WHITE PAPER

THE PREDICTIVE VALUE OF THE IVEY PMI FOR MONTHLY CANADIAN GDP

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Ivey

Abstract

The Ivey Purchasing Managers Index (Ivey PMI) is a measure of month-to-month variation in Canadian economic activity, collected by surveying a panel of purchasing managers, and is prepared by the Ivey Business School (Ivey). This paper presents two models that use the Ivey PMI data to forecast the monthly GDP growth rate in Canada. Findings indicate that the Ivey PMI provides predictive power for forecasting Canadian macroeconomic activity. Specifically, results show that when Ivey PMI hits one standard deviation or higher than the mean, there is a 0.1459 percent increase in the growth rate of monthly GDP in the current month. The proposed models provide an improvement over the performance of standard forecasting models. Findings presented in this paper provide opportunities for governmental agencies, managers and scholars to use the Ivey PMI for predicting monthly GDP growth rate in Canada.

1. Introduction

The Ivey Purchasing Managers Index (Ivey PMI) is a measure of month-to-month variation in Canadian economic activity, collected by surveying a panel of purchasing managers, and is prepared by the Ivey Business School (Ivey). The Ivey PMI is one of five economic indices collected; the other four are employment, inventories, supplier deliveries and prices. Collectively, these are referred to as the Ivey Indices.

This paper presents two models that use the Ivey PMI data to forecast the monthly GDP growth rate in Canada. The first model uses the adjusted Ivey PMI series as the regressor in a simple regression to predict the GDP growth rate. The second model extracts the trend in the series, and hence provides an alternative way to use the Ivey PMI data for the purposes of forecasting GDP.

We found that the Ivey PMI provides predictive power for forecasting Canadian macroeconomic activity. Specifically, the Ivey PMI data can be used to predict movements in monthly GDP growth in Canada. The proposed models provide an improvement over the forecasting performance of standard models, such as the random walk model and a first order autoregressive model.

In the next section, we summarize the literature for research in purchasing managers indices. Section 3 provides the methodology and data analysis, and section 4 presents the findings and discussion of the results. The conclusion and opportunities for future research are provided in section 5.

2. Previous Research

Table 1 provides a summary of the PMI literature. Purchasing managers indices are available in most developed economies and previous research has found that they can be useful in predicting fluctuations in economic activity. Using data from the Institute for Supply Management (ISM) PMI, Harris (1991) found that the index added predictive power in forecasting general macroeconomic conditions. In particular, combined with other economic variables, it can be helpful to forecast the overall

economic conditions and short-term trends in the economy. More recently, research by Koening (2002), provided evidence that the ISM PMI could be used to forecast U.S. GDP growth rate. The author argued that if the index were to be used by itself, the level would matter. The index could also be used to signal changes in monetary policy. De Bondt (2012) found similar results using data from Euro region PMIs to predict the quarterly growth rate of real GDP. GDP forecasts in the near future based on PMI data were found to be more accurate than officially released GDP estimates in the Euro region. This is especially true when the economy is not going through a crisis.

There has also been limited literature using the Ivey PMI to predict macroeconomic conditions in Canada. Cho and Ogwang (2006) was among the first to evaluate Ivey PMI as a leading indicator of Canadian economic activity. Using principal component analysis, they compared the use of the Ivey PMI and composite Ivey Indices in predicting the GDP growth rate, finding that the Ivey PMI provided predictive power. Scotti (2016) constructed weights for data on output, industrial production, employment, retail sales and Ivey PMI using a dynamic factor model. The author constructed a surprise index that summarizes recent economic data surprises and measures the outlook of the state of the economy using these data. He found that such an index can be a parsimonious way to represent the surprising events in the economy.

In contrast to methodologies used in previous research (e.g., Cho and Ogwang (2006) and Scotti (2016)), this paper uses regression analysis to assess the predictive power of the Ivey PMI for changes in GDP. However, the results are consistent with prior research, where the Ivey PMI has predictive power for economic activity.

3. Methodology

Collection of data for the five Ivey Indices started in December 2000, and has been collected monthly on a continuous basis since that time. The raw data are seasonally adjusted according to the United States Census Bureau's X12-ARIMA Seasonal Adjustment Program. A similar approach is applied to macroeconomic variables released by Statistics Canada. Appendix 1 provides a description of the data collection process for the Ivey Indices.

The analysis in this paper covers the period from December 2000 to December 2016. Table 2 provides the mean and variance of each series, and Table 3 provides the correlation matrix of the PMI indices. The unadjusted data has greater variability compared to the adjusted data, as indicated by the higher standard deviations. The following analysis uses the adjusted PMI series as explanatory variables, which is consistent with the other macroeconomic variables used in the models.

Monthly GDP

The total quantity of goods and services produced in the economy for a given period is called aggregate output, or gross domestic output (GDP). GDP series are released in two frequencies. The quarterly data series released by Statistics Canada is collected from the income or the expenditure approach. The monthly data series supplements the quarterly data series. The data is collected by measuring activities associated with the production of goods and services from each industry. For the purposes of our analysis we use the growth rate of monthly GDP, which is collected by Statistics Canada and is released with a lag of two months. For example, the GDP of December in 2016 was released in February 2017. The monthly growth rate of GDP has a mean of 0.16 percent, and a standard deviation of 0.25.

Data Analysis

We used regression analysis to assess the predictive power of the Ivey PMI for monthly GDP growth. The results are then used to forecast the monthly GDP growth

in 2016. The sample was split into a regression sample (or a training sample) and a hold-out sample (or a testing sample). We fit linear time series models on the regression sample, and used fitted models to predict the macroeconomic variables on the hold-out sample. The regression model used in the analysis was:

$$mGDP_t = \beta_1 + \beta_2 pmi_t + e_t,$$

where:

$mGDP_t$ is the monthly growth rate of GDP.

pmi_t is the monthly released adjusted Ivey PMI or the binned index constructed below.

A one-standard deviation rule was used to construct the binned index of the Ivey PMI. The values of Ivey PMI in the given time frame were classified into three groups: high, normal, or low. The thresholds for these groups were the mean of the Ivey PMI plus or minus the standard deviation of the series. If the value of Ivey PMI was above the mean plus one standard deviation, it was classified as high, or "+1" in the regression analysis. If the value of the Ivey PMI was below the mean minus one standard deviation, it was classified as low, or "-1" in the regression analysis. If the value of the Ivey PMI was between the two threshold values, it was classified as norm, or "0" in the regression analysis. Based on a normal standard deviation, approximately 15 percent of the data would be in the high group and approximately 15 percent of the data would be in the low group.

The significance of correlation coefficients in regression were considered as a measure of the goodness of fit for the models. To calculate the statistical significance of the coefficients, it was assumed that the true parameter value followed a standard normal distribution, and that it could be tested against the null hypothesis that the coefficient was nonzero using a standard t-test.

To analyze the predictive power of Ivey PMI, the correlation coefficients in front of Ivey PMI series should be statistically significantly different from zero. The point estimate of the correlation coefficient is also provided in Table 4.

Forecast accuracy was compared to a random walk model and a standard autoregressive model of order 1 (abbreviated as the AR(1) model). The MSFE and directional prediction were compared to a random walk model and a AR(1) model. The random walk model does not need fitting, but instead uses the lag of a series at a given month, to predict its value in the future month. For instance, if we were interested in predicting the monthly GDP growth rate in August 2011 using the random walk model, the predicted value would be the monthly GDP growth rate in July, 2011.

The AR(1) model is slightly more complicated. We first fitted the data to the following form and estimate the coefficient β_1 and β_2:

$$mGDP_{t+1} = \beta_1 + \beta_2 mGDP_t + \varepsilon_t,$$

where:
$mGDP_t$ is the monthly growth rate of GDP
ε_t is assumed to be the standard error term.

We then used the estimated coefficient for forecasting.

The following criteria were used to evaluate the predictive power of the forecasting models:

1. Mean squared forecast error (abbreviated as MSFE), which was calculated as the squared difference between out-of-sample forecasts and the real values. A good forecasting model should have low MSFE. The MSFE of the fitted model

compared benchmark models, such as a random walk model[1], to evaluate predictive power.

2. Directional prediction (DP), which is calculated as the percentage of out-of-sample forecasts that correctly predicts the increase or decrease of the series compared to its value in the previous period. We adopted this measure to augment the MSFE comparison. A low MSFE may not always reflect better predictive power, such as with a series that has values close to zero. In this situation, a low MSFE could be achieved with predictions of zero throughout. Therefore, we also considered directional prediction in the analysis.

4. Findings and Discussion

Table 4 provides the regression results for the monthly GDP growth rate under two different regressors: adjusted Ivey PMI and the constructed binned index that mimics the trend of adjusted Ivey PMI. When using the adjusted Ivey PMI, a one-point increase in Ivey PMI predicts a 0.00171 percent increase in the growth rate of monthly GDP in the current month. A one-point decrease in Ivey PMI hence predicts a 0.00171 percent decrease. Using the binned index, the model predicts that when Ivey PMI hits one standard deviation or higher than the mean, there is a 0.1459 percent increase in the growth rate of monthly GDP in the current month. Similarly, when Ivey PMI hits one standard deviation or lower than the mean, there is a 0.1459 percent decrease in the growth rate.

Table 5 presents the forecasting results using two regressors. The hold-out sample consisted of 12 data points in 2016. As mentioned previously, we use MSFE and DP to measure the forecast accuracy. The forecast performance of the proposed models provided an improvement over the random walk and the AR(1) model in terms of

[1] The random walk model is widely used in finance and forecasting. For example, to predict the stock price tomorrow, a random walk model takes the stock price today plus a random shock.

forecast accuracy. In particular, the proposed models have approximately a 60 percent improvement over the MSFE of commonly used random walk and AR(1) models. The model using the binned index can predict the direction of change in the growth rate correctly 90 percent of the time. Figures 1 and 2 provide a plot of the forecasted series against the actual values in the hold-out sample, along with estimated five percent confidence intervals.

5. Conclusion

Using the two simple regression models with Ivey PMI, we found that there is predictive power using the Ivey PMI for monthly GDP growth rate in Canada. In particular, the model with binned index has a simple yet useful interpretation for predicting the monthly GDP growth rate. Thus, the results presented in this paper provide opportunities for governmental agencies, managers and scholars to use the Ivey PMI for predicting monthly GDP growth rate in Canada. The results in this paper show that when Ivey PMI hits one standard deviation or higher than the mean, there is a 0.1459 percent increase in the growth rate of monthly GDP in the current month. For example, Ivey PMI hit one standard deviation lower the mean in Oct., 2008 – Mar., 2019. The model predicts consistent decreases in the growth rate of monthly GDP for the six months, which is true in the data.

Future research can focus on exploiting the information contained in other Ivey PMI series. In this paper, we presented results and forecast accuracy improvements using the Ivey PMI. There are four other Ivey PMI series: employment, prices, supplier deliveries and inventories. This data may be useful in predicting economic performance, including the unemployment rate, inflation rate, or interest rates. One possibility would be to construct a composite index, similar to the approach taken by ISM, to forecast overall economic performance.

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Table 1: Relevant literature on purchasing manager's index

Country	Literature	Data Source	Findings
U.S.	Harris et al. (1991)	(ISM PMI) New orders, production, employment, deliveries, and inventories	Effective, but can be misleading
	Koenig et al. (2002)		Important for economic activities and monetary policies
	Afshar et al. (2011)		Causal relations with GDP is present
Canada	Cho & Ogwang (2008) and Bragoli & Modugno (2017)	(Ivey PMI) Purchases, employment, price, deliveries, and inventories	Not as helpful as ISM PMI on Canadian economy
	Scotti (2016)		Contributes to the surprise index for Canadian economy
	Rossiter (2010)	(Markit PMI) New orders, output, employment, deliveries, and inventories	Reliable predictor for trends, but not good at forecasting the extent of the financial crisis
Europe	de Bondt (2012)	Output	Higher forecasting ability than models without PMI

Table 2: Summary statistics for the adjusted and unadjusted series

Data Series		Mean	Standard deviation
Ivey PMI, adjusted		56.4	5.62
Ivey PMI, unadjusted		56.4	7.24
PMI price, adjusted		62.7	6.43
PMI price, unadjusted		62.7	7.12
PMI employment, adjusted		53.3	4.36
PMI employment, unadjusted		53.3	5.14
PMI delivery, adjusted		46.3	3.46
PMI delivery, unadjusted		46.3	3.65
PMI inventory, adjusted		51.7	5.26
PMI inventory, unadjusted		51.7	5.65

Table 3: Correlation matrix of the Ivey PMI

	Ivey PMI	Price	Employment	Delivery	Inventory
Ivey PMI					
Price	0.468***				
Employment	0.486***	0.359***			
Delivery	-0.133*	-0.275***	-0.077		
Inventory	0.547***	0.437***	0.419***	-0.215***	

Note: Results based on Pearson's product-moment correlation.

***p<0.01; *p<0.1; N=192.

Table 4: Regression results for the monthly GDP growth rate

Regressor	Ivey PMI	Binned Index of Ivey PMI
Data frame	Dec., 2000 – Dec., 2016	Dec., 2000 – Dec., 2016
Coefficient β_2	0.00171***	0.1459***

***p<0.01

Table 5: Forecasting results for the monthly GDP growth rate in 2016

Regressor	Adjusted Ivey PMI	Binned Index of Ivey PMI
Mean Squared Forecast Error (MSFE)	0.0108	0.0957
MSFE improvement upon random walk model	58.84%	63.54%
MSFE improvement upon AR(1) model	17.07%	26.54%
Successfully predicting the direction of change (DP)	0.7273	0.9091
DP improvement upon random walk model	300%	300%
DP improvement upon AR(1) model	400%	400%

Figure 1: Plot of forecast using adjusted PMI for purchases

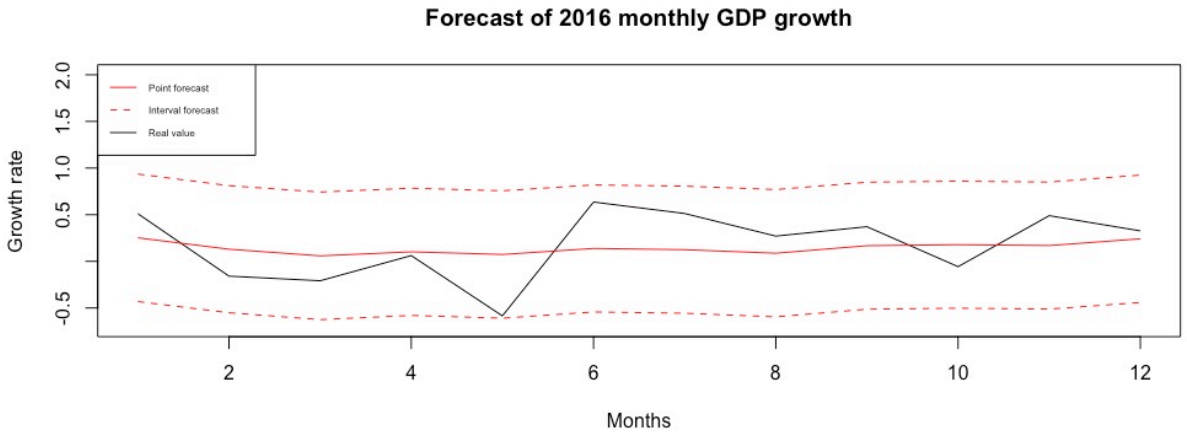
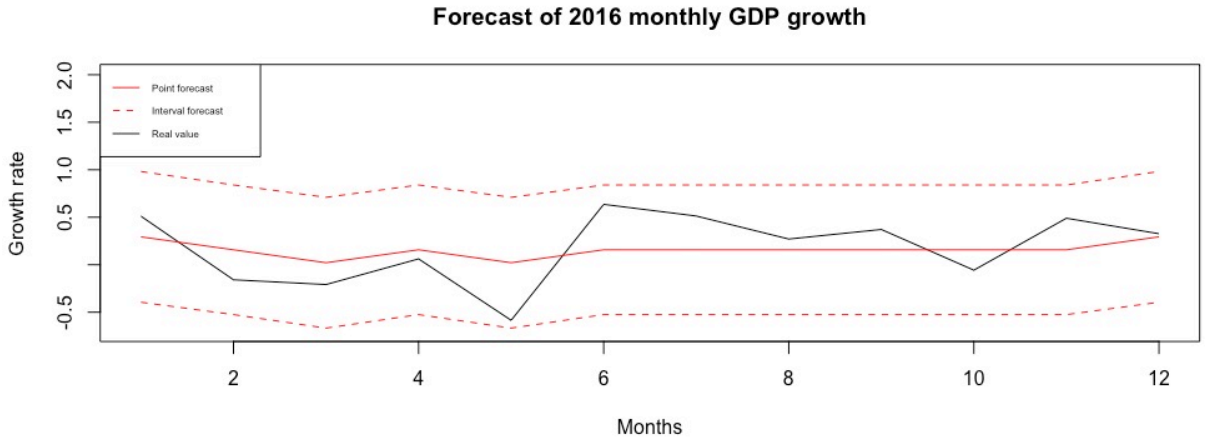


Figure 2: Plot of forecast using binned index of PMI for purchases



Appendix 1: Ivey PMI Data Collection Process

The Ivey PMI measures month to month changes in dollars of purchases as indicated by a panel of purchasing managers who have been carefully selected geographically and by sector of activity to match the Canadian economy as a whole. The PMI includes both the public and private sectors and is based on month end data. Ivey PMI panel members indicate whether their organizations activity is higher than, the same as, or lower than the previous month across the following five categories: purchases, employment, inventories, supplier deliveries, and prices.

The Ivey PMI indices consist of five series: purchases, employment, inventory, supplier deliveries, and prices. Each index represents a summary of the response to the following questions:

Purchases:

Is the overall level of purchases in ($) in your organization:
Greater than a month ago
Same as a month ago
Less than a month ago

Employment:

Is the level of employment in your organization:
Higher than a month ago
Same as a month ago
Less than a month ago

Inventories:

Is the current overall level (in units, not dollars) of PURCHASED inventories (including raw, MRO, intermediaries, but NOT finished goods, unless purchased):
Higher than a month ago
The same as a month ago
Lower than a month ago

Supplier Deliveries:

Is the month's average rate of supplier deliveries:

Faster than a month ago

The same as a month ago

Slower than a month ago

Prices:

Is this month's net average weighted prices of the requirements you buy:

Higher than a month ago

The same as a month ago

Lower than a month ago.

Each index is calculated by categorizing the survey responses into percentages of higher than, the same at, or lower than the previous month. The difference between the higher and lower percentages, either positive or negative, is divided by two. The resulting number is added to or subtracted from 50 to give the monthly index number. An index below 50 indicates a decrease compared to the previous month, and an index above 50 indicates an increase.