Early Monthly Estimation of Mexico's Manufacturing Production Level using Electric Energy Consumption data

June 2020

Introduction

In order to have **timely information about Mexico´s manufacturing production level** in these times of the **COVID-19 pandemic**, in which **business surveys non-response rates have increased considerably**, INEGI has just **published**, as of **May 2020**, a **new experimental indicator called Timely Monthly Index of Manufacturing Activity (IMOAM)*** which is a **nowcast** of Mexico´s manufacturing production level.

IMOAM uses: 1) **data on electric energy consumption** from an **administrative register** managed by the **Federal Electricity Commission** (CFE) **to build** a **Monthly Electric Energy Consumption Index in Mexico's manufacturing sector (ICEE)**, and 2) a **Statistical Model** that **describes** the functional *relationship* between **manufacturing production level and ICEE**. The Statistical Model generates nowcasts for Mexico´s manufacturing production level.

*All acronyms are in Spanish

Introduction

IMOAM could potentially be **used as a important data source** to **know** the **manufacturing production level variable** in the following **next months**, **if missing data** in **traditional business surveys** become a **significant** factor.
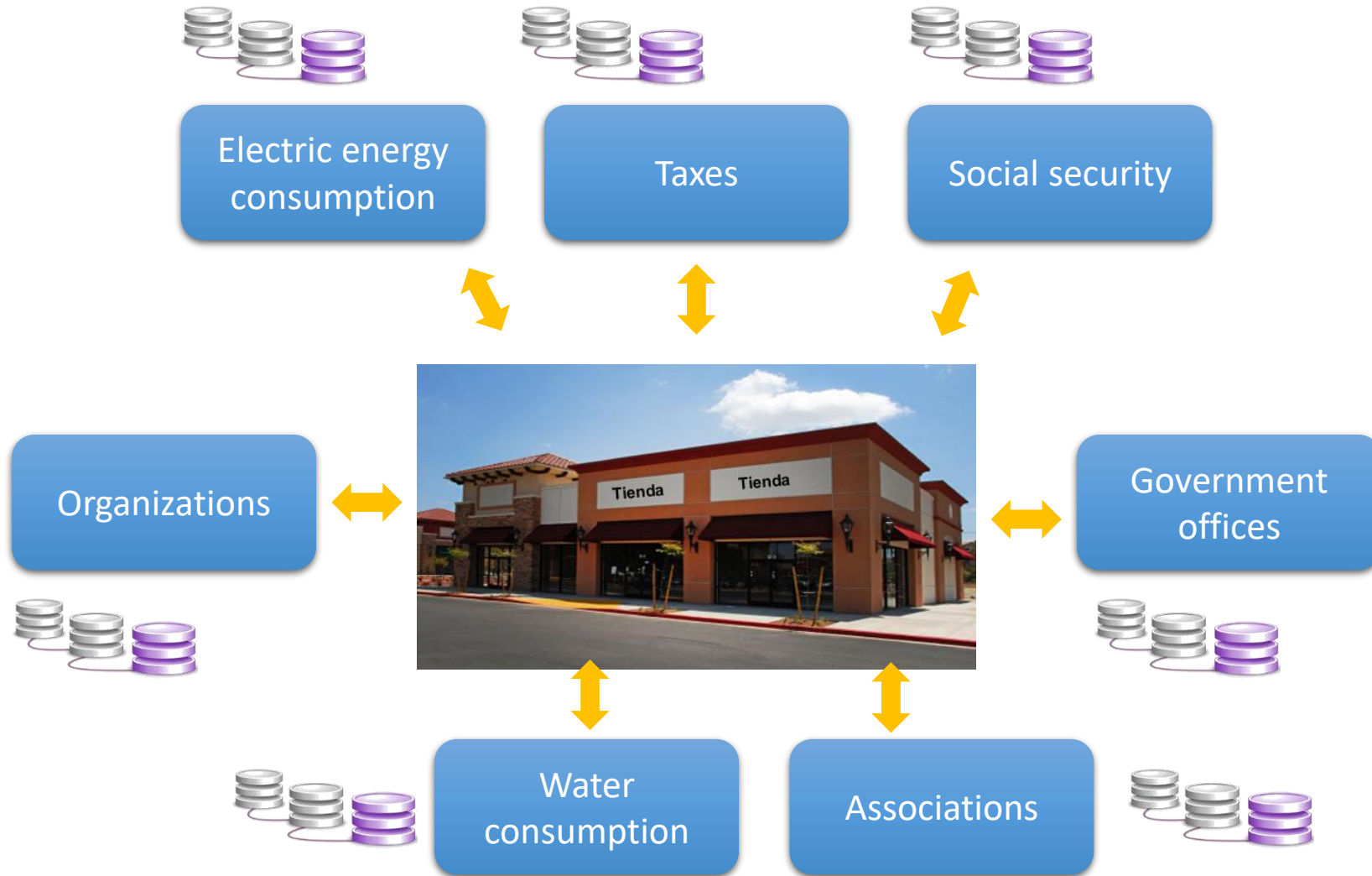
Quality of the IMOAM index itself is dependent on the quality and timeliness of CFE's administrative registers. **CFE provides electric energy to most businesses in Mexico**, and its administrative register has the main purpose of collecting CFE's customers fees **in a timely fashion**, **even** in this difficult time of the **COVID-19 pandemic**. For this IMOAM project, CFE has provided administrative data to INEGI on time without missing a single month up to this date.

The following slides describe the main aspects considered in the construction of the IMOAM index.

Use of Administrative Registers

Major challenge for National Statistical Offices:

Use of administrative registers for statistical purposes

Electric energy consumption

Taxes

Social security

Organizations

Government offices

Water consumption

Associations

Use of Administrative Registers

- INEGI has worked with national government agencies in Mexico to harmonize and link administrative registers to INEGI´s Statistical Business Register (SBR)

- The most significant advances in this respect, are with the electric utility company (CFE) and the tax administration agency (SAT)

- With **administrative data linked to the SBR at establishment level**, it is possible to **build indicators** which can then be used **to explain economic variables through statistical models**. This can be especially **advantageous** when data used for generating response economic variables are **harder to collect** through **traditional business surveys**; this data collection problem is occurring right now due to the COVID-19 pandemic

- This presentation focuses on the work made jointly between CFE and INEGI to nowcast Mexico's manufacturing production level (response variable) as a function of electric energy consumption (explanatory variable)

Objectives of using CFE´s administrative data

1. **Link CFE´s administrative data to a master sample** (from the **SBR**), which contains Mexico's **largest establishments** in the **manufacturing** sector, in order to **obtain** an *electric energy consumption index (ICEE)*

2. Use **ICEE** in order to **nowcast** the **Monthly Production Level Index** for the **Manufacturing** Sector (IMAI3133) through an **econometric model**. This is possible to implement given the timeliness of CFE´s administrative data, together with the **high linear correlation** observed between IMAI3133 and ICEE

3. If the need arises, provisionally use this IMAI3133 **nowcast** as **auxiliary information** to update the variable itself; IMAI3133 is built with data from INEGI's business surveys, which right now are experiencing difficulties collecting data in a timely fashion due to the COVID-19 pandemic.

Master sample coverage in the manufacturing sector

Sector/ Subsector	Description	Coverage Percentage					
		Master Sample			Master Sample linked to CFE data		
		Establishments	Revenue	Employees	Establishments	Revenue	Employees
31-33	Manufacturing industries	4%	88%	68%	3%	79%	57%
311	Food products	2%	89%	47%	1%	77%	39%
312	Beverage and tobacco products	3%	93%	59%	2%	87%	48%
313	Textile mills	3%	95%	70%	2%	75%	53%
314	Textile product mills	1%	77%	30%	1%	65%	25%
315	Apparel manufacturing	4%	81%	66%	3%	64%	54%
316	Leather and allied products	7%	81%	60%	5%	75%	54%
321	Wood products	2%	66%	28%	1%	55%	22%
322	Paper products	12%	95%	82%	9%	72%	62%
323	Printing and related support activities	3%	73%	41%	2%	63%	36%
324	Petroleum and coal products	51%	81%	75%	42%	80%	74%
325	Chemical manufacturing	30%	72%	78%	21%	61%	65%
326	Plastics and rubber products	27%	92%	79%	21%	79%	67%
327	Nonmetallic mineral products	4%	93%	56%	2%	65%	38%
331	Primary metal manufacturing	44%	99%	91%	34%	89%	78%
332	Fabricated metal products	2%	84%	46%	1%	66%	38%
333	Machinery manufacturing	27%	94%	82%	21%	86%	73%
334	Computer and electronic products	60%	96%	93%	50%	89%	83%
335	Electrical equipment, appliance, components	44%	93%	86%	36%	85%	77%
336	Transportation equipment	48%	98%	94%	38%	91%	80%
337	Furniture and related products	2%	73%	43%	1%	59%	37%
339	Miscellaneous manufacturing	4%	89%	75%	3%	80%	67%

Joint Work CFE-INEGI

CFE provides INEGI with electric energy consumption data at contract level (establishment), approximately 4.8 million records per month
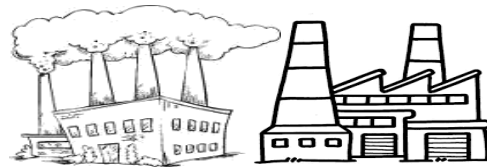
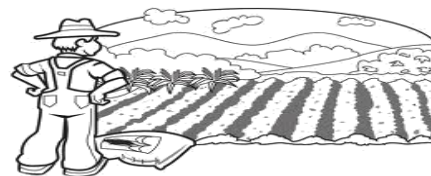Industrial

Trade

Services

Agriculture

CFE - INEGI have worked on:

- **Data harmonization**
- **Data linking**
- **Data Integration**
- **Data analysis**

Objective: To produce monthly indicators on electric energy consumption

Results Obtained with linked CFE´s data

- Using records from the master sample linked to CFE data, INEGI builds the Electric Energy Consumption Index (ICEE) for the Manufacturing sector. INEGI receives administrative data from CFE approximately 15 days after the end of the reference month

- the Monthly Production Level Index for the Manufacturing Sector (IMAI3133) is published by the System of National Accounts, approximately 40 days after the end of the reference month

- Given the opportunity with which the ICEE index is built, and its significant linear relationship to IMAI3133, it is feasible to obtain an early estimate for IMAI3133 through a linear regression model

Electric Energy Consumption Index (ICEE)

Construction of the ICEE index (X_t variable):

1. For month t, the electric energy consumption (in kWh) for each record (establishment) in the linked sample SBR-CFE is multiplied by a weight which depends on the manufacturing subsector the establishment belongs to; this weight is provided by the System of National Accounts. Note that electric energy consumption data comes from CFE, while economic activity information comes from the SBR

2. All weighted electric energy consumption values are added, obtaining S_t

3. Finally, S_t scale is changed to coincide with IMAI3133 (variable Y_t) on a base month (January 2013)

Logarithmic differences as approximations to monthly and annual growth rates

Let X_t be a time series, where sub index $t = 1,2,3, \ldots$ distinguishes months. Let $m_t := \frac{X_t}{X_{t-1}} - 1$ and $a_t := \frac{X_t}{X_{t-12}} - 1$ be the monthly and annual growth rates, respectively, for series X at month t.

X_t logarithmic difference for two consecutive months $t-1, t$ is defined as:

$$\nabla_m \ln(X_t) := \ln(X_t) - \ln(X_{t-1})$$

Using properties of logarithms,

$$\nabla_m \ln(X_t) = \ln\left(\frac{X_t}{X_{t-1}}\right) = \ln\left[\frac{(1+m_t)X_{t-1}}{X_{t-1}}\right] = \ln(1 + m_t) \approx m_t$$

In other words, $\widehat{m}_t := \nabla_m \ln(X_t)$ is a good approximation for X_t monthly growth rate.
Similarly, $\nabla_a \ln(X_t) := \ln(X_t) - \ln(X_{t-12})$ approximates X_t annual growth rate.

Note that $\nabla_a \ln(X_t) = [\ln(X_t) - \ln(X_{t-1})] + [\ln(X_{t-1}) - \ln(X_{t-2})] + \cdots + [\ln(X_{t-11}) - \ln(X_{t-12})]$

i.e., $\widehat{a}_t = \widehat{m}_t + m_{t-1} + \cdots + m_{t-11}$

**Logarithmic difference model for estimating IMAI3133
as a function of the electric energy consumption index (ICEE)**

$$\nabla_m \ln Y_t = \beta_1 \nabla_m \ln X_t + \beta_2 i_{oct} + \beta_3 i_{apr} + \varepsilon_t,$$
$$\varepsilon_t = \rho \varepsilon_{t-1} + v_t$$

Y_t is IMAI3133 for month t; X_t is the ICEE index for month t

$i_{oct} = 1$ for October 2013, 2014, 2015, 2016, 2018 and 2019; 0 otherwise
$i_{apr} = 1$ for April 2014, 2015, 2017, 2019 and 2020; 0 otherwise

Note : ε_t possesses an AR(1) structure.
Cochrane-Orcutt method is used for estimating the model's parameters.

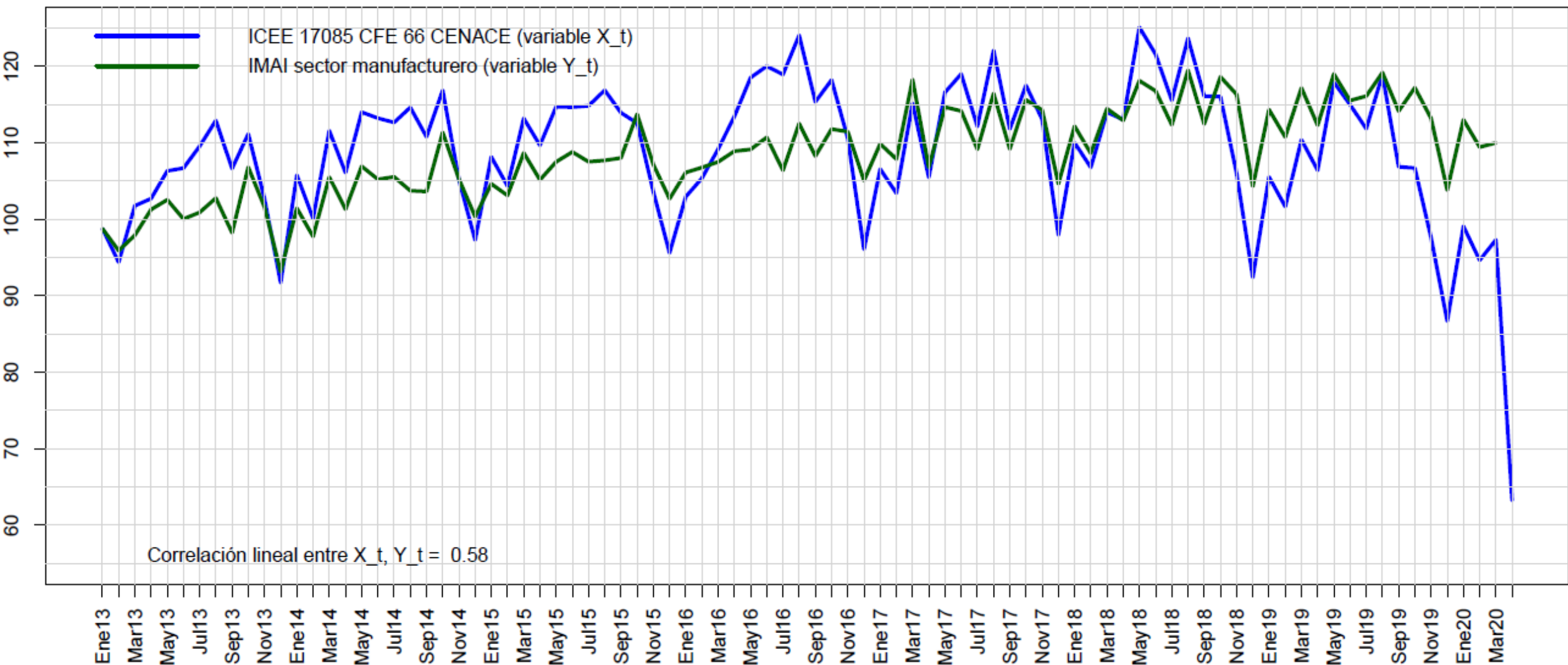**Obtaining IMAI 31-33 estimates from the logarithmic difference model**

The logarithmic difference model generates direct estimates $\widehat{m}_t$ for IMAI3133 monthly growth rates. From these $\widehat{m}_t$ values, it is also possible to obtain estimates $\widehat{Y}_t$ for the IMAI3133 index itself:

$$\text{from } \widehat{m}_t = \ln \frac{\widehat{Y}_t}{Y_{t-1}}, \text{ one obtains}$$

$$\ln \widehat{Y}_t - \ln Y_{t-1} = \widehat{m}_t$$
$$\ln \widehat{Y}_t = \widehat{m}_t + \ln Y_{t-1}$$
$$\boldsymbol{\widehat{Y}_t = \exp(\widehat{m}_t)\, Y_{t-1}}$$

To estimate IMAI3133 at month t, we multiply the true IMAI3133 value at month $t-1$ by the exponential function (natural logarithm inverse) evaluated at the estimate for the IMAI3133 monthly growth rate at month t.
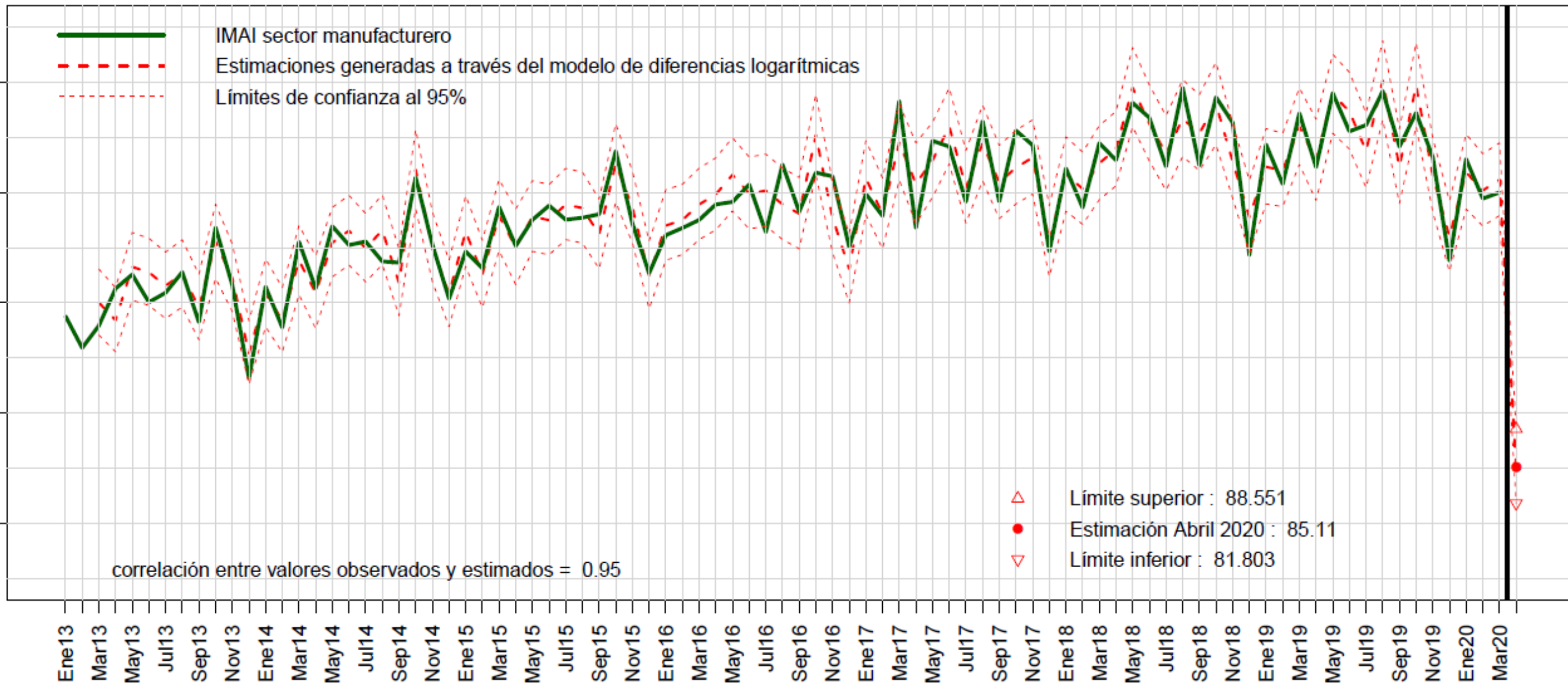
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ICEE and IMAI3133 time series

ICEE 17085 CFE 66 CENACE (variable X_t)
IMAI sector manufacturero (variable Y_t)

Correlación lineal entre X_t, Y_t = 0.58

Logarithmic differences: ICEE and IMAI3133

Correlación lineal entre X_t, Y_t = 0.91
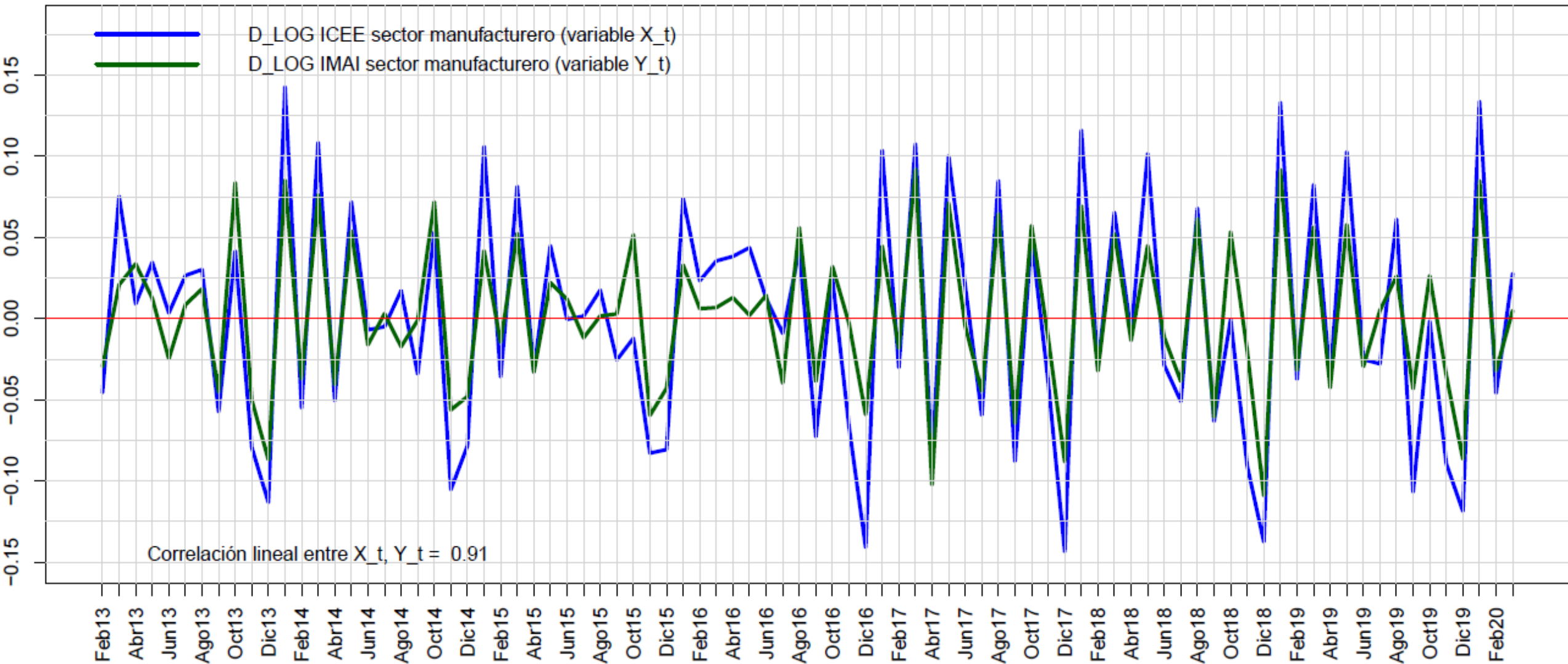
Estimates obtained with the model

Estimates for the IMAI3133 index up to April 2020

IMAI sector manufacturero
Estimaciones generadas a través del modelo de diferencias logarítmicas
Límites de confianza al 95%

△ Límite superior : 88.551
● Estimación Abril 2020 : 85.11
▽ Límite inferior : 81.803

correlación entre valores observados y estimados = 0.95
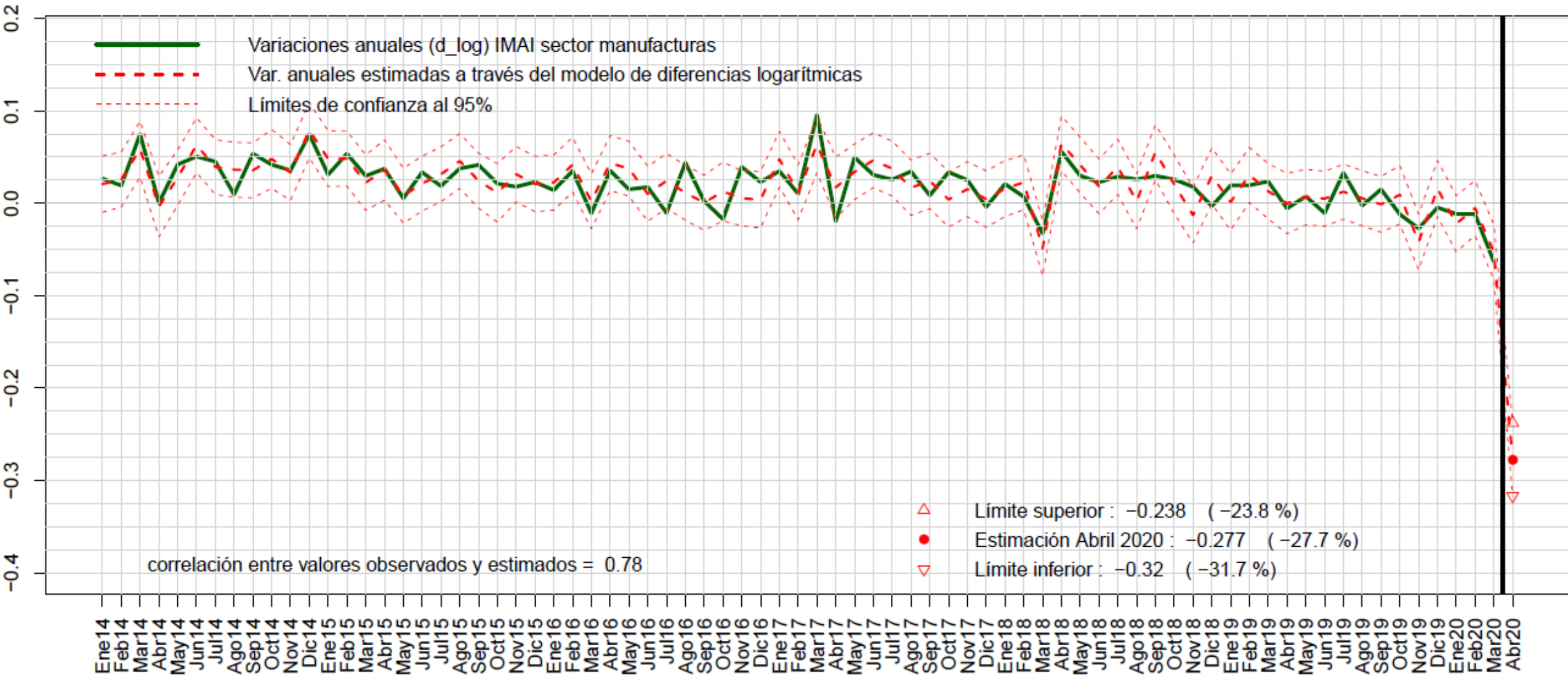
Historical assessments
for model's estimates
in real time

Assessments for IMAI3133 early estimates
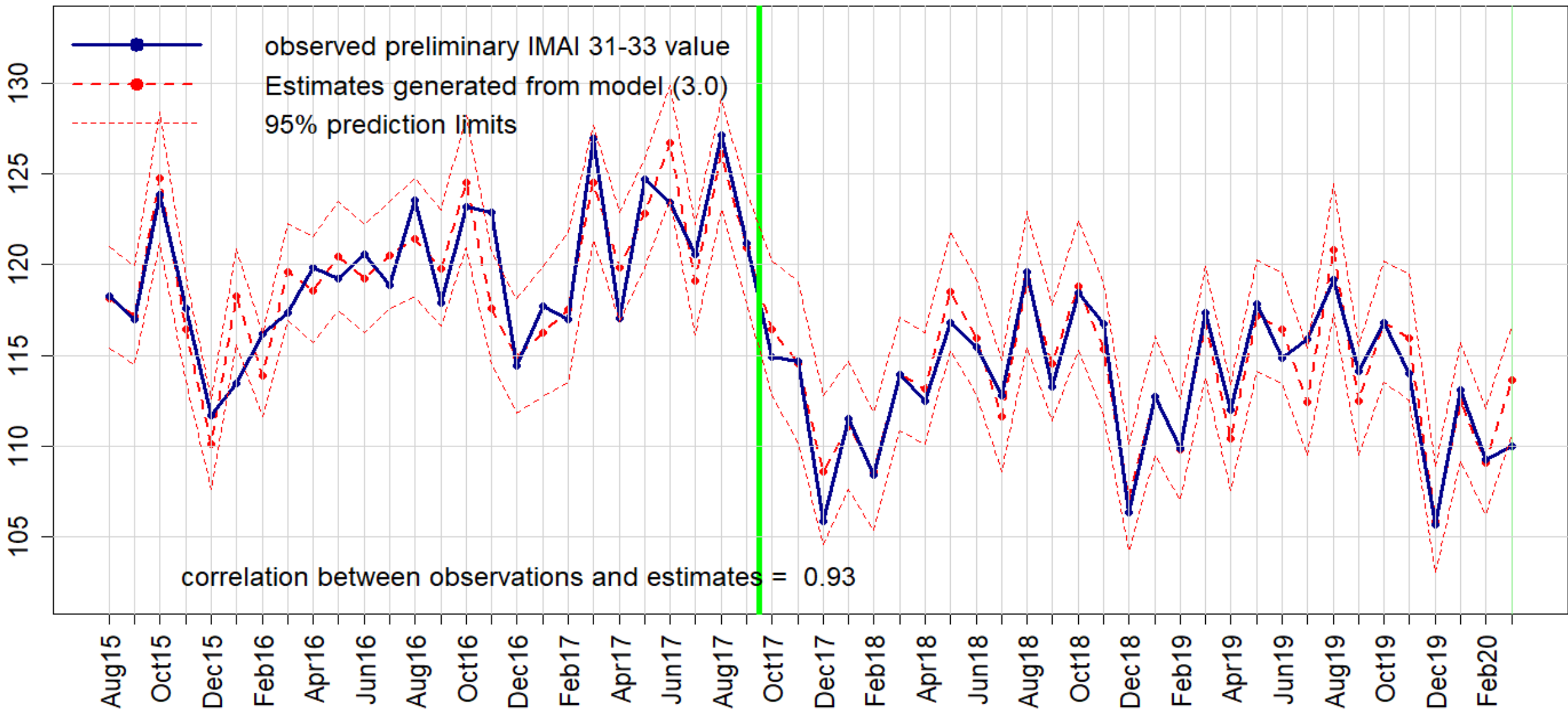
Vertical green line indicates change in base year from 2008 to 2013

Concluding remarks

- From the historical assessment, it can be observed that 91% of the time (51 out of 56 months), the official IMAI3133 value is located inside the prediction interval, which was computed with a 95% confidence level; this means that, in this case, observed empirical accuracy approached the theoretical confidence level. This is empirical evidence in favor of the structural stability of the working model

- Overall, although there is not a formal Memorandum of Understanding (MoU) between CFE and INEGI, there have been no months during the realization of this project in which no data has been received from CFE; this has enabled the successful realization of the project. There is work in progress to establish a formal MoU between CFE and INEGI

Concluding remarks

These IMAI3133 nowcasts are now being communicated publicly, since May 2020, as experimental statistics at the INEGI internet site. This new experimental indicator is called Timely Monthly Index of Manufacturing Activity (IMOAM).

More details and documentation can be found at these sites:

Main results (in Spanish):
https://ww.inegi.org.mx/investigacion/imoam/

Methodological preprint (in English):
https://www.inegi.org.mx/contenidos/investigacion/imoam/doc/manufacturing.pdf

References

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3. Kutner, M. H.; Nachtsheim, C. J.; Neter, J. (2004). Applied Linear Regression Models (4th ed.). McGraw-Hill Irwin

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