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# ASSESSING THE SHORT-TERM FORECASTING POWER OF CONFIDENCE INDICES

Euler Pereira G. de Mello *
Francisco Marcos R. Figueiredo †

**Resumo**

Este artigo avalia o poder preditivo dos principais índices de confiança disponíveis no Brasil para com relação a atividade econômica. Mais especificamente, consideramos um conjunto de variáveis de atividade econômica e, para cada uma delas, comparamos o poder preditivo de um modelo autorregressivo univariado com o de um modelo similar que inclui um índice de confiança. Os resultados preliminares utilizando o teste Diebold-Mariano sugerem que o Índice de Confiança da Indústria fornece informações relevantes, tanto para o presente quanto para o futuro, para algumas variáveis de atividade econômica de interesse para os agentes econômicos.

**Palavras-chave:** Indices de confiança; Atividade econômica; Previsão

**Abstract**

This paper assesses the predictive power of the main confidence indices available in Brazil to forecast economic activity. More specifically, we consider a set of economic activity variables and, for each of those, compare the predictive power of a univariate autoregressive model to that of a similar model that includes a confidence index. Preliminary results using the Diebold Mariano test suggest that the Industry Confidence Index provides relevant information, for both present and the near future, on some economic activity variables of interest to the economic agents.

**Keywords:** Confidence indices; Economic activity; Forecasting
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* Research Department (Depep), Banco Central do Brasil. E-mail: euler.mello@bcb.gov.br
† Research Department (Depep), Banco Central do Brasil. E-mail: francisco-marcos.figueiredo@bcb.gov.br

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## 1 Introduction

A proper assessment of the current level of economic activity is of utmost importance to the decisions of the economic agents. Nonetheless, measures of economic activity are released with some time lag, leading agents to search for leading/coincident indicators to help their decision-making process. An important class of such measures is composed of confidence indices, measures that aim at capturing the perception of determined groups of economic agents about the current and future development of some key variables.

A relevant empirical question is, thus, whether confidence indices contain any piece of relevant information about the current/future behavior of the level/rate of economic activity growth. As shown in Curtin (2000), this issue has been under debate since the release of the first confidence surveys[1]. There is still no consensus in the literature, but according to Dées & Brinca (2013), most authors find a statistically significant relationship between measures of confidence and the current and future behavior of economic variables. Mourougane & Roma (2003), Ludvigson (2004) and Wilcox (2007) for the US, Kwan & Cotsomitis (2006) for Canada and Easaw & Heravi (2004) for the UK find that consumer confidence tends to reduce forecasting errors in models that include traditional macroeconomic variables. On the other hand, Smith (2009) for the UK, Al-Eyd et al. (1986) for OECD countries and Claveria et al. (2007) for Euro zone members show that the predictive power of those indices is weak and limited to a few cases, or even inexistent.

In Brazil, the increasing importance given to confidence indices is reflected in both the increase in the number of confidence indices and in the amount of media coverage dedicated to their release. Nonetheless, there is a lack of research on assessing the relevance of those indicators to help predict current/future economic variables. Such an assessment is relevant for the design and implementation of monetary policies, since it tries to identify the potential of those indices to provide additional pieces of information about the current state of the economy and signals about its future path.

For the Brazilian case, one of the few papers is that of Bentes (2006), which aims at identifying the predictive power of the Consumer Confidence Index (ICC), computed by the Federação de Bens, Serviços e Turismo (Fecomercio) do Estado de São Paulo, with respect to different consumption categories, after controlling for some macroeconomic variables, such as unemployment, industrial production and inflation. The results obtained by that author are highly heterogeneous, with emphasis on the positive effect for automobiles.

This paper aims at taking a step towards assessing the predictive power of the main confidence indices available for the Brazilian economy as a whole. More specifically, the proposed exercise is to consider a set of economic activity variables and, for each of those, compare the predictive power of a univariate autoregressive model against a similar model that, on top of the autoregressive part, includes an appropriate confidence index. Our preliminary results point out that the Industry Confidence Index (ICI) provides relevant

[1] George Katona at the University of Michigan's Survey Research Center constructed the first consumer survey in 1946. This was the precursor to the University of Michigan's Index of Consumer Sentiment. Using the 1953 sample of this survey, Klein & Lansing (1955) found that surveys questions on buying intentions, feeling of financial well-being and price expectations predict consumer expenditures on durable goods.

information, for both present and the near future, on some economic activity variables of interest to the economic agents.

An important limitation of confidence measures is that they are subjective assessments - which might stem from a mix statistical modeling and judgments, of the current and future environment where economic agents make their decisions. Furthermore, as shown by Dominitz & Manski (2004), such indices might be contaminated by measurement errors, since their survey questions might be ambiguous and their qualitative aspect might hinder quantitative assessments. Nevertheless, we follow the literature and assume that the indices used in this paper are good approximations for the agents' perceptions about the economic environment and, hence, would be good candidates for improving the prediction of economic activity variables.

The sections of this paper are organized as following. In the next section, we describe both the confidence indices and the variables used by this work to measure the Brazilian economic activity. Section 3 describes the methodology and our estimation strategy. We present our results in Section 4, while we conclude and discuss further extensions in Section 5.

## 2 Data

Currently, there are several confidence indices available for the Brazilian economy. In the top half of Table 1, we present the confidence indices considered in this paper. From Fundação Getulio Vargas (FGV), we included the confidence indices based on the Consumer Survey (the Consumer Confidence Index - ICC and the Coincident Indicator of Unemployment - ICD) and the Manufacturing Industry Survery (Industry Confidence Index - ICI and the confidence indices for the capital goods and for the construction material sectors). We also consider two other consumer confidence indices for our analysis: the National Confidence Index (INC), from the Associação de Comércio de São Paulo (ACSP); National Consumer Confidence Index (INEC), from the Confederação Nacional da Indústria (CNI). Finally, we include the Business Confidence Index (ICEI) from CNI and Markit's Purchasing Manager's Index (PMI).

There are other confidence indices for the Brazilian economy that were not included in our analyses, either because they do not cover the country as a whole (e.g., the Consumer Confidence Index of Rio Grande do Sul, from the Centro de Estudos e Pesquisas em Administração da Universidade Federal do Rio Grande do Sul) or because their time span is too short (e.g., Services Sector Survey and the Construction Survey, from FGV).

Table 1 also shows the variables used to capture the level of economic activity, computed by the Instituto Brasileiro de Geografia e Estatística (IBGE). From the Monthly Survey of Industry (PIM), the Physical Production Indices for Manufacturing, Capital Goods and Construction Materials were used[2]. From the Monthly Survey of Trade (PMC), we considered the Extended Retail Sales Volume Index (PMC - Extended), which includes vehicles and construction inputs, and the (restrict) Retail Sales Volume Index (PMC - Restrict).

[2]The data from PIM have suffered a change in the methodology, to incorporate the classification CNAE 2.0, from IBGE. The original series were discontinued in February 2014. Using the new classification, the starting date would be 2002, thus, in order to have more data, for those series from PIM, we chose to keep using the original series and stop our analyses at February 2014.

**Table 1**: Confidence indices and measures of activity level used in the analysis

| **Variable**[a)] | **Acronym** | **Source** | **Frequency*** | **Releasing Date for Period t**** |
|---|---|---|---|---|
| Confidence Indices | | | | |
| Industry Confidence Index (ICI) | ICI | FGV | M | 25th of month $t$ |
| ICI-Capital Goods | BK.ICI | FGV | M | 25th of month $t$ |
| ICI-Construction Material | MC.ICI | FGV | M | 25th of month $t$ |
| Consumer Confidence Index | ICC | FGV | M | 25th of month $t$ |
| Coincident Indicator of Unemployment | ICD | FGV | M | 10th of month $t+1$ |
| Purchasing Manager's Index | PMI | Markit | M | 1st of month $t+1$ |
| National Confidence Index | INC | ACSP | M | 10th of month $t+1$ |
| National Consumer Confidence Index[b)] | INEC | CNI | Q[b)] | 30th of month $t$ |
| Business Confidence Index[b)] | ICEI | CNI | Q[b)] | 15th of month $t$ |
| Activity Level Variables | | | | |
| Physical Production Index for Manufacturing Industry | PIM-Manufacturing | IBGE | M | 1st of month $t+2$ |
| Physical Production Index for Civil for Construction Materials | PIM-Construction | IBGE | M | 1st of month $t+2$ |
| Physical Production Index for Capital Goods | PIM-Capital Goods | IBGE | M | 1st month of $t+2$ |
| Unemployment Rate | Unemployment | IBGE | M | 10th of month $t+2$ |
| Retail Sales Volume Index | PMC-Restrict | IBGE | M | 15th of month $t+2$ |
| Extended Retail Sales Volume Index | PMC-Extended | IBGE | M | 15th of month $t+2$ |
| Household Consumption Expenditures in GDP | GDP-Consumption | IBGE | Q | End of $2^{nd}$ month of $t+1$ |
| Manufacturing Industry in GDP | GDP-Manufacturing | IBGE | Q | End of $2^{nd}$ month of $t+1$ |
| Civil Construction in GDP | GDP-Construction | IBGE | Q | End of $2^{nd}$ month of $t+1$ |
| Gross Fixed Capital Formation in GDP | GDP-GFCF | IBGE | Q | End of $2^{nd}$ month of $t+1$ |

Sources: Fundação Getúlio Vargas (FGV), Markit, Associação Comercial de São Paulo (ACSP) and Instituto Brasileiro de Geografia e Estatística (IBGE): Monthly Survey of Industry - Physical Production (PIM), Monthly Employment Survey (PME), Monthly Survey of Trade (PMC) and National Accounts System (SCN).
a) Seasonally adjusted data. INC, INEC and ICEI were seasonally adjusted by the authors using X12-ARIMA.
b) Data were transformed into quarterly series since 2010 using quarterly averages. * M = Monthly; Q = Quarterly. ** Approximation based on the latest releases.

Regarding the Quarterly National Accounts, the GDP components for household consumption expenditures, manufacturing industry, civil construction industry and gross fixed capital formation were used.

The sample considered in this paper was determined by the availability of the confidence indices, and thus, varies depending on the particular index at study. Table 2 shows the starting point of the sample for each index, the total number of observations and some descriptive statistics[3]. In some sense, this table also helps emphasize three limitations of this paper. First, the available time series have a relative short time span (ranging from 50 to 222 observations), which might hinder the power of our tests. Second, confidence indices are qualitative, usually summarized in a scale from 0 to 200, with values higher than 100 indicating optimism[4]. Therefore, the relationship between the confidence index and the predicted variable could depend on the level of the confidence index (with different patterns depending whether the actual level is lower or higher than 100), something that is not explored in this paper. Finally, this paper only considers some of the several possible relationships that could be tested, though it focuses on the simplest and less subjective type of forecasting models.

In the next section, we will describe our strategy to test the predictive power of the aforementioned confidence indices.

## 3 Methodology and estimation strategy

As mentioned before, this paper considers a set of variables concerning the growth rate of economic activity and for each of them, compares the predictive power of a univariate autoregressive model (Equation (1)) against the predictive power of a similar model that includes a confidence index (Equation (2)):

$$\text{Univariate:} \qquad y_{t+h} = \alpha + \sum_{i=1}^{P} \beta_i y_{t-i} + \epsilon_{t+h} \tag{1}$$

$$\text{Extended model:} \qquad y_{t+h} = \alpha + \sum_{i=1}^{P} \beta_i y_{t-i} + \sum_{j=0}^{K} \gamma_j y_{t-j} + \epsilon_{t+h} \tag{2}$$

where $y_t = \Delta lnY_t$, $ic_t = \Delta lnIC_t$. $Y_t$ is period's $t$ value of the variable capturing the level of economic activity and $IC_t$ is period's $t$ value of the confidence index. The forecasting horizon for the above equations is $h$.

For the pseudo-out-of-sample forecast, there are two possible approaches. We could estimate a model to make a one-step-ahead prediction and then obtain the forecast for $h$ steps by iteration. We could, alternatively, build a model aimed directly at forecasting $h$ steps ahead, using $Y_{t+h}$ as the dependent variable (direct forecast). Even though the best approach to follow is an empirical question, theory suggests that direct forecasts are more robust to misspecifications, whereas the iterative procedure would be more efficient in case the

[3]The descriptive statistics for the logarithm values of the variables were shown in Table A.1.

[4]Nonetheless, there are exceptions, *e.g.*, the Purchasing Managers' Index (PMI) and the Business Confidence Index (ICEI), which range from 0 to 100, values of 50 or higher would be considered optimism.

**Table 2**: Descriptive statistics of confidence indices and activity level measures and activity level measures

| Variable | Beginning of | Obs. | Standard | Minimum | Maximum | |
|---|---|---|---|---|---|---|
| Confidence Indices | | | | | | |
| Monthly | | | | | | |
| ICI | Apr/1995 | 233 | 98.8 | 10.4 | 69.5 | 117.5 |
| ICI-Current Situation (ICI-ISA) | Apr/1995 | 233 | 99.1 | 11.8 | 67.3 | 121.3 |
| ICI-Expectations (ICI-IE) | Apr/1995 | 233 | 98.5 | 9.5 | 71.7 | 116.6 |
| BK.ICI | Apr/1995 | 233 | 95.9 | 18,7 | 51.1 | 128.2 |
| BK.ICI-Current Situation (BK.ICI-ISA) | Apr/1995 | 233 | 96.7 | 21.4 | 45.6 | 139.4 |
| BK-ICI-Expectations (BK.ICI-IE) | Apr/1995 | 233 | 95.0 | 17.4 | 47.2 | 124.8 |
| MC.ICI | Apr/1995 | 233 | 102.3 | 13.9 | 55.8 | 136.7 |
| MC.ICI-Current Situation (MC.ICI-ISA) | Apr/1995 | 233 | 102.5 | 14.9 | 42.8 | 143.6 |
| MC.ICI-Expectations (MC.ICI-IE) | Apr/1995 | 233 | 102.1 | 14.4 | 68.3 | 129.7 |
| ICC | Sep/2005 | 108 | 112.0 | 7.5 | 94.7 | 127.8 |
| ICC-Current Situation (ICC-ISA) | Sep/2005 | 108 | 119.5 | 15.1 | 96.8 | 147.8 |
| ICC-Expectations (ICC-IE) | Sep/2005 | 108 | 108.0 | 5.2 | 93.1 | 119.4 |
| ICD | Sep/2008 | 106 | 78.4 | 14.4 | 60.4 | 101.9 |
| PMI | Nov/2005 | 103 | 51.0 | 3.6 | 38.1 | 57.8 |
| INC | Apr/2005 | 113 | 141.1 | 13.8 | 113.9 | 170.7 |
| Quarterly | | | | | | |
| INEC | $1^{st}$ Q/2001 | 54 | 109.8 | 4.9 | 97.1 | 117.8 |
| ICEI | $2^{nd}$ Q/1999 | 61 | 58.0 | 4.9 | 46.9 | 69.7 |
| Activity Level Variables | | | | | | |
| Monthly | | | | | | |
| PIM-Manufacturing | Jan/1995 | 230 | 109.0 | 13.4 | 87.3 | 130.8 |
| PIM-Construction Material | Jan/1995 | 230 | 109.8 | 13.1 | 87.0 | 137.1 |
| PIM-Capital Goods | Jan/1995 | 230 | 129.9 | 38.3 | 76.0 | 198.8 |
| Unemployment | Mar/2002 | 146 | 8.5 | 2.4 | 4.6 | 13.2 |
| PMC-Restrict | Jan/2000 | 175 | 77.9 | 20.8 | 53.5 | 116.2 |
| PMC-Extended | Jan/2003 | 139 | 81.2 | 21.2 | 49.6 | 114.8 |

Sources: Fundação Getúlio Vargas (FGV), Markit, Associação Comercial de São Paulo (ACSP) e Instituto Brasileiro de Geografia e Estatística (IBGE).
For ICI, current situation and expectations have weight 50%, for the ICC current situation and expectation have weight 2/5 and 3/5, respectively. Further information can be obtained from the methodological notes available at FGV's site.

**Table 2**: Descriptive statistics of confidence indices and activity level measures and activity level measures (continuation)

| Variable | Beginning of | Obs. | Standard | Minimum | Maximum | |
|---|---|---|---|---|---|---|
| Quarterly | | | | | | |
| INEC | $1^{st}$ Q/2001 | 54 | 109.8 | 4.9 | 97.1 | 117.8 |
| ICEI | $2^{nd}$ Q/1999 | 61 | 58.0 | 4.9 | 46.9 | 69.7 |
| Activity Level Variables | | | | | | |
| Monthly | | | | | | |
| PIM-Manufacturing | Jan/1995 | 230 | 109.0 | 13.4 | 87.3 | 130.8 |
| PIM-Construction Material | Jan/1995 | 230 | 109.8 | 13.1 | 87.0 | 137.1 |
| PIM-Capital Goods | Jan/1995 | 230 | 129.9 | 38.3 | 76.0 | 198.8 |
| Unemployment | Mar/2002 | 146 | 8.5 | 2.4 | 4.6 | 13.2 |
| PMC-Restrict | Jan/2000 | 175 | 77.9 | 20.8 | 53.5 | 116.2 |
| PMC-Extended | Jan/2003 | 139 | 81.2 | 21.2 | 49.6 | 114.8 |
| Quarterly | | | | | | |
| GDP | $1^{st}$ Q/1996 | 69 | 128.2 | 21.1 | 100.1 | 165.3 |
| GDP-Household Consumption | $1^{st}$ Q/1996 | 74 | 131.3 | 25.8 | 98.5 | 178.7 |
| GDP-Manufacturing | $1^{st}$ Q/1996 | 74 | 113.8 | 12.3 | 94.0 | 132.9 |
| GDP-Construction | $1^{st}$ Q/1996 | 74 | 123.9 | 18.8 | 101.3 | 160.4 |
| GDP-GFCF | $1^{st}$ Q/1996 | 74 | 130.0 | 32.1 | 93.5 | 189.4 |

Sources: Fundação Getúlio Vargas (FGV), Markit, Associação Comercial de São Paulo (ACSP) e Instituto Brasileiro de Geografia e Estatística (IBGE).
For ICI, current situation and expectations have weight 50%, for the ICC current situation and expectation have weight 2/5 and 3/5, respectively. Further information can be obtained from the methodological notes available at FGV's site.

model is correctly specified[5]. In this paper, as shown in Equations (1) and (2), we will follow the second approach.

In order to make our pseudo-out-of-sample forecasting exercise as close as possible to a real time analysis, we took into account the availability of confidence indices over time[6]. Figure 1 presents, for the monthly data, the timeline of the release of the confidence indices ($IC$) and the predicted variable ($Y$) built from the release dates shown in Table 1. Since our goal is to exploit the timeliness of confidence index to improve our short-run forecasts of the variables related to the level of economic activity, we compute the forecasts for the current level of economic activity (nowcasting, $h = 0$) and for one step ahead ($h = 1$).

In the case of the nowcasting exercise, as shown in the top half of Figure 1, the forecast for $Y_t$ is computed in the beginning of the $t + 1$ month, once $Y_t$ and $IC_t$ are released (and hence, belong to the information set, the area of Figure 1 shaded in gray)[7].

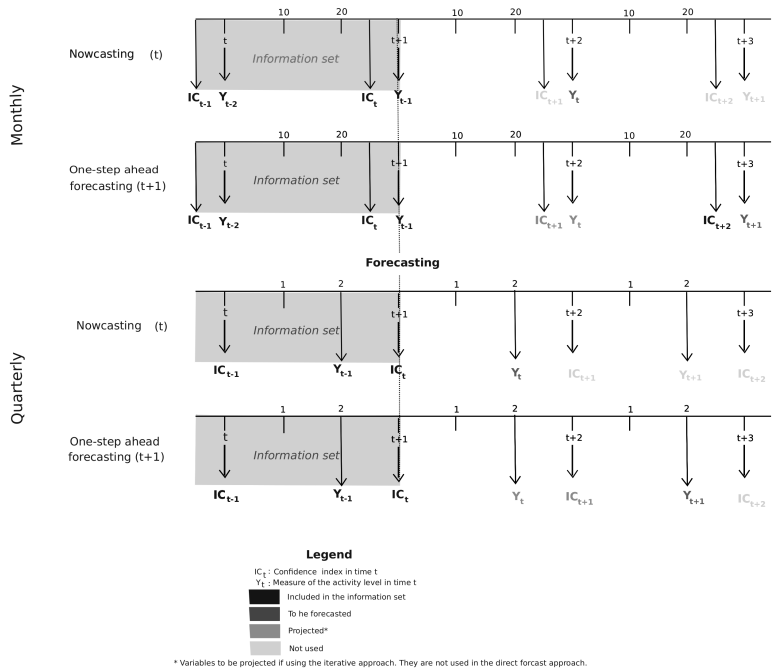


**Figure 1**: Framework for nowcasting and one-step-ahead forecasting - monthly and quarterly data

For the one-step-ahead forecasting, since it is computed at the same point in time as the nowcasting, the information set is the same as before, the only change is that the predicted variable is $Y_{t+1}$ instead of $Y_t$.

[5]See *inter alia* Elliott & Timmermann (2008), Marcellino et al. (2006), and Ing (2003).

[6]Some variables such as GDP and its components are occasionally revised back in time. The data used in the analysis are the latest available vintage of the series in September 2014.

[7]The timeline depicted in Figure 1 was build based on the design of the indices derived from Consumer and Manufacturing Industry surveys, from FGV and from the physical production indices of PIM, IBGE. Nonetheless, the main features of this framework are still valid for other combination of variables. The same reasoning applies to the models that use quarterly data.

In the bottom half of Figure 1, we show the estimation strategy for the models that use quarterly data. The main differences are that the confidence indices used (ICI, INEC and ICEI) had to be converted to a quarterly frequency[8]. Similarly to the monthly data models, the forecast is done in period $t+1$, but with the difference that the last piece of information embodied in the information set is $IC_t$.

The choice of the optimal number of lags for the models in this paper is based on the Bayesian Information Criterion (BIC)[9]. More specifically, among the AR models of order less than or equal to $P$ given by Equation (1), we choose the model with the lowest BIC value. The same criterion is used to select among the models with up to $K$ lags of the confidence index and autoregressive terms of lower order or equal to $P$ given by Equation (2). In this paper, the maximum value for $K$ and $P$ is 6 and 4 for monthly data and quarterly data, respectively, so as to prevent losing too much information in our estimates.

After the choices of lags, we obtain the nowcasting and the one-step-ahead forecasts. Then, we move the window forward by one period (rolling-window) and compute the new predicted values based on the re-estimated models. We continue with this procedure until we reach the end of the sample. After collecting all the forecasts, we compute their root mean-squared forecasting errors. We estimated our models using a moving window of fixed size, containing 60% of the available data, since for some series with smaller samples, smaller rolling windows would make estimation infeasible. Nonetheless it is important to highlight that the same exercise was performed using a window size of 55% and 65%, with no qualitative difference in the results.

Since the choices of lags for the autoregressive part of the Equation (2) are independent of the choices for the models given in (1), the models chosen for a specific relationship between $Y$ and $IC$ are not necessarily nested. Thus, we decided to follow Giacomini & White (2006) and test their predictive power using a rolling window scheme. The predictive ability of the models is evaluated based on the statistics of Diebold & Mariano (1995) applied to the difference of the mean squared errors obtained when comparing the model without the confidence index and the model where the confidence index is included. We interpret the occurrence of a significant value for this statistic as an indication of predictive power gain from using a confidence index.

Besides using the Diebold and Mariano test for predictive performance tests, we also use the Superior Predictive Ability (SPA) Test by Hansen (2005), which is robust to the period analyzed (data snooping)[10]. Additionally, following Hansen et al. (2011) we built the Model Confidence Sets (MCS), which are useful for establishing the set of models that contain the correct forecasts in a certain level of significance[11]. Notice that if the corresponding (univariate) benchmark model turns out not to belong to the model confidence set, this

[8] The INEC and ICEI started to be released on a monthly basis in 2010, before that they were released every quarter.

[9] While the BIC is a consistent criterion for determining the order of the model, not necessarily is the best criterion for an appropriate specification in terms of finite sample optimal forecast.

[10] In comparison to the Reality Check test proposed in White (2000), the Superior Predictive Ability test is more powerful and less sensitive to the inclusion of poor alternatives (Hansen 2005).

[11] We used the MULCOM 3.0 package by Hansen & Lunde (2014) for all computations of the SPA and MCS tests.

would be evidence that using confidence indices provides relevant pieces of information for forecasting the economic variables under study[12].

While acknowledging the existence of a range of possibilities to be tested, in this paper we focused only on a few of the possible relationships involving the variables described in Table 1.

## 4 Results

Table 3 summarizes the results obtained from the nowcasting and from the one-step-ahead forecasting exercises, by showing the occurrence of significant values for the Diebold-Mariano statistics in the test of forecasting ability against the best univariate model for the models' dependent variable[13]. We also performed the analysis using a combination of forecasts. We used equal weights for all combination exercises, which usually is a very competitive approach in applied work[14]. For indices with ISA and IE components, we combined the forecasts of the two components. Forecasts using PMI were combined with forecasts using ICI, whereas combinations of forecasts of PMC (restrict and extended) used the forecasts in INC and ICC. The overall results from combining forecasts have shown no improvement when compared to individual forecasts.

According to Table 3, the Industry Confidence Index (ICI) provides relevant information for both present and the near future of the growth of economic activity. In the case of the other indices, there was no sufficient evidence of a forecasting improvement. Nonetheless, this could be a consequence of a lower test power due to the smaller number of observations.

For monthly data, ICI and its components are found to have a greater predictive power against the best univariate model not only for the PIM-Manufacturing, but also for the PIM-Construction Goods both for the present ($T$) and the near future ($T+1$).

For quarterly data, it is worth emphasizing that for the growth of Construction industry and the Gross Fixed Capital formation as a percentage of the Gross Domestic Product (GDP), there is enough statistical evidence to claim (at a 5% significance level) that the Industry Confidence Index and its components improve upon the forecasts of the univariate model two months before the release of the GDP data. For growth of GDP itself, there is also enough evidence to reject that the null of the Industry Confidence Index does not help predict GDP's growth.

The results in Table 3 were computed using the root mean square errors (RMSE) from the forecasts. Tables A.6 to A.11 display the mean absolute error (MAE) and mean error (ME) for monthly and quarterly data, as well as for the nowcasting and one-step-ahead forecasting exercises, besides the RMSE. We see that the different metrics shows similar results.

Besides testing the predictive performance using the Diebold-Mariano test, we also tested for the Superior Predictive Ability (SPA) through the test sug-

[12] No benchmark needs to be defined in order to use the MCS procedure.

[13] See Tables A.2 - A.5 in the Appendix for detailed results of the tests such as root mean square errors and p-values from Diebold-Mariano statistics. The best univariate model is considered here to be the one that minimizes BIC.

[14] See, *inter alia*, Stock & Watson (2004) and Smith & Wallis (2009).

**Table 3**: Results for the test of predictive power

| | Index | Nowcasting | | | | One-Step-Ahead | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Aggregate | ISA | IE | Comb.** | Aggregate | ISA | IE | Comb.** |
| Monthly | | | | | | | | | |
| PIM-Manufacturing Industry | ICI | XX | XXX | XX | XX | X | - | - | - |
| PIM-Capital Goods | BK.ICI | - | - | X | - | X | X | - | X |
| PIM-Construction Material | MC.ICI | XX | XX | XX | XX | XX | X | XX | XX |
| PMI | Markit | - | | | - | - | | | - |
| Unemployment Rate | ICD | - | | | | - | | | |
| PMC-Extended | ICC | - | - | - | - | - | - | - | - |
| PMC-Extended | INC | - | | | - | - | | | - |
| PMC-Restrict | ICC | - | - | - | - | - | - | - | - |
| PMC-Restric | INC | - | | | - | - | | | |
| Quarterly | | | | | | | | | |
| Household Consumption | INEC | - | | | | - | | | |
| PMC-Restrict | INEC | - | | | | - | | | |
| PMC-Extended | INEC | - | | | | - | | | |
| GDP-Manufacturing Industry | ICEI | - | | | | - | | | |
| GDP-Manufacturing Industry | ICI | - | - | - | - | - | - | X | X |
| GDP-Construction Industry | MC.ICI | XX | XX | XX | XX | - | - | - | - |
| GDP-GFCF | ICI | XX | XX | XX | - | X | X | - | |
| GDP | INEC | - | | | - | - | | | |
| GDP | ICI | XX | XX | X | | XX | XX | X | |
| GDP | BK.ICI | X | XX | X | | - | - | - | |
| GDP | MC.ICI | - | X | - | | - | - | - | |
| GDP | ICEI | - | | | | - | | | |

"XXX", "XX" e "X" represent significant results at 1, 5 e 10% levels, respectively, and "-" indicates absence of significance at 10% level.

* Either ICI and sectors indices are comprised by the Current Situation (ISA) and Expectation (IE) indices, which are individually used in the regressions. ** For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PMI, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.

gested by Hansen (2005)[15]. Additionally, following Hansen et al. (2011), we built the Model Confidence Sets (MCS), which are the sets of models that contain the correct forecasts with a given level of confidence.

The results for both tests are presented in Tables A.12 - A.15 in the Appendix. The MCS[16] selects the set of best models by attaching p-values to each of these different forecasts. Tables A.12 - A.15 report, in the last column, each model included in $M_0$ along with its corresponding p-value. In general, the results obtained using the MCS approach corroborate the key findings previously discussed.

For monthly data (Table A.12), in line with the results obtained in Table A.2, the corresponding (univariate) benchmark model was not selected to the MCS for predicting PIM - Manufacturing, PIM - Capital Goods or PIM - Construction Goods. These results suggest that taking into account the information provided by confidence indices results in some improvement in terms of nowcasting. For the one-step ahead, Table A.13 also points in the same direction as Table A.4, by not selecting the corresponding benchmark model to the MCS in the cases of PIM - Capital Goods and PIM - Construction Goods.

For quarterly data, the results reported in Tables A.3 and A.5 concerning the improvement of predictive power in case of GDP-GFCF are corroborated in Tables A.14 and A.15. Nonetheless, for GDP and GDP construction, the benchmark model was selected to the MCS, contradicting the results from the Diebold-Mariano test[17].

## 5 Conclusion

In this paper, we assessed the predictive power of the main confidence indices available in Brazil to forecast economic activity. More specifically, we considered a set of economic activity variables and, for each of them, compared the predictive power of a univariate autoregressive model to that of a similar model that includes a confidence index. In summary, the results presented in this paper suggest that among the confidence indices under analysis, the ICI and its components stand out in helping to improve univariate forecasts of variables capturing the level of economic activity for both present (nowcasting) and the near future (one-step-ahead prediction).

It is important, however, to highlight the main limitations of our results. First, the list of relationships used in this paper is quite limited; it is important to analyze the contribution of confidence indices for other variables of interest to economic agents. Second, the time series are short, which may compromise the power of the tests. Third, the results point towards predictive ability, which does not necessarily imply causality. Fourth, the models used in this paper do not take into account possible feedback effects or nonlinearities. Fifth, there is nothing that guarantees that the gain in predictive terms is still valid for other models with other exogenous variables of top of the indices of confidence. Finally, the sample includes periods of crisis, which may have led to important changes in the economic fundamentals.

[15] Note however, that this strategy for controlling the familywise error rate might be too stringent, as discussed by Romano et al. (2008).

[16] For the model confidence set (MCS), the lag length was set to 2. For the Superior Predictive Ability (SPA) test, the dependence parameter was set to 0.5. We use the stationary bootstrap with 100,000 replications when constructing the p-values.

[17] Notice that the results obtained by SPA are in line with those resulting from the MCS.

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## Bibliography

Al-Eyd, A., Barrell, R. & Davis, E. (1986), 'Consumer confidence indices and short-term forecasting of consumption', *Manchester School* **77**(1), 96–111.

Bentes, F. G. M. (2006), 'O poder preditivo do índice de confiança do consumidor no brasil: uma análise através de vetores autorregressivos'.

Claveria, O., Pons, E. & Ramos, R. (2007), 'Business and consumer expectations and macroeconomic forecasts', *International Journal of Forecasting* **23**(1), 47–69.

Curtin, R. (2000), 'Psychology and macroeconomics: fifty years of the surveys of consumers'.

Diebold, F. & Mariano, R. (1995), 'Comparing predictive accuracy', *Journal of Business e Economic Statistics* **13**, 253–263.

Dominitz, J. & Manski, C. F. (2004), 'How should we measure consumer confidence?', *Journal of Economic Perspectives* **18**(2), 51–66.

Dées, S. & Brinca, P. S. (2013), 'Consumer confidence as a predictor of consumption spending: evidence for the united states and the euro area', *International Economics* **134**, 1–14.

Easaw, J. Z. & Heravi, S. M. (2004), 'Evaluating consumer sentiments as predictors of uk household consumption behavior are they accurate and useful?', *International Journal Of Forecasting* **20**(4), 671–681.

Elliott, G. & Timmermann, A. (2008), 'Economic forecasting', *Journal of Economic Literature* pp. 3–56.

Giacomini, R. & White, H. (2006), 'Tests of conditional predictive ability', *Econometrica* **74**(6), 1545–1578.

Hansen, P. R. (2005), 'A test for superior predictive ability', *Business Journal of Economic Statistics* **23**(4), 365–380.

Hansen, P. R. & Lunde, A. (2014), 'Mulcom 3.00. econometric toolkit for multiple comparisons'.

Hansen, P. R., Lunde, A. & Nason, J. M. (2011), 'The model confidence set', *Econometrica* **79**(2), 453–497.

Ing, C. (2003), 'Multistep prediction in autoregressive processes', *Econometric Theory* **19**(2), 254–279.

Klein, L. & Lansing, J. (1955), 'Decisions to purchase consumer durable goods', *Journal of Marketing* **XX**, 109–132.

Kwan, A. C. & Cotsomitis, J. A. (2006), 'The usefulness of consumer confidence in forecasting household spending in canada: a national and regional analysis', *Economic Inquiry* **44**(1), 185–197.

Ludvigson, S. C. (2004), 'Consumer confidence and consumer spending', *Journal of Economic Perspectives* **18**(2), 29–50.

Marcellino, M., Stock, J. & Watson, M. (2006), 'A comparison of direct and iterated multistep ar methods for forecasting macroeconomic time series', *Journal of Econometrics* **135**, 499–526.

Mourougane, A. & Roma, M. (2003), 'Can confidence indicators be useful to predict short term real gdp growth', *Applied Economics Letters* **10**(8), 519–522.

Romano, J., Shaikh, A. & Wolf, M. (2008), 'Formalized data snooping based on generalized error rates', *Econometric Theory* **24**, 404–447.

Smith, B. M. (2009), 'Forecasting utility of uk consumer sentiment indexes in real time: do consumer sentiment surveys improve consumption forecasts in real time?'.

Smith, J. & Wallis, K. F. (2009), 'A simple explanation of the forecast combination puzzle', *Oxford Bulletin of Economics and Statistics* **71**(3), 331–355.

Stock, J. H. & Watson, M. W. (2004), 'Combination forecasts of output growth in a seven-country data set', *Journal of Forecasting* **23**, 405–430.

White, H. (2000), 'A reality check for data snooping', *Econometrica* **68**(5), 1097–1126.

Wilcox, J. A. (2007), 'Forecasting components of consumption with components of consumer sentiment', *Business Economics* **42**(4), 22–32.

## Appendix A

**Table A.1**: Descriptive statistics of confidence indices and activity

| Variable (dlog) | Beginning of sample | Obs. | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Confidence Indices | | | | | | |
| Monthly | | | | | | |
| ICI | May/1995 | 232 | −0.001 | 0.036 | −0.199 | 0.171 |
| Current Situation (ICI-ISA) | May/1995 | 232 | −0.002 | 0.043 | −0.230 | 0.241 |
| Expectations (ICI-IE) | May/1995 | 232 | −0.001 | 0.033 | −0.165 | 0.109 |
| BK.ICI | May/1995 | 232 | −0.002 | 0.075 | −0.379 | 0.271 |
| Current Situation (BK.ICI-ISA) | May/1995 | 232 | −0.003 | 0.096 | −0.533 | 0.417 |
| Expectations (BK.ICI-IE) | May/1995 | 232 | −0.001 | 0.075 | −0.370 | 0.245 |
| MC.ICI | May/1995 | 232 | −0.001 | 0.057 | −0.310 | 0.309 |
| Current Situation (MC.ICI-ISA) | May/1995 | 232 | −0.001 | 0.071 | −0.448 | 0.422 |
| Expectations (MC.ICI-IE) | May/1995 | 232 | 0.000 | 0.061 | −0.262 | 0.232 |
| ICC | Oct/2005 | 107 | 0.000 | 0.027 | −0.134 | 0.058 |
| Current Situation (ICC-ISA) | Oct/2005 | 107 | 0.001 | 0.037 | −0.152 | 0.094 |
| Expectations (ICC-IE) | Oct/2005 | 107 | 0.000 | 0.026 | −0.124 | 0.065 |
| ICD | Oct/2008 | 105 | −0.003 | 0.023 | −0.079 | 0.069 |
| PMI | Nov/2005 | 102 | −0.001 | 0.030 | −0.098 | 0.088 |
| INC | May/2005 | 112 | 0.002 | 0.028 | −0.070 | 0.070 |
| Quarterly | | | | | | |
| INEC | $2^{nd}$ Q/2001 | 53 | 0.001 | 0.028 | −0.063 | 0.099 |
| ICEI | $3^{nd}$ Q/1999 | 60 | −0.001 | 0.062 | −0.117 | 0.185 |
| Activity Level Variables | | | | | | |
| Monthly | | | | | | |
| PIM-Manufacturing | Feb/1995 | 229 | 0.001 | 0.020 | −0.125 | 0.062 |
| PIM-Construction Material | Feb/1995 | 229 | 0.001 | 0.017 | −0.062 | 0.039 |
| PIM-Capital Goods | Feb/1995 | 229 | 0.002 | 0.045 | −0.268 | 0.136 |
| Unemployment | Apr/2002 | 145 | −0.007 | 0.028 | −0.078 | 0.073 |
| PMC-Restrict | Feb/2000 | 174 | 0.004 | 0.009 | −0.023 | −0.026 |
| PMC-Extended | Feb/2003 | 138 | 0.005 | 0.025 | −0.102 | 0.082 |
| Quarterly | | | | | | |
| GDP | $2^{nd}$ Q/1996 | 68 | 0.007 | 0.013 | −0.042 | 0.044 |
| GDP-Household Consumption | $2^{nd}$ Q/1996 | 73 | 0.008 | 0.013 | −0.030 | 0.046 |
| GDP-Manufacturing | $2^{nd}$ Q/1996 | 73 | 0.003 | 0.036 | −0.110 | 0.142 |
| GDP-Construction | $2^{nd}$ Q/1996 | 0.005 | 0.025 | −0.055 | 0.051 | |
| GDP-GFCF | $2^{nd}$ Q/1996 | 73 | 0.008 | 0.037 | −0.125 | 0.088 |

Sources: Fundação Getúlio Vargas (FGV), Markit, Associação Comercial de São Paulo (ACSP) e Instituto Brasileiro de Geografia e Estatística (IBGE).

**Table A.2**: Relative root mean square error for nowcasting - monthly data

| Endogenous | Index | Agg. | ISA | IE | Combination | Begin | End |
|---|---|---|---|---|---|---|---|
| PIM-Manufacturing | ICI | **0.88** (0.01) | **0.90** (0.01) | **0.88** (0.03) | **0.89** (0.01) | Apr/1995 | Aug/2006 |
| PIM-Capital Goods | BK.ICI | 0.98 (0.23) | 1.00 (0.58) | 0.95 (0.08) | 0.97 (0.14) | Apr/1995 | Aug/2006 |
| PIM-Construction Goods | MC.ICI | **0.85** (0.01) | **0.96** (0.02) | **0.89** (0.03) | **0.91** (0.01) | Apr/1995 | Aug/2006 |
| PIM-Manufacturing | PMI | 0.98 (0.40) | | | 0.95 (0.21) | Feb/2006 | Dec/2010 |
| Unemployment Rate | ICD | 1.01 (0.70) | | | | Dec/2005 | Dec/2010 |
| PMC-Extended | ICC | 1.03 (0.92) | 1.04 (0.85) | 1.02 (0.92) | 1.02 (0.85) | Sep/2005 | Jan/2011 |
| PMC-Extended | INC | 1.01 (0.82) | | | 1.02 (0.91) | Sep/2005 | Jan/2011 |
| PMC-Restricted | ICC | 1.07 (0.96) | 1.12 (0.91) | 1.05 (0.90) | 1.07 (0.94) | Sep/2005 | Jan/2011 |
| PMC-Restricted | INC | 1.02 (0.71) | | | 1.03 (0.92) | Sep/2005 | Jan/2011 |

p-values from Diebold-Mariano statistics in parentheses.
Alternative hypothesis: model with confidence index has greater predictive power than the univariate model. In all models, the variables used were the first difference of the logarithm of the original variables.
Values in bold indicate significance at 10% level.
For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PML, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.

**Table A.3**: Relative root mean square error for nowcasting - quarterly data

| Endogenous | Index | Agg. | ISA | IE | Combination | Begin | End |
|---|---|---|---|---|---|---|---|
| Consumption Expenditures | INEC | 0.97 (0.27) | | | | 2001Q1 | 2009Q1 |
| PMC-Restricted | INEC | 1.05 (0.90) | | | | 2001Q1 | 2009Q1 |
| PMC-Extended | INEC | 1.03 (0.63) | | | | 2003Q2 | 2009Q4 |
| GDP-Manufacturing | ICEI | 0.96 (0.35) | | | 0.86 (0.18) | 1999Q2 | 2008Q2 |
| GDP-Manufacturing | ICI | 1.01 (0.52) | 0.98 (0.44) | 1.08 (0.70) | 1.01 (0.53) | 1996Q2 | 2007Q1 |
| GDP-Construction | MC.ICI | **0.70** (0.02) | **0.75** (0.04) | **0.67** (0.02) | **0.68** (0.02) | 1996Q2 | 2007Q1 |
| GDP-GFCF | ICI | **0.62** (0.02) | **0.67** (0.02) | **0.62** (0.01) | | 1996Q2 | 2007Q1 |
| GDP | ICEI | 0.93 (0.16) | | | | 1999Q2 | 2008Q2 |
| GDP | ICI | **0.66** (0.05) | **0.69** (0.04) | **0.68** (0.06) | | 1996Q2 | 2007Q1 |
| GDP | BK.ICI | **0.75** (0.06) | **0.70** (0.05) | **0.82** (0.05) | | 1996Q2 | 2007Q1 |
| GDP | MC.ICI | 0.74 (0.14) | **0.77** (0.09) | 0.77 (0.13) | | 1996Q2 | 2007Q1 |
| GDP | INEC | 0.90 (0.23) | | | 0.55 (0.04) | 2001Q1 | 2009Q1 |

p-values from Diebold-Mariano statistics in parentheses.
Alternative hypothesis: model with confidence index has greater predictive power than the univariate model. In all models, the variables used were the first difference of the logarithm of the original variables.
Values in bold indicate significance at 10% level.
For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PML, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.

**Table A.4**: Relative root mean square error for one-step ahead forecasting - monthly data

| Endogenous | Index | Agg. | ISA | IE | Combination | Begin | End |
|---|---|---|---|---|---|---|---|
| PIM-Manufacturing | ICI | **0.94** (0.09) | 0.95 (0.12) | 0.97 (0.36) | 0.95 (0.21) | Apr/1995 | Aug/2006 |
| PIM-Capital Goods | BK.ICI | **0.93** (0.07) | **0.95** (0.05) | 0.96 (0.19) | **0.95** (0.07) | Apr/1995 | Aug/2006 |
| PIM-Construction Goods | MC.ICI | **0.93** (0.03) | **0.95** (0.06) | **0.94** (0.02) | **0.94** (0.02) | Apr/1995 | Aug/2006 |
| PIM-Manufacturing | PMI | 1.05 (0.73) | | | 1.02 (0.66) | Feb/2006 | Dec/2010 |
| Unemployment Rate | ICD | 1.00 (0.53) | | | | Dec/2005 | Dec/2010 |
| PMC-Extended | ICC | 1.01 (0.71) | 1.00 (0.48) | 1.02 (0.96) | 1.01 (0.77) | Sep/2005 | Jan/2011 |
| PMC-Extended | INC | 1.01 (0.90) | | | 1.01 (0.87) | Sep/2005 | Jan/2011 |
| PMC-Restricted | ICC | 1.03 (0.82) | 1.02 (0.84) | 1.02 (0.72) | 1.02 (0.74) | Sep/2005 | Jan/2011 |
| PMC-Restricted | INC | 1.04 (0.84) | | | | Sep/2005 | Jan/2011 |

p-values from Diebold-Mariano statistics in parentheses.
Alternative hypothesis: model with confidence index has greater predictive power than the univariate model. In all models, the variables used were the first difference of the logarithm of the original variables.
Values in bold indicate significance at 10% level.
For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PML, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.

**Table A.5**: Relative root mean square error for one-step ahead forecasting - quarterly data

| Endogenous | Index | Agg. | ISA | IE | Combination | Begin* | End* |
|---|---|---|---|---|---|---|---|
| Consumption Expenditures | INEC | 1.02 (0.84) | | | | 2001Q1 | 2009Q1 |
| PMC-Restricted | INEC | 1.00 (0.51) | | | | 2001Q1 | 2009Q1 |
| PMC-Extended | INEC | 1.07 (0.85) | | | | 2003Q2 | 2009Q4 |
| GDP-Manufacturing | ICEI | 0.91 (0.11 | | | 0.93 (0.21) | 1999Q2 | 2008Q2 |
| GDP-Manufacturing | ICI | 1.01 (0.52) | 0.99 (0.46) | **0.87** (0.06) | **0.90** (0.08) | 1996Q2 | 2007Q1 |
| GDP-Construction | MC.ICI | 0.97 (0.28) | 1.00 (0.55) | 0.94 (0.17) | 0.97 (0.24) | 1996Q2 | 2007Q1 |
| GDP-GFCF | ICI | **0.83** (0.10) | **0.85** (0.08) | 0.93 (0.34) | | 1996Q2 | 2007Q1 |
| GDP | ICEI | 0.94 (0.21) | | | | 1999Q2 | 2008Q2 |
| GDP | ICI | **0.88** (0.04) | **0.89** (0.04) | **0.89** (0.06) | | 1996Q2 | 2007Q1 |
| GDP | BK.ICI | 0.92 (0.16) | 0.92 (0.16) | 0.94 (0.16) | | 1996Q2 | 2007Q1 |
| GDP | MC.ICI | 0.97 (0.15) | 1.00 (0.47) | 0.94 (0.11) | | 1996Q2 | 2007Q1 |
| GDP | INEC | 1.00 (0.59) | | | 0.89 (0.15) | 2001Q1 | 2009Q1 |

p-values from Diebold-Mariano statistics in parentheses.
Alternative hypothesis: model with confidence index has greater predictive power than the univariate model. In all models, the variables used were the first difference of the logarithm of the original variables.
Values in bold indicate significance at 10% level.
For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PML, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.
* Q stands for quarter. Thus, *e.g.*, Q1-01 represents the first quarter of the year 2001.

**Table A.6**: Measures of accuracy for nowcasting - monthly data

| Endogenous | Index | Aggregated | | | ISA | | | IE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ME | RMSE | MAE | ME | RMSE | MAE | ME | RMSE | MAE |
| PIM | | | | | | | | | | |
| Manufacturing | ICI | 0.001 | 0.019 | 0.012 | 0.001 | 0.019 | 0.013 | 0.001 | 0.019 | 0.013 |
| Capital Goods | BK.ICI | 0.005 | 0.050 | 0.031 | 0.005 | 0.051 | 0.032 | 0.004 | 0.048 | 0.030 |
| Construction Goods | MC.ICI | 0.003 | 0.016 | 0.013 | 0.002 | 0.018 | 0.014 | 0.003 | 0.017 | 0.013 |
| Manufacturing | PMI | 0.000 | 0.016 | 0.013 | | | | | | |
| Unemployment Rate | ICD | 0.001 | 0.023 | 0.019 | | | | | | |
| PMC | | | | | | | | | | |
| Extended | ICC | −0.006 | 0.026 | 0.017 | −0.004 | 0.026 | 0.017 | −0.007 | 0.026 | 0.017 |
| Extended | INC | −0.007 | 0.026 | 0.017 | | | | | | |
| Restricted | ICC | −0.002 | 0.008 | 0.007 | −0.002 | 0.009 | 0.007 | −0.003 | 0.008 | 0.007 |
| Restricted | INC | −0.003 | 0.008 | 0.007 | | | | | | |

ME: Mean Error, RMSE: Root Mean Squared Error, MAE: Mean Absolute Error. For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PMI, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.

**Table A.7**: Measures of accuracy for nowcasting - quarterly data

| Endogenous | Index | Aggregated | | | ISA | | | IE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ME | RMSE | MAE | ME | RMSE | MAE | ME | RMSE | MAE |
| Consumption Expenditures | INEC | −0.001 | 0.008 | 0.007 | | | | | | |
| PMC-Restrict | INEC | 0.002 | 0.014 | 0.012 | | | | | | |
| PMC-Extended | INEC | −0.007 | 0.026 | 0.021 | | | | | | |
| GDP-Manufacturing | ICEI | −0.010 | 0.039 | 0.026 | | | | | | |
| GDP-Manufacturing | ICI | −0.010 | 0.035 | 0.021 | −0.008 | 0.034 | 0.021 | −0.012 | 0.037 | 0.023 |
| GDP-Construction | MC.ICI | 0.007 | 0.019 | 0.015 | 0.007 | 0.020 | 0.016 | 0.006 | 0.018 | 0.014 |
| GDP-GFCF | ICI | 0.005 | 0.026 | 0.020 | 0.005 | 0.028 | 0.022 | 0.004 | 0.026 | 0.020 |
| GDP | INEC | −0.002 | 0.013 | 0.009 | | | | | | |
| GDP | ICI | −0.001 | 0.009 | 0.006 | −0.001 | 0.009 | 0.006 | −0.001 | 0.009 | 0.006 |
| GDP | BK.ICI | 0.000 | 0.010 | 0.007 | −0.001 | 0.009 | 0.007 | −0.001 | 0.011 | 0.008 |
| GDP | MC.ICI | −0.001 | 0.010 | 0.008 | −0.001 | 0.010 | 0.008 | 0.000 | 0.010 | 0.008 |
| GDP | ICEI | 0.000 | 0.010 | 0.008 | | | | | | |

ME: Mean Error, RMSE: Root Mean Squared Error, MAE: Mean Absolute Error.

**Table A.8**: Measures of accuracy for one-step ahead forecasting - monthly data

| Endogenous | Index | Aggregated | | | ISA | | | IE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ME | RMSE | MAE | ME | RMSE | MAE | ME | RMSE | MAE |
| PIM | | | | | | | | | | |
| Manufacturing | ICI | 0.001 | 0.020 | 0.013 | 0.001 | 0.020 | 0.014 | 0.002 | 0.021 | 0.014 |
| Capital Goods | BK.ICI | 0.004 | 0.048 | 0.030 | 0.004 | 0.049 | 0.031 | 0.004 | 0.049 | 0.030 |
| Construction Goods | MC.ICI | 0.003 | 0.017 | 0.014 | 0.002 | 0.018 | 0.014 | 0.003 | 0.017 | 0.014 |
| Manufacturing | PMI | −0.001 | 0.017 | 0.013 | | | | | | |
| Unemployment Rate | ICD | −0.008 | 0.025 | 0.020 | | | | | | |
| PMC | | | | | | | | | | |
| Extended | ICC | −0.005 | 0.028 | 0.018 | −0.004 | 0.028 | 0.018 | −0.005 | 0.028 | 0.018 |
| Extended | INC | −0.005 | 0.028 | 0.018 | | | | | | |
| Restricted | ICC | −0.003 | 0.008 | 0.007 | −0.002 | 0.008 | 0.006 | −0.003 | 0.008 | 0.006 |
| Restricted | INC | −0.003 | 0.008 | 0.006 | | | | | | |

ME: Mean Error, RMSE: Root Mean Squared Error, MAE: Mean Absolute Error. For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PMI, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.

**Table A.9**: Measures of accuracy for one-step ahead forecasting - quarterly data

| Endogenous | Index | Aggregated | | | ISA | | | IE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ME | RMSE | MAE | ME | RMSE | MAE | ME | RMSE | MAE |
| Consumption Expenditures | INEC | −0.002 | 0.010 | 0.008 | | | | | | |
| PMC-Restrict | INEC | −0.002 | 0.013 | 0.011 | | | | | | |
| PMC-Extended | INEC | −0.009 | 0.028 | 0.023 | | | | | | |
| GDP-Manufacturing | ICEI | 0.000 | 0.034 | 0.024 | | | | | | |
| GDP-Manufacturing | ICI | 0.002 | 0.033 | 0.024 | 0.002 | 0.032 | 0.025 | 0.001 | 0.028 | 0.019 |
| GDP-Construction | MC.ICI | 0.009 | 0.027 | 0.023 | 0.008 | 0.028 | 0.024 | 0.009 | 0.027 | 0.022 |
| GDP-GFCF | ICI | 0.009 | 0.040 | 0.031 | 0.009 | 0.041 | 0.032 | 0.002 | 0.045 | 0.032 |
| GDP | INEC | −0.004 | 0.014 | 0.010 | | | | | | |
| GDP | ICI | −0.002 | 0.012 | 0.008 | −0.002 | 0.013 | 0.009 | −0.002 | 0.013 | 0.008 |
| GDP | BK.ICI | −0.002 | 0.013 | 0.009 | −0.002 | 0.013 | 0.009 | −0.002 | 0.013 | 0.009 |
| GDP | MC.ICI | −0.002 | 0.014 | 0.010 | −0.002 | 0.014 | 0.010 | −0.002 | 0.013 | 0.009 |
| GDP | ICEI | −0.002 | 0.009 | 0.008 | | | | | | |

ME: Mean Error, RMSE: Root Mean Squared Error, MAE: Mean Absolute Error.

**Table A.10**: Measures of accuracy - monthly data - combination

| Endogenous | Index | Nowcasting | | | One-step Ahead | | |
|---|---|---|---|---|---|---|---|
| | | ME | RMSE | MAE | ME | RMSE | MAE |
| PIM-Manufacturing | ICI | 0.001 | 0.019 | 0.013 | 0.001 | 0.020 | 0.014 |
| PIM-Capital Goods | BK.ICI | 0.004 | 0.049 | 0.031 | 0.004 | 0.049 | 0.030 |
| PIM-Construction Goods | MC.ICI | 0.003 | 0.017 | 0.013 | 0.003 | 0.017 | 0.014 |
| PIM-Manufacturing | PMI | 0.001 | 0.016 | 0.013 | 0.000 | 0.017 | 0.013 |
| Unemployment Rate | ICD | | | | | | |
| PMC-Extended | ICC | −0.006 | 0.026 | 0.017 | −0.004 | 0.028 | 0.018 |
| PMC-Extended | INC | −0.007 | 0.026 | 0.017 | −0.005 | 0.028 | 0.018 |
| PMC-Restricted | ICC | −0.002 | 0.008 | 0.007 | −0.003 | 0.008 | 0.006 |
| PMC-Restricted | INC | −0.003 | 0.008 | 0.006 | −0.003 | 0.008 | 0.006 |

ME: Mean Error, RMSE: Root Mean Squared Error, MAE: Mean Absolute Error. For indices with ISA and IE component, the column combination uses weights 1/2 for each component. In the row corresponding to PMI, the column combination uses weights 1/2 to PMI and 1/2 to ICI. In the rows corresponding to INC, the column combination uses a combination of 1/2 INC and 1/2 ICC.

**Table A.11**: Measures of accuracy - quarterly data - combination

| Endogenous | Index | Nowcasting | | | One-step Ahead | | |
|---|---|---|---|---|---|---|---|
| | | ME | RMSE | MAE | ME | RMSE | MAE |
| Consumption Expenditures | INEC | | | | | | |
| PMC-Restrict | INEC | | | | | | |
| PMC-Extended | INEC | | | | | | |
| GDP-Manufacturing | ICEI | −0.010 | 0.035 | 0.023 | 0.000 | 0.035 | 0.024 |
| GDP-Manufacturing | ICI | −0.010 | 0.035 | 0.021 | 0.002 | 0.029 | 0.021 |
| GDP-Construction | MC.ICI | 0.007 | 0.018 | 0.015 | 0.009 | 0.027 | 0.023 |
| GDP-GFCF | ICI | | | | | | |
| GDP | INEC | | | | | | |
| GDP | ICI | | | | | | |
| GDP | BK.ICI | | | | | | |
| GDP | MC.ICI | | | | | | |
| GDP | ICEI | −0.001 | 0.005 | 0.004 | −0.002 | 0.008 | 0.007 |

ME: Mean Error, RMSE: Root Mean Squared Error, MAE: Mean Absolute Error.

**Table A.12**: Measures of accuracy for nowcasting - monthly data

| Endogenous | Indexes | SPA-p-value | | | MCS |
|---|---|---|---|---|---|
| | | Lower | Consistent | Upper | |
| PIM | | | | | |
| Manufacturing | ICI | 0.05 | 0.05 | 0.05 | ICI(1), ICI.IE(0.5369), ICI.ISA(0.2678) |
| Capital Goods | BK.ICI | 0.10 | 0.11 | 0.11 | BK.ICI.IE(1) |
| Construction Goods | MC.ICI | 0.06 | 0.06 | 0.06 | ICI(1) |
| PMC | | | | | |
| Extended | ICC, INC | 0.80 | 0.99 | 0.99 | Benchmark (1), INC(0.5157), ICC.ISA(0.5157), ICC(0.3515), ICC.IE(0.2741) |
| Restrict | ICC, INC | 0.89 | 1.00 | 1.00 | Benchmark(1), INC(0.5160), ICC.ISA(0.5160), ICC.IE(0.5160), ICC(0.4440) |

All bootstraps performed 100,000 re-samples. For the Superior Predictive Ability (SPA) test, the dependence paramenter was set to 0.5. For the Model Confidence Set (MCS), the lag length was set to 2.

**Table A.13**: One-step ahead forecasting - monthly data

| Endogenous | Indexes | SPA-p-value | | | MCS |
|---|---|---|---|---|---|
| | | Lower | Consistent | Upper | |
| PIM-Manufacturing | ICI | 0.11 | 0.11 | 0.11 | IC(1), ICI.IE(0.3768), ICI.ISA(0.2716), Benchmark(0.2538) |
| PIM-Capital Goods | BK.ICI | 0.08 | 0.08 | 0.08 | BK.ICI(1), BK.ICI.ISA(0.2733), BK.ICI.IE(0.2733) |
| PIM-Construction Good | MC.ICI | 0.05 | 0.05 | 0.05 | ICI(1), ICI.IE(0.4725) |
| PMC-Extended | ICC, INC | 0.54 | 0.82 | 0.91 | ICC.ISA(1), Benchmark(0.9483), ICC(0.7701), INC(0.3520), ICC.IE(0.2647) |
| PMC-Restrict | ICC, INC | 0.69 | 0.93 | 0.93 | Benchmark(1), INC(0.7603), ICC(0.7603), ICC.ISA(0.7603), ICC.IE(0.7603) |

All bootstraps performed 100,000 re-samples. For the Superior Predictive Ability (SPA) test, the dependence paramenter was set to 0.5. For the Model Confidence Set (MCS), the lag length was set to 2.

**Table A.14**: Measures of accuracy for nowcasting - quarterly data

| Endogenous | Indexes | SPA-p-value Lower | SPA-p-value Consistent | SPA-p-value Upper | MCS |
|---|---|---|---|---|---|
| GDP-Manufacturing | ICEI, ICI | 0.25 | 0.25 | 0.25 | ICI(1), ICI.ISA(0.7327), ICI.IE(0.7327), Benchmark(0.5401), ICEI(0.5066) |
| GDP-Construction | MC.ICI | 0.12 | 0.12 | 0.12 | MC.ICI(1), MC.ICI.ISA(0.6976), MC.ICI.IE(0.6976), Benchmark(0.5366) |
| GDP-GFCF | ICI | 0.06 | 0.06 | 0.06 | ICI(1), ICI.IE(0.6528) |
| GDP | INEC, ICI, BK.ICI, MC.ICI, ICEI | 0.11 | 0.11 | 0.11 | ICI.ISA(1), ICEI(0.4817), ICI(0.4817), BK.IC(0.4817), BK.ICI.ISA(0.4817), BK.ICI.IE(0.4817), Benchmark(0.4817), INEC(0.4817), ICI.IE(0.4817), MC.ICI(0.4393), MC.ICI.IE(0.4393), MC.ICI.ISA(0.4351) |

All bootstraps performed 100,000 re-samples. For the Superior Predictive Ability (SPA) test, the dependence paramenter was set to 0.5. For the Model Confidence Set (MCS), the lag length was set to 2.

**Table A.15**: Measures of accuracy for one-step ahead forecasting - quarterly data

| Endogenous | Indexes | SPA-p-value Lower | SPA-p-value Consistent | SPA-p-value Upper | MCS |
|---|---|---|---|---|---|
| GDP-Manufacturing | ICEI, ICI | 0.11 | 0.12 | 0.12 | ICI.IE(1), ICEI(0.8264), ICI(0.8264), ICI.ISA(0.8264), Benchmark(0.3077) |
| GDP-Construction | MC, ICI | 0.19 | 0.20 | 0.20 | MC.ICI.IE(1), Benchmark(0.2651) |
| GDP-GFCF | ICI | 0.11 | 0.11 | 0.11 | ICI(1), ICI.IE(0.4192), ICI.ISA(0.3573) |
| GDP | INEC, ICI, BK.ICI, MC.ICI, ICEI | 0.22 | 0.23 | 0.23 | ICI.IE(1), ICI(0.6107), INEC(0.6056), Benchmark(0.5170), ICI.ISA(0.5125), ICI.BK.ISA(0.5061), MC.ICI.ISA(0.5061), ICI.BK (0.5032), MC.ICI(0.5032), ICEI(0.4834), MC.ICI.IE(0.3234) |

All bootstraps performed 100,000 re-samples. For the Superior Predictive Ability (SPA) test, the dependence paramenter was set to 0.5. For the Model Confidence Set (MCS), the lag length was set to 2.