consecutive quarters of economic decline as reflected by a country's Gross Domestic Product (GDP) [1]. There are other traits of a recession such as monthly unemployment and interest rates being high. So, a recession can be observed through quarterly GDP data or monthly economic indicators. There are metrics that are used as leading indicators for a recession, but they do not guarantee an accurate prediction. Looking at them together does give useful information regarding a country's economy.

This paper is an investigation of what can be used to predict a recession. Firstly, it will examine a currently used recession indicator known as the composite leading indicator from the Organization for Economic Co-operation and Development (OECD). It will also look at how certain economic trends may or may not tell us about an upcoming recession, and present a potential solution looking at all the explored economic indicators

II. Recession Indicators

A. *OECD Consumer Confidence Index (CCI)*

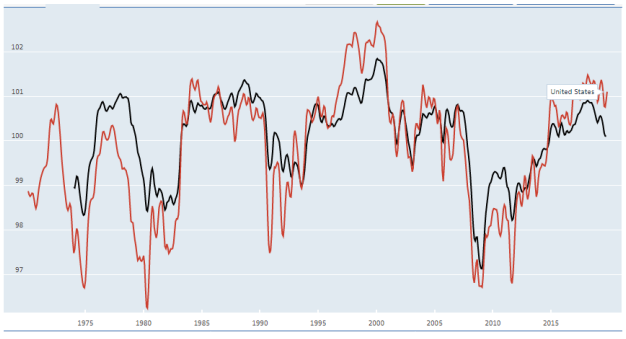

Fig. 1. Chart of US Consumer Confidence Index time series values from 1970 to 2019 (US in red; OECD total among all countries in black)

According to the OECD, the Consumer Confidence Index (CCI) gives us a qualitative measure of how consumers save and spend regarding their own financial situations and the general economic conditions [2]. Values above 100 show that consumers are confident in how the economy is performing and are more likely to make big purchases. Values under 100 show that consumers are not encouraged about the performance of the economy and are more likely to save their money where possible.

The OECD database contains a multitude of economic data for the 33 countries that are a part of the OECD. From the database, the consumer and business confidence index values were obtained for all participating countries. The data ranges from January 1970 to the most recently completed month, November 2019. The months with confidence values below 100 would indicate economic decay, while values over 100 would indicate economic growth.

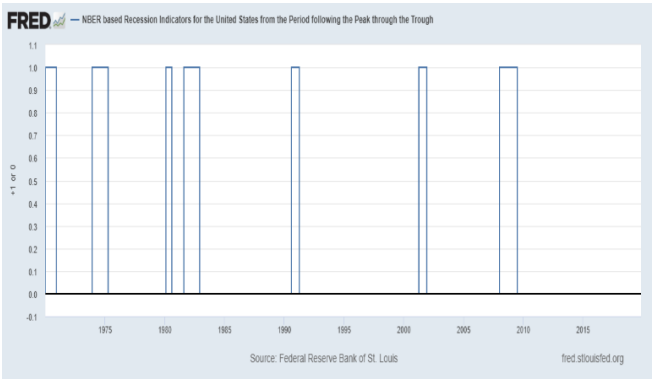

Fig. 2. Time-series data for United States recession from period following peak through to trough

One way to test the reliability of confidence index values in determining a recession is to compare them to monthly recession data. Recession data was obtained from the Federal Reserve Economic Data (FRED) which is a database maintained by the research division of the Federal Reserve Bank of St. Louis. The recession data is a time series that tells us which months in US history experienced economic growth or recession. This data is

found by the National Bureau of Economic Research (NBER) and they focus on the ongoing business cycle of the United States. By their definition, a recession is between a peak and a trough in the economy's performance [3], which is labeled as 1 in the time series. An expansion is between a trough and a peak, which is labeled as 0. To see the reliability of CCI, it is trained against the recession time series data.

From 1970 to 2019, there are values for consumer confidence and the presence of economic recession regarding US business cycles for each month of each year. Economic data for the US was chosen to be trained and modeled because there was more data from the OECD available for the US then there was for Canada. A training and testing set split of 75 percent training and 25 percent testing was chosen for making recession predictions. 75 was chosen since choosing any higher of a split would render the test samples very small and since there are more instances of economic expansion, it could be possible that there would be no examples of recession in a smaller test set. Logistic regression and support vector machines were chosen to make predictions on the data since the datasets are relatively simple with binary classification and a 1-dimensional feature set. Both classification methods showed similarly strong accuracy with logistic regression at 92% accuracy and support vector machine at 94% when making recession or expansion prediction on the test data.

TABLE I. CONFUSION MATRIX FOR CCI PREDICTIONS

	Predicted: Expansion (0)	***Predicted: Recession (1)***
Actual: Expansion (0)	True Negative = 126	False Positive = 6
Actual: Recession (1)	False Negative = 3	True Positive = 15

The test data was chosen from all values after 75 percent of the time series has passed, looking into the 2000s it is apparent from the confusion matrix that most of the test set contains expansion values but there are recession times there that if a model were accurate enough, it would be able to predict.

Regardless, the Consumer Confidence Index appears to very strongly predict when the economy is in expansion. This would suggest that the performance of an economy can be mostly determined by observing consumer spending and saving habits and from the consensus of the consumers regarding the shape of the economy. This also indicates that observing the performance of the economy is not only done by gauging stock market performance but also by observing consumer habits, which in turn influence businesses and the free market. 94 percent is a fairly strong accuracy score, but that number could be improved. One way that could be done is by considering the economic data and confidence index values of countries that America is close to or in business with. The data set used was not very large since the classifiers had very low computation time, so a larger data set with other countries data is likely to produce even better results.

This data is certainly useful for what to expect if another recession were to hit, but it does not necessarily tell us when the economy is going to collapse or experience extreme growth. This could be evident from multiple months or even a year of continued growth or decay but knowing if that great expansion or recession is coming is something that economists to this day with their abundance of data have yet to figure out. Another thing to note is that the accuracy for recession prediction is lower than expansion prediction, with six out of fifteen predictions correct.

B. Unemployment Rate

Fig. 3. Chart of US and Canada Unemployment Rate time series values from 1970 to 2019 (US in red; Canada in blue)

Another statistic that would seem to indicate the shape of an economy is the unemployment rate. Unemployment rate tells us the percentage of workers in the labour force that are not employed and are seeking work [4]. General intuition would have us believe that a high unemployment rate means more people are out of work and thus the economy is or will be in bad shape. Unemployment rate data was obtained from the OECD database for the same time interval as the recession data. There was data for unemployment rate dating back to 1970 for both the United States and Canada, so data for both countries was trained and classified. Unemployment rate yielded interesting results for recession prediction.

TABLE II. CONFUSION MATRIX FOR US UNEMPLOYMENT PREDICTION

	Predicted: Expansion (0)	***Predicted: Recession (1)***
Actual: Expansion (0)	True Negative = 132	False Positive = 0
Actual: Recession (1)	False Negative = 18	True Positive = 0

TABLE III. CONFUSION MATRIX FOR CANADA UNEMPLOYMENT PREDICTION

	Predicted: Expansion (0)	***Predicted: Recession (1)***
Actual: Expansion (0)	True Negative = 76	False Positive = 0
Actual: Recession (1)	False Negative = 74	True Positive = 0

The US unemployment rate seems to be a strong indicator of a recession due to the strong accuracy score of the classification. This is not the case however, since the classifier was only able to make accurate predictions on true negative data, which is for expansion. Unlike the Consumer Confidence Index, the unemployment rate was not able to make recession predictions on the test data.

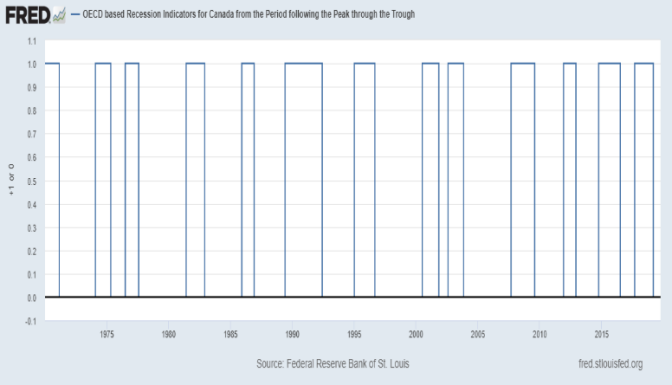

Fig. 4. Time-series data for Canada recession indication from period following peak through to trough

The prediction results are far less accurate when looking at Canada's unemployment data. Once again, no recession predictions are made, and the accuracy score for expansion prediction is just barely above fifty percent. In either case, unemployment rate does not appear to be a strong indicator of a recession. One reason the accuracy for Canadian prediction was far lower is that the recession data has a lot more recession time periods than the U.S recession data. So, this data has more to do with economic decay than it does with a full-blown recession. Also, the Canadian economy is not as strong as the American economy, so it makes sense that there would not be as much expansion.

It is documented and known that in a recession, unemployment rates go up and many layoffs across industries occur. During the 2008 to 2009 recession, Canada's unemployment rate reached 8.3 percent, 2.2 percent higher than what it was before the recession hit [5]. But why would unemployment rate not necessarily tell us if a recession will happen? What has happened in the past is that unemployment rate reaches a new low about a year before a recession happens. This happened with the last five recessions in the United States [6]. The reason for this is that low unemployment numbers lead to a quick increase in credit growth, which is a cause and potential indicator for a recession. Seeing as how unemployment is generally at record lows before a recession happens means that it is not a good indicator for an upcoming recession. Since high unemployment is a symptom of a recession happening, it may be helpful in forecasting recession alongside other potential indicators.

C. Interest Rate Spread

One indicator that is often used is interest rate spread. Interest rate spread is the difference between short-term federal funds rate and long-term U.S. Treasury Bond Yield. Federal fund rates represent short-term rates that financial institutions charge for borrowing balances at the federal reserve. This rate is determined by multiple financial institutions in cooperation. Meanwhile, treasury bonds are bought for long periods of time. The money used to purchase the bond is essentially lent to the U.S. treasury, who in turn give the buyer interest back of a certain rate. [7]

Bonds can be sold before they reach a maturity date, but the interest rate on them could change over time. Bond yield represents the financial return that the buyer receives. It is calculated by taking the yearly interest rate payment and dividing it by the price of the bond at the time of selling it.

Interest rate spread is found by subtracting federal funds rate from the yield of treasury bonds with 10-year terms. In general, if bond yields increase and they near maturity, then there will be a positive interest rate. Interest rates will go down if the opposite happens, and this can be a sign of a recession occurring. In such a time, bond owners are likely to start selling off what they have so they can liquidate their assets and be ready for the recession.

Thus, the interest rate spread seems to be a strong economic indicator. Despite all this, on its own, it does not seem to be able to predict the presence of a recession. The prediction results from training a time-series of 10-year U.S treasury constant maturity minus federal rates ended up with identical results to making predictions with unemployment rate.

TABLE IV. CONFUSION MATRIX FOR INTEREST RATE SPREAD PREDICTION

	Predicted: Expansion (0)	***Predicted: Recession (1)***
Actual: Expansion (0)	True Negative = 132	False Positive = 0
Actual: Recession (1)	False Negative = 18	True Positive = 0

The reason for this could be similar as to why predicting with unemployment rate did not work. For one, low interest rate spread is a symptom of recession more than it is an indicator of one coming. Recessions are not generally declared by the US treasury or government until the economy is well into one, so a lot of the activity of selling off bonds in bad economic times may occur at the start of a recession and not right before. Also,

interest rate spread may be another indicator that does not work so strongly on its own and must be paired with other potential indicators as well.

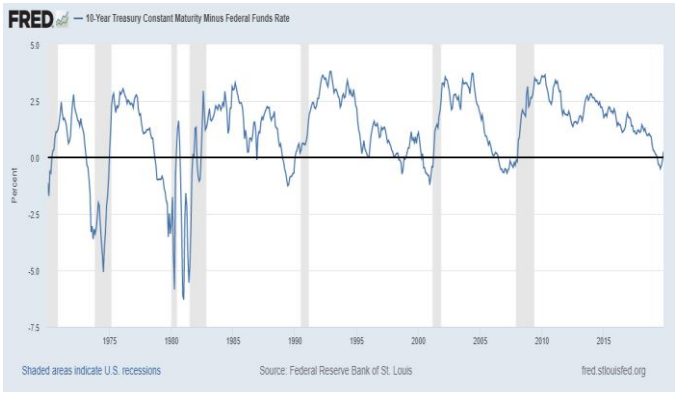

Fig. 5. Time-series data for 10-year treasury constant maturity minus federal funds rate

Looking at the time series graph for maturity rates, you can see that while for the most part recessions occur at times of low interest rates, it is not always at the lowest point. The shaded regions on the graph represent times of U.S. recession, and in the last three recessions, interest rate is at its lowest in a long time right before the recession occurs.

This lends to the unpredictable nature of a recession since it begins when the interest rate starts to increase from the trough. It is not quite as simple as having a negative interest rate guarantees recession. There are instances of interest rate spread dropping below 0 and no recession following, but it happens enough to warrant attention now and in the future.

From the confusion matrices for interest rate spread and unemployment rate, it looks as though they are lagging indicators of a recession and not immediate indicators. A lagging indicator is something that undergoes change after a large change in some target variable has occurred [8]. If the target value is something such as GDP, where two quarters of a low GDP indicate a recession present, then unemployment and interest rates would be lagging indicators since they undergo a big change after the recession hits. Thus, they are useful in identifying recessions but not as much in predicting them.

D. OECD Business Confidence Index

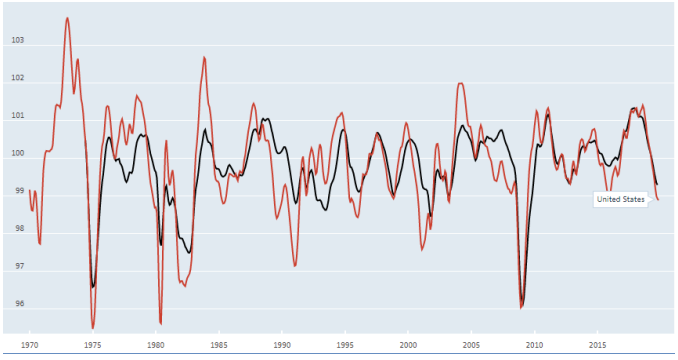

Fig. 6. Chart of US Business Confidence Index time series values from 1970 to 2019 (US in red; OECD total among all countries in black)

Another economic indicator that comes from the OECD is the Business Confidence Index (BCI). The BCI is determined from opinion surveys on developments in production and stocks on goods in the industry sector [9]. Values above 100 show optimism and increased confidence in business performance and values below 100 indicate a lack of confidence in business performance. It is similar to the Consumer Confidence Index since it is about the confidence that people have but the difference is that CCI reflects how consumers feel about the economy and how they will likely spend or save their money, while BCI instead focuses on the performance of businesses and not the individual consumer.

TABLE V. CONFUSION MATRIX FOR BCI PREDICTION

	Predicted: Expansion (0)	***Predicted: Recession (1)***
Actual: Expansion (0)	True Negative = 132	False Positive = 0
Actual: Recession (1)	False Negative = 10	True Positive = 8

In terms of recession prediction, BCI is stronger than some of the individual economic indicators such as unemployment rate and interest rate spread. Prediction was strong with both logistic regression and support vector machine but was slightly better with support vector machine. Predicting with BCI data managed to be able to predict some recession months accurately, and with no false recession predictions.

The higher accuracy regarding recession prediction does not necessarily make it a better indicator for recession. Predicting on the CCI data yielded more recession predictions with an accuracy of 15/21 = 71%. Taking into consideration that the test data has 18 recession months in the set, the CCI predictions managed to predict almost as many recessions as the test data had with decent accuracy. Meanwhile, the BCI predictions only managed to correctly predict half of them so CCI is the stronger recession indicator based on the recession data being used to train on.

There are some other index values that could be strong economic indicators but are not available for free such as the Purchasing Manager's Index (PMI) and the Conference Board's Leading Economic Indicator. Looking at the indicators that were investigated, it is hard to say that any of them can confidently predict a recession. The OECD index values seem to give a decent idea as to whether a recession may be approaching, but it is far from a guarantee. The individual economic variables such as unemployment rate and interest rate spread would generally seem to be useful indicators of a recession, but outside factors and rippling effects from abnormal values for those variables reduces the strength of them as indicators.

III. Recession prediction with multiple indicators

For the most part, single variable analysis was not strong in predicting which months are in a recession. A potential way to improve prediction would be to consider multiple indicators seeing as how they all hold relevance to the strength of an economy. Each of the four indicators mentioned in this paper were put into one feature set and recession predictions were made by a support vector machine. Support vector machine is a useful classifier for data with multiple features since it is easy to implement and can provide accurate results versus linear or logistic regression. CCI data managed to predict a recession with an accuracy score of 71 percent, so it is expected that using all these indicators should improve on that figure.

TABLE VI. Confusion matrix for multiple indicator prediction

	Predicted: Expansion (0)	***Predicted: Recession (1)***
Actual: Expansion (0)	True Negative = 130	False Positive = 2
Actual: Recession (1)	False Negative = 2	True Positive = 16

The indicator data was trained on a support vector machine with a linear kernel. Linear kernel gave stronger predictions than the other kernels likely due to the simplicity of the data since it is just simple integer values, but another kernel should be better to use when dealing with a much larger dataset or different types of values. With an accuracy score of 97%, predicting with all the indicators is clearly the strongest prediction method. Using multiple indicators helps with both expansion and recession prediction, but expansion prediction was already easily done by the other single variable analysis. What is more interesting is how recession prediction has improved accuracy greatly. With sixteen out of eighteen recession predictions correct, that is an accuracy score of 89% for recession prediction. This is an 18% improve in recession prediction over predicting with CCI index values. There are many other potential economic indicators that are used in projecting and predicting economy status, so this accuracy could be improved upon even more. Applying this to the real world is a little more difficult because one would have to account for the volatility of markets. Economists with PhDs cannot tell us when a recession is coming but keeping track of trends with economic indicators can help in deciding when a recession may be coming. A potential solution that was not done is to take many more economic indicators from the OECD or FRED databases as inputs in a neural network and get an output of recession or expansion. A recurrent neural network may be the best option due to the autoregressive nature of the problem seeing as how economy and market time-series data has a certain degree of randomness. Considering the high accuracy that was obtained from a support vector machine, using other indicators in a recurrent neural net should create a recession prediction model that could approach 100 percent certainty, but not quite reach it. With all the data that is available today, one can get a good idea of when a recession may come.

References

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