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A Diffusion Index analysis of the Argentinean business economic cycle during the Covid-19 pandemic.*

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Abstract

The Central Banks use diffusion indexes (DIs) to synthesize information from proprietary surveys that complement official statistics generating real time proxies of the economically relevant variables. According to the evidence, the DIs closely follow the economic cycle reflected in those official statistics. In this paper, the *Survey of Business Economic Perspectives* collected by the Central Bank of Argentina, is used to calculate two diffusion indexes: (i) the marginal diffusion index (MDI) based on the balance of answers and demeaned by the averaged participant response aiming at correcting for the "respondent bias" and; a (ii) marginal fixed diffusion index (MFDI) that corrects the ex-post changes on past MDI index generated by changes in the average participant response. Both indexes are analyzed for the 2017-2022 period, a particularly volatile business cycle for Argentina and (given the impact of Covid-19) for the global economy. An econometric procedure aimed at assessing the indexes relationships with the official economic activity indicators is introduced. The analysis indicates that the DIs calculated with the BCRA's Survey information closely follow and even anticipate the behavior of other official activity indicators both for the entire sample of firms and the industrial sector.

JEL Classification: C18, C83, E32, E66.

Keywords: Diffusion Index, Business cycle, Economic Activity.

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Resumen

Los Bancos Centrales utilizan índices de difusión (ID) para sintetizar información de encuestas propias que complementan las estadísticas oficiales y generan indicadores en tiempo real de variables económicas relevantes. Según la evidencia, los ID siguen de cerca el ciclo económico reflejado en esas estadísticas oficiales. En este trabajo, se utiliza la *Encuesta de Perspectivas Económicas* del Banco Central de la Argentina, para calcular dos índices de difusión: (i) el índice de difusión marginal (IDM) basado en el balance de respuestas de cada participante considerado como desvío de su respuesta promedio a lo largo del ciclo, al restar la tendencia se corrige el *"sesgo de respuesta individual"* que surge cuando los encuestados tienen una valoración personal diferente acerca de un determinado cambio en la variable, y (ii) el índice de difusión marginal fijo (IDMF) que corrige el sesgo que se observa en el IDM cuando conforme el promedio de respuesta de cada participante se modifica, cambian los valores pasados del IDM, modificando la lectura pasada del ciclo económico a medida que se agrega nueva información. Ambos índices se analizan para el período 2017-2022, un ciclo económico particularmente volátil para la Argentina y (dado el impacto del Covid-19) para la economía global. Se utiliza un procedimiento econométrico destinado a evaluar las relaciones de los IDs con el ciclo económico. El análisis muestra que los IDs calculados con información de la Encuesta del BCRA siguen de cerca e incluso anticipan el comportamiento de otros indicadores oficiales de actividad tanto para toda la muestra global de empresas como para el sector industrial.

1 Introduction

The rapid and unexpected impact of the pandemic Covid-19 generated a strong and significant economic shock both globally and in Argentina. Indeed, the Argentinean domestic economic activity dropped by 25% yearly in April 2021. A strong initial impact was observed in essential and (even stronger) in non-essential activities. In this context, the government implemented a series of economic policies initially focused on avoiding a disruption on households' income, assisting companies to preserve employment and to guarantee supply and enhancing public health services. The annual change in GDP was $-9,94\%$ in 2020 and recovered 10.39% in 2021. The initial negative shock and posterior recovery was reflected by the *Survey of Business Economic Perspectives*, collected by the Central Bank among a sample of non-financial firms. During a period of significant uncertainty, the Survey, neither mandatory nor part of the official statistics, showed considerable participation engagement. Furthermore, through both qualitative and quantitative questions and follow up interviews captured the relevance of the pandemic shock.

The objective of the paper is to highlight how the microdata from the *Survey of Business Economic Perspectives* can be used to generate synthetic indicators that, in real time, can provide reliable information about the economic business cycle. In Argentina, the official economic activity information is compiled and published by the national statistical agency: the *Instituto Nacional de Estadísticas y Censos (INDEC).* Typically, the aggregated economic activity information is released with delay (one-month lag) and may be subject to revisions. As indicated by Pinto et al. (2020), the Central Banks and/or other government agencies, collect survey microdata to calculate synthetic indexes that provide closer to real time and/or to complement information not compiled in the aggregated official statistics. On the other hand, the survey allows Central Banks to maintain a direct liaison with non-financial companies.

The unique microdata from the *Survey of Business Economic Perspectives* is used to calculate diffusion indexes (DIs) (including a novel one introduced in Elosegui et al. (2022)). The DIs are calculated using the answers to the qualitative question regarding the *economic situation of the firm* both for the last and the next six months. The question has five different possible answers, including two positive (low or significant) and two negative (low or significant) answers as well as one reflecting a neutral vision (no change). It should be noted that DIs are usually based on the balance of responses. As highlighted by the literature[1] they may present *"response bias"* due to differences in the relative participant's optimism or pessimism and/or due to differences in sector's idiosyncratic cycles. The Marginal DI (MDI) proposed by the Federal Reserve of Chicago corrects this bias by calculating the balance of responses (using the sign of the differences) demeaning each answer with respect to the average participant's response during the cycle. The MDI has several attractive features with respect the usual response balance as increases the variance and corrects the

[1] See for instance Pinto et al. (2015).

potential *"response bias."*[2] However, as the MDI is calculated by subtracting the participant's average answer through the entire period, this average can change during abnormal periods (periods with sharp economic shocks) changing the MDI past observations. To solve the latter inconvenient, the Marginal Fixed DI is introduced. The $MFDI$ calculates the MDI in pseudo real time, considering the firm's average response until the current period and saving the index in order to keep it invariant to future trend changes. Therefore the $MFDI$ complements the cycle analysis derived from the MDI. As we will show, the *MDI* changes as the average response of each firm is affected by the new and unexpected information arising from the Covid-19 shock,[3] but the $MFDI$ is unaffected as it is calculated using only current information. The comparison of both observations in a particular date complement the cycle analysis. Both DIs are econometrically analyzed in order to assess how well they relate to the best available monthly GDP indicator, the *Monthly Estimator of Economic Activity* $(MEEA)$.[4] Also, an analysis is performed for the sample of industrial companies and compared with the aggregated industrial production indicator (IPI).[5]

The analysis indicates that the diffusion indexes calculated with the *Survey of Business Economic Perspectives* information closely follow and even anticipate the behavior of other official activity indicators in the context of shocks as relevant as Covid-19 and in a very volatile economic environment as the one that characterized the Argentinean economy between 2017-2022. The results validate the auspicious statistical properties of the diffusion indexes and highlight the potential value of strengthening the *Survey of Business Economic Perspectives*. In particular, the calculated DIs required no seasonality adjustment indicating that the participant firms incorporate a seasonal adjustment in their individual. In contrast, both $MEEA$ and IPI indicators require seasonality adjustments. Also, both the MDI and the $MFDI$ for the last six months are leading and contemporaneous indicators of the $MEEAsa$. The $MFDI$ for the next six months shows simultaneity with the $MEEAsa$ suggesting that the firms consider the activity level as a relevant input in their expectation's formation process. In addition, the results for the DIs calculated for the industrial sector sample show similar behavior with respect to the main industrial sector production indicator. Finally, the results underscore the relevance and the close relationship between the business economic perspectives and the economic activity through the Argentinean

[2] It should be noted that in order to demean participant's responses it is necessary to have a minimum number of contiguous observations for each participant.

[3] Similarly to other business cycle filters, as the popular HP filter. See Orphanides & Norden (2002) for an interesting discussion.

[4] The $MEEA$ is a monthly index calculated by INDEC aiming at maintaining the quarterly Gross Domestic Product (GDP) estimation methodology. Then, the $MEEA$ is a provisional indicator of the evolution of GDP at constant 2004 prices that according to INDEC "will be released with a lag of 50 to 60 days after the end of the reference month."

[5] The industrial manufacturing production index (IPI) includes an exhaustive survey of all the manufacturing economic activities of the industrial sector, with national representative coverage. The indicator measures the evolution of the sector on a monthly basis and is calculated from the variables of production, sales, input use and apparent consumption in physical units as well as number of hours worked by personnel affected by the production process and sales at deflated current prices.

economic business cycle both before and after the strong impact of the Covid-19 pandemic shock.

The rest of the paper is organized as follows. Section 2 describes the source of microdata, the proprietary information from the Business Survey of Economic Perspectives and the actual question used for the diffusion indexes calculation. Section 3 introduces the different diffusion indexes proposed to analyze the participant's information, including a novel diffusion index. Section 4 introduces the econometric procedures to analyze the relationship between the DIs and the economic activity series. Finally, Section 5 introduces the main conclusions and the next steps of this research agenda.

2 The Business Survey of Economic Perspectives

Since December 2016, the Argentinean CB implements a monthly *Survey of Business Economic Perspectives* for non-financial companies. The survey is submitted online by non-financial companies from different economic sectors, including industrial, commercial, energy, construction and services. The sample includes more than 100 non-financial companies that are economically relevant in their markets and represent around 6% of formal private employment. It should be noted that the sample is not statistically significant nor random. Also, as it is the case in many other Central Banks, the participation in the survey is voluntary as the *Business Economic Perspectives Survey* for non-financial companies is not including in any information regime required by the Central Bank as financial regulatory agency.

The participant companies designate a qualified informant, with access to both internal balance sheet and company's planning information, responsible for submitting the survey. Additionally, the qualified informant is contacted for follow up questions that aim to assess the economic situation of the company and its economic sector. This anecdotal information is aggregated to complement the quantitative and qualitative information revealed in the survey. The online survey includes a qualitative question about the company's economic situation both current (last 6 months) and expected (next 6 months) together with a set of qualitative and quantitative questions about the quarterly changes (past and expected) of prices, costs (domestic/foreign inputs and unit labor costs), sales (domestic/foreign) and output. See Elosegui & Sangiácomo (2022) for a comprehensive Survey description.

The diffusion indexes are calculated based on the answers to the first qualitative question about the firm's economic situation:

- How do you evaluate the economic situation of your company compared to six months ago?
  - Significantly improved.
  - Moderately improved.
  - Did not change.

  - Moderately worse.
  - Significantly worse.

- And for the next six month?
  - Will improve significantly.
  - Will improve moderately.
  - Will not change.
  - Will get moderately worse.
  - Will get significantly worse.

In order to quantify the responses, a numerical value of 1, 0.5, 0, -0.5 or -1 is applied to the answers, respectively for each survey from the firm i during a period t. The firm responses are used to calculate the diffusion indexes as detailed in the following section.

3 Diffusion Indexes

Diffusion indexes are intended to provide real time assessment and/or leading indicators of economic activity, aiming to capturing changes in the direction of economic activity. The Diffusion indexes are defined in terms of the proportions of answers indicating opposed visions (or disagreement) around a given question (either qualitative or quantitative). As indicated by Pinto et al. (2020), by considering the discrepancy arising from the data the DIs *"provide a measure of the breadth of change"* in the corresponding aggregated series associated to the particular question.[6] The original or balance of answer's based DIs have been extensively analyzed in terms of their ability to forecast economic activity indicators.[7] In fact, several Federal Reserves in U.S. use these DIs to capture the direction of change in real terms of different economic variables, like inventories or sales, that are not usually measured (at least in real time) by the official statistics. Despite their usefulness, an interesting feature of this DI based on balance of answer is that two different scenarios may lead to the same synthetic result. For instance, in the case of two participants with contrasted visions, one moderately positive and other moderately negative, the DI is neutral and generates the same result as in the case where both firms have a neutral vision. As indicated by Pinto et al.

[6] In the case of the Board of Governors of the Federal Reserve System (1991) the information comes from a set of industrial production series that are synthesized as a unique industrial production index.

[7] As highlighted by the Board of Governors of the Federal Reserve System (1991), the original diffusion index (ODI) is based on the balance of answers of qualitative or quantitative surveys. Let's $R_{i,t}$ is the response value for a firm i. The set of possible answers is given by $R_{i,t} = (1, 0.5, 0, -0.5, -1)$. Then ODI is calculated as a weighted average at t of the proportion of firms with positive (increasing) answers comparing with the proportion with negative (decreasing) answers over the "span" (or time period) of the DI. A value above (below) 0 is interpreted as an improvement (worsening) of the economic situation over the span time period. As already mentioned, a problem with the ODI, among other flaws mentioned in the literature, as in Pinto et al. (2015), Pinto & Waddell (2022) and Brave et al. (2015), is the potential answer bias derived from differences in the relative perception of the participants with respect to the actual breadth of change of the variable under analysis.

(2020), both cases can be reflecting a no change economic condition situation, but the implied uncertainty regarding the business cycle reflected in the polarized answers is not fully reflected by the original DI. The authors proposed an approximation of the DI distribution to allow considering a measure of uncertainty. Recently, Brave et al. (2015) at the Chicago Federal Reserve, proposed a different DI, called the Marginal DI (MDI), that generates solid correlations *"with other regional and national indexes of economic activity, as well as gross output growth"*. As discussed below, the MDI is calculated based on the sign of the difference of the individuals' responses relative to their average responses through the business cycle. The latter feature adds more variability and ameliorate the potential individual response bias. However, as the average responds of each individual changes through time, the MDI may also change for past periods.[8] As mentioned before, this paper uses a modified version of the MDI aimed to correct the latter potential bias, see Elosegui & Sangiácomo (2022). The indexes are discussed below and then used to analyze their econometric behaviour with respect to the Argentinean economic business cycle.[9]

3.1 The Marginal Diffusion Index

At the Federal Reserve Bank of Chicago, Brave et al. (2015) proposed a demeaned diffusion index used to calculate different Chicago Fed Survey of Economic Conditions (CFSBC) indicators.[10] The authors introduce an adjustment to the traditional diffusion index formula by measuring the individuals' responses relative to their respective average responses. Then, a response is positive (negative) if it is above or below the firm's average response. In that sense, the answer by each participant is demeaned or re-scaled before to applying a traditional DI balance of response formula. The proposed index captures (what we call) the *marginal* response of each company with respect to its own average answer during the sample period. Therefore, the marginal diffusion index MDI is demeaned by subtracting the firm's average response in the complete sample period. The demeaning process helps to deal with several concerns associated with the traditional diffusion indexes Pinto & Waddell (2022). For instance, the *response bias* due to the fact that participants: (i) may differently assess a given variation as a slightly and/or a significant variation[11] or (ii) may potentially have optimistic (pessimistic) bias. In these cases, the individual participant responses would always fall within the same range. To deal with this concern the authors rely on the participant's own assessment regarding the average change in the variable to

[8] It should be noted that a basic data requirement for the MDI is that the sample of participant should be stable, for at least a minimum period of time, so that individual answers can be de-trended with the mean.

[9] It should be noted that the question regarding the company's economic situation is an open question, not strictly related and/or referenced to the economic activity level. In fact, the economic situation of the companies in the sample can be affected by other macroeconomic or sector variables. However, the DIs based on this particular question, as we will see, are closely related to the overall economic activity level. In addition, the seasonality analysis indicates that the firms seasonally adjust their answer to this question.

[10] Publicly available at Chicago Fed Survey of Economic Conditions (CFSEC).

[11] The same qualitative answer may have different meanings (and different numerical scores) for different individuals.

determine how far the recent answer is from the *normal* (long run) value of the variable. Also, this procedure can help to increase variation on the marginal answer enhancing the aggregate variance.[12] Furthermore, the procedure is particularly useful in cases of small or not statistically significant nor random samples and/or in samples with participants (firms) belonging to different sectors.[13] However, the procedure requires a relative balanced sample as correlative (and several) observations are needed in order to correctly demean the participant's average response. In sum, the MDI considers the average quantitative response $R_{i,t}$ for each firm i and period t until the last period T.

$$\bar{R}_{i,T} = \frac{1}{T}\sum_{t=1}^{T} R_{i,t} \tag{1}$$

In every period t until T each firm's response $R_{i,t}$ is compared with the average trend $\bar{R}_{i,T}$ and the sign is preserved:

$$R^*_{i,t} = 1 \iff sign(R_{i,t} - \bar{R}_{i,T}) > 0 \tag{2}$$

$$R^*_{i,t} = -1 \iff sign(R_{i,t} - \bar{R}_{i,T}) < 0 \tag{3}$$

As described before, the marginal index is calculated through a traditional DI formula applied to the modified (demeaned) data,

$$MDI_t = \left[\frac{1}{N}\sum_{i=1}^{N} R^*_{i,t}\right] \times 100 \tag{4}$$

The MDI ranges from -100 to 100, with values above (below) zero indicating an improving (worsening) vision zone. As highlighted by Brave et al. (2015), the MDI presents a greater variance comparing with the traditional DI and generates solid correlations *"with other regional and national indexes of economic activity, as well as gross output growth"*. However, there is a concern due to the fact that the index may change as the trend changes. As noted by the authors as the histories of firms responses increases *"their average responses evolve, sometimes changing whether we treat earlier responses as positive, neutral, or negative, which in turn changes earlier values of the CFSBC indexes"*. In order to address this issue we propose a variation of the MDI, that only considers the information available at any given date to avoid index changes for past periods.[14]

[12] As noted by Brave et al. (2015), *"moderately optimistic respondents are counted as having a positive outlook only when they are feeling very optimistic and our moderately pessimistic respondents are counted as having a positive outlook even when they are feeling slightly pessimistic."* The authors show evidence indicating an increased statistical variance in the sample analyzed.

[13] Brave et al. (2015) also recommend to smooth the average of repeated respondents, taking into account the change in the number or participants in the survey.

[14] See Elosegui et al. (2022).

3.2 The Marginal Fixed Diffusion Index

The Marginal Fixed Diffusion Index ($MFDI$) is a novel variation of the MDI aimed to deal with the $MDI's$ changes in past observations as recent information modified the participant average response trend. Indeed, the average trend may change during volatile cycles modifying the MDI past observations.[15] In the $MFDI$ each new observation is compared with the participant's average response calculated until the period under analysis. The actual assessment in period t is then saved (fixed) and does not change thereafter. Them $MFDI$ uses the average participant answer $R_{i,t}$ considering the information available up to the $t = \tau$:

$$\bar{R}_{i,t} = \frac{1}{\tau} \sum_{t=1}^{\tau} R_{i,t} \tag{5}$$

At $t = \tau$ the (marginal) participant answer is compared with its average answer up to the period τ. Then the next period, the MDI is calculated again and replaced for period $t + 1$, with the corresponding average until $\tau = t + 1$ and, again is fixed and saved. It should be noted that in the MDI the average was calculated until period T. In the $MFDI$ case, the MDI is fixed after t. In contrast to the MDI, the $MFDI$ in t is not recalculated in $t + 1$ even if new information arises that could change the average until $t + 1$ and, the MDI at t and/or in past periods.

$$R^*_{i,t} = 1 \iff sign(R_{i,t} - \bar{R}_{i,t}) > 0 \tag{6}$$

$$R^*_{i,t} = -1 \iff sign(R_{i,t} - \bar{R}_{i,t}) < 0 \tag{7}$$

$$MFDI_t = \left[\frac{1}{N} \sum_{i=1}^{N} R^*_{i,t} \right] \times 100 \tag{8}$$

The $MFDI$ indicator is calculated just like the MDI and the information for each period t is saved and then remain invariant. In particular, the calculation and saving procedure is done using Stata's ROLLSTAT module designed by Panigo & Sangiácomo (2003).

The $MFDI$ gives a slightly different and complementary business cycle interpretation with a good predictive behavior. In particular, in any given current period MDI and the $MFDI$ are equal. However, the past values for the latter stay fixed as time evolves whereas the MDI past values may change provided the participant's long run trends is affected by new shocks and modified with new information. Therefore, the $MFDI$ shows the real time period valuation as measured by the diffusion index calculated with the actual information available up to the period. The MDI is not useful to analyze past periods.

[15] The early values may change if the economy is not growing near its long-term trend or facing a sharp economic shock and/or when new firms are incorporated to the sample in different phases of the business cycle.

But, from purely statistical point of view the MDI should capture the long run trend information characterizing the (invariant) participant characteristics. Therefore, the indexes are complementary, the $MFDI$ solves the past changes in perspective as time pass while the MDI indicates the long run participant's perspectives. In a context of highly volatile economic business cycles and in periods with sharp and unexpected shocks the past periods differences between both indexes are quite informative as analyzed in the Elosegui et al. (2022).

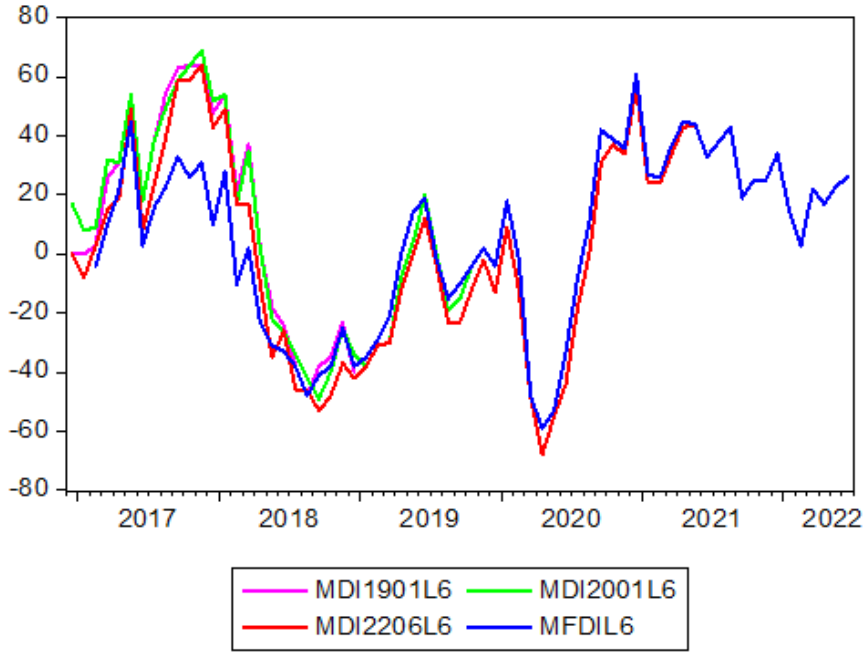
As already mentioned, we apply the $MFDI$ and the MDI to the Business Economic Perspectives Survey and analyze the behaviour of both indexes in the context of the Argentinean economic business cycle. The $MFDI$ and MDI are calculated using the qualitative question concerning the firm's economic situation both for the current (last 6 months) and expected (next 6 months) periods. An econometric analysis is performed contrasting indexes against the Monthly Estimator of Economic Activity $(MEEA)$. Also, the industrial sub-sample indexes are contrasted to the Industrial Production Index (IPI).

3.3 The Marginal and Fixed DI's calculation and analysis

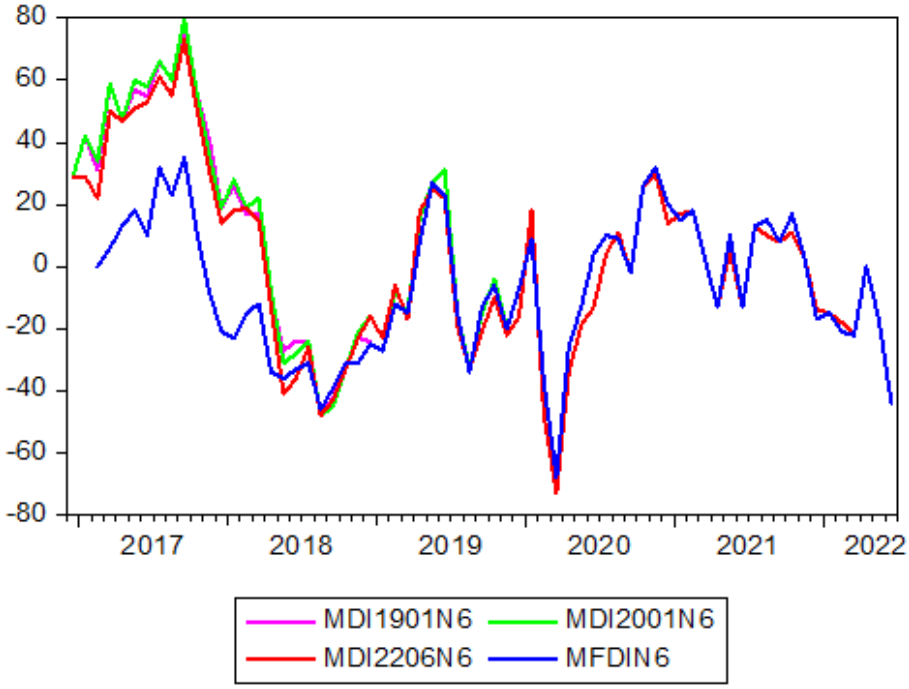
The calculated MDI and $MFDI$ indexes can be seen in the Figure 1 both for the last and next 6 months. The main differences between both DI result relevant at the beginning of the sample period and after important shocks such as the Covid-19. During such volatile periods the average trend changes modifying the perception registered by the participants with the information accrued at each given period. In fact, there is an important difference between the MDI and $MFDI$ during 2017 and the difference become important again during the 2020's Covid-19 period. In the first case, the MDI clearly overestimate the positive perspective, as the long run economic situation worsens for most of the participants. In fact, the Figure 1a shows the MDI calculation considering different initial periods for the average response of each company and resulting in different MDI values that are in all cases above the $MFDI$ calculated with the information up to the period. A similar situation arises during the unexpected Covid-19 shock. In particular, the $MDIs$ overestimate the extent of the crisis. After the initial shock in March and April, as the economy rapidly improves, participant's average also improve and for some of them, the difference between the period's perception and the average, adjusted after the crisis, changes the perspective's sign. Indeed, participant's perception overestimate the actual perception at that period. The technical note by Elosegui et al. (2022) analyzes the economic business cycle comparative performance of both indexes ($MDIL6$ and $MFDIL6$). It is clear from the comparison in the Figure 1 that the $MFDI$ does not change with time as the average perception for each company changes, reflecting participant's perspectives based on the available information during each given period.

The variance and covariance matrix of the different DIs are summarized in Table 1. The comparison includes the ODI, calculated as the simple difference of response index. It

Figure 1: MDI (different periods) & $MFDI$



(a) $MFDI$ and $MDIs$ for the last 6 months. The latter calculated with information up to 01-2019, 01-2020 and 06-2022.



(b) $MFDI$ and $MDIs$ for the next 6 months. The latter calculated with information up to 01-2019, 01-2020 and 06-2022.

should be noted that $ODI's$ variance (the diagonal of the variance-covariance matrix) is always the lowest value. As mentioned before, the MDI comparing with the ODI, allow correcting the response bias at individual and sector level.

Table 1: Diffusion Index Variance and Covariance Matrix

Series	$ODIL6$	$MDIL6$	$MFDIL6$	$ODIN6$	$MDIN6$	$MFDIN6$
$ODIL6$	**171,8**	389,5	335,0	60,8	157,4	168,6
$MDIL6$		**1152,0**	950,9	112,3	407,8	370,8
$MFDIL6$			**896,7**	38,2	147,3	252,2
$ODIN6$				**92,0**	254,6	167,7
$MDIN6$					**943,8**	590,8
$MFDIN6$						**509,6**

In order to analyze the comparative behaviour of the diffusion indexes with respect to the actual economic business cycle information, the next section introduces a systematic econometric procedure. The procedure is applied to the MDI and $MFDI$ calculated for the whole sample included in the *Survey of Economic Business Perspective*[16] in comparison with the economic activity index $(MEEA)$. In addition, in the ANNEX the industrial sub-sample DI's are compared to the industrial activity index (IPI).

4 Econometric Analysis

The comparative behaviour of the different DIs is analyzed with a *step by step* econometric procedure. The purpose of the econometric analysis is to modelling the DI's dynamics and to evaluating its relationship with the economic business cycle -measured by the Monthly Estimator of Economic Activity, $MEEA$-. The analysis is aimed at understanding DIs ability as a lead/simultaneous indicator of economic activity level and assessing the DIs behaviour during the Covid-19 pandemic shock. In addition, it provides information highlighting the relevance of the DIs as a policy making decision tool.

Econometric analysis relies in a procedure with several steps highlighted in the specialized literature, see for instance Enders (2010) and Landro & González (2009). The procedure involves modelling and evaluating the DIs temporal dynamic with respect to the economic activity level. The econometric procedure is applied to both the last and next 6 months.

Proposed econometric procedure for each series involves:

- A seasonality analysis, following the CENSUS X13 procedure.[17]
- A second-order stationary condition analysis.

[16] As mentioned before the only data requirement is for each company in the sample to have a minimum of eight consecutive observations.

[17] The X-13 ARIMA-SEATS seasonal adjustment procedure was developed by the U.S. Census Bureau and can be applied using different statistical software. In this case, is used the CENSUS X13 EVIEWS Program.

- A unit root test analysis considering the presence of structural breaks. As indicated before, the breaks are actually important during the considered period, 2017 to 2022.
- A differentiation of the series according to the number of unit roots found with the extended Dickey-Füller test for unit roots under structural break.

Table 2 summarizes the result of the initial steps of the proposed econometric analysis, including in each column: the seasonality, the date of identifiable structural breaks and the integration order for each of the analyzed series.

Table 2: Series structural breaks and integration

Series	Seasonality	Structural Breaks	Integration Order
$MDIL6$	non-identifiable	April 2020	I(1)
$MDIN6$	non-identifiable	September 2020	I(1)
$MFDIL6$	non-identifiable	June 2020	I(1)
$MFDIN6$	non-identifiable	September 2020	I(1)
$MEEA$	identifiable	May 2019	I(1)
$MEEAsa$	adjusted	April 2020	I(1)

Note: Own calculations with EVIEWS Program. See Enders (2010) for reference.

In Argentina, the economic activity indicators as $MEEA$ present a clear seasonality and are properly adjusted by the INDEC. The relevance of the seasonality in the Argentinean economy can be clearly seen in the Figure 2a below. The $MEEA$ has a seasonal peak in the second quarter mainly explained by the agricultural sector influence. The agricultural sector impact is smoothed by the seasonal adjustment process.[18] In contrast, the DIs have non-identifiable seasonality. Interestingly, the latter result is informative, as it is reflecting that the participants consider their own seasonality judgment at the moment of assessing their economic situation.[19] Given the significant $MEEA$ seasonality the relationship between the activity indicator and the DIs is analyzed using the index seasonally adjusted by the INDEC, the $MEEAsa$.

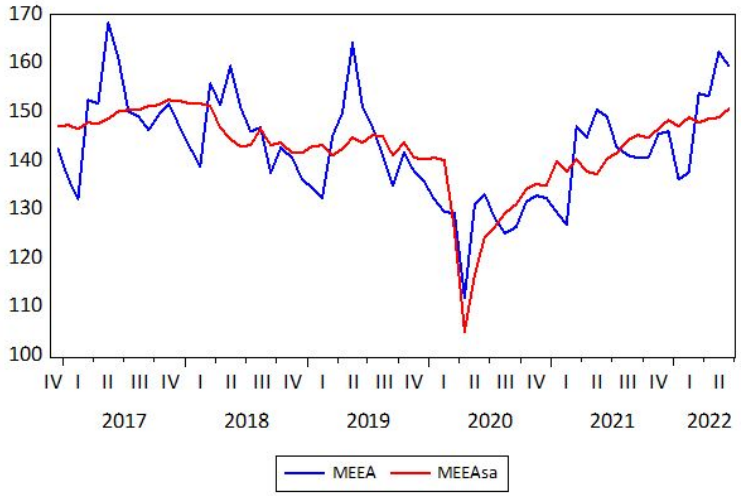
In addition, Figure 2b shows the economic trend and cycle of the $MEEAsa$ for different sub-periods. The trend calculated by INDEC is not lineal nor stable and was clearly affected by the Covid-19 shock. Furthermore, the Figure shows different sub-periods trends that are clearly diverse and the $MEEAsa$ indicator presents significant volatility throughout the period. There is an initial increasing trend, lasting until the beginning of 2018. Then, the economy cane better described by a decreasing trend that goes through 2018-2019 (after several exchange rate depreciation episodes) and clearly deepened during the Covid-19 shock. Subsequently, the recovery trend path after Covid-19 is clearly sustained until the end of the sample. These structural breaks, analyzed in Table 2 certainly have an important effect on the appraisal of companies regarding their owns averaged economic situation. As

[18] The IPI also has a seasonal behaviour, not directly related, but influenced, by the agricultural sector.

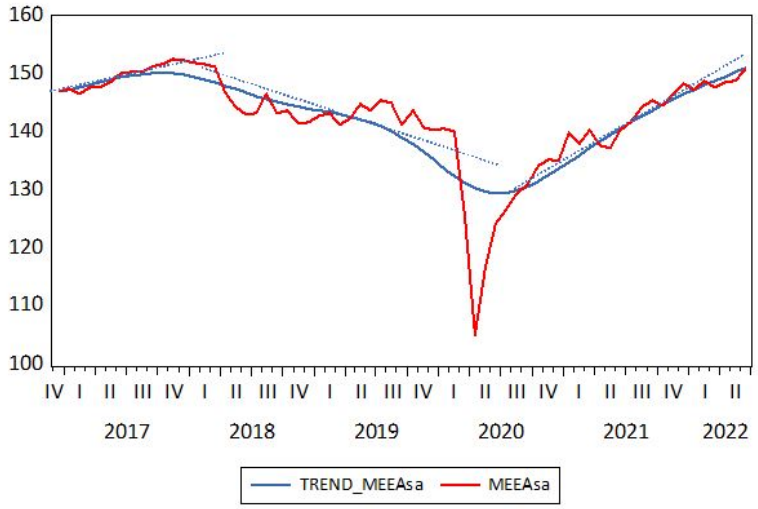
[19] It should be noted that the firm's sample in the survey is not comparable with the firms and sectors represented in the $MEEA$ indicator.

noted in the Figure, a company's average response may differ depending on the period of analysis and the information set available at that particular time.

Figure 2: The monthly estimator of economic activity ($MEEA$)



(a) Economic activity seasonality - $MEEA$ & $MEEAsa$. Source: INDEC.



(b) Economic trend and cycle - $MEEAsa$ & $MEEAsa - Trend$. Source: INDEC. The figure includes 3 different trends for the 2004-2017, 2017 - 2020 and 2020-2022 periods (own calculations).

Based on the previous analysis, the series are *"whitened"* identifying the actual data generating process to specify the *"best"* model for each of the series.[20] Then, the cross correlation estimation between the (now) pure random residuals (or white-noise) models are performed. Finally, the transfer functions modelling and assessing the DIs ability

[20]The *pre-whitening* process allowed the time series to be "cleaned" from their auto-regressive component. Therefore, the dynamic relationships between the different DIs and the $MEEAsa$ can be inferred from the residuals cross-correlogram.

as simultaneous/advanced indicators with respect to the economic activity level during the recent pandemic period are analyzed. The results are analyzed and discussed in the remaining sections, beginning by studying the relationship between the past (6 months) MDI and $MFDI$ indicators with the $MEEAsa$ and then analyzing the relationship with the prospective indexes.

4.1 Relative performance of "observed" $MDIL6$ & $MFDIL6$ vs $MEEAsa$

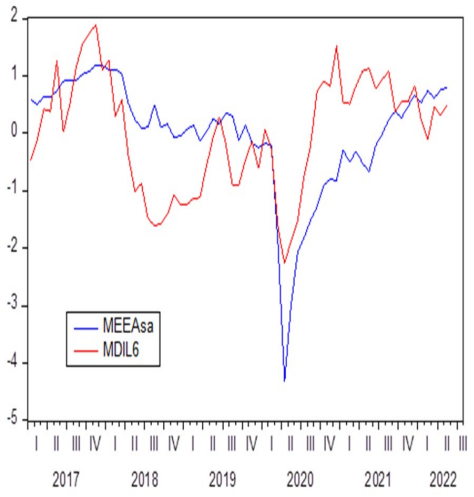
As can be noted in Figure 3a there is a close relationship between the MDI for the last 6 months $MDIL6$ and the $MEEAsa$. It is interesting to observe that the $MDIL6$ index captures the impact of the Covid-19 shock as well as the fast recovery. In addition, the $MDIL6$ reveals a positive perspective of the participants after the Covid-19, beginning at the third quarter 2020 and up to the last observation.

The relationship is confirmed by the cross correlation among the properly treated series as shown by Figure 3b. In particular, the cross-correlogram indicates that the series show significant lag correlation for two periods as well as a one period lead with a simultaneous (positive) correlation. It should be underscored that the $MEEA$ is calculated and published by the INDEC with 50 days and 35 days lag respectively. Whereas, the Survey EPE is processed and the MDI and $MFDI$ are calculated with no more than 30 days lag. Therefore, the $MDIL6$ can be considered as a leading indicator (at least one month ahead) of the $MEEAsa$.

Then, Figure 3c indicates the relationship between the $MEEAsa$ and the novel $MFDI$ for the last 6 months. It is interesting to note the close relationship observed between both indicators. The $MFDIL6$ follows closely the $MEEAsa$ capturing the decline in economic activity during 2018 and 2019, as well as the recovery at the end of 2019 and the sharp decline in economic activity due to the Covid-19. Also, the $MFDIL6$ reveals the fast recovery after the initial pandemic shock and the participant's positive perception during the latest periods. The econometric analysis indicates a strong and statistically significant relationship between the $MFDI$ for the last 6 months and the $MEEAsa$. Figure 3d reflects the cross correlation analysis indicating a strong and statistically significant simultaneous as well as a one lead relationship between the variables. Similarly to the MDI, and taking into account the relative lag between the indicators, the $MFDI$ is a promising real time predictor of the economic activity. Also, the correlation value for the first lag is 0.4223 and it is statistically significant and stronger than the one corresponding to the MDI, that is 0.3553 as shown in previous Figure 3b. In addition, another difference with the MDI is the important feedback relationship between the $MFDI$ and the $MEEAsa$ as shown by the significant 5 and 8 months lead cross correlations. The results indicate the relative relevance that the expectations regarding the economic activity has in defining the participant perceptions regarding the firm's economic situation in the previous months. Again, the $MEEAsa$ seems to play a significant role in firm's expectation formation (at least for the short run within a 6

month horizon), as we will see this relationship is captured as even stronger with the $MFDI$ for the next 6 periods.

Figure 3: $MEEAsa$ vs MDI & $MFDI$ for the last 6 months.

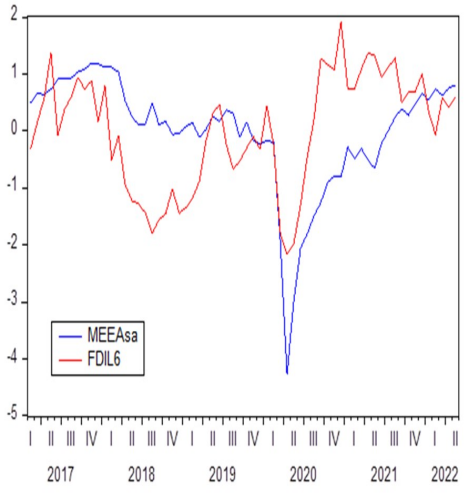


(a) $MEEAsa$ & $MDIL6$ (standardized)

Sample: 2017M01 2022M12
Included observations: 63
Correlations are asymptotically consistent approximations

RMEEAsa,RMDIL6(-i)	RMEEAsa,RMDIL6(+i)	i	lag	lead
		0	0.3699	0.3699
		1	0.3553	0.1674
		2	-0.0040	0.0040
		3	-0.0002	-0.1227
		4	0.1545	-0.1106
		5	-0.1529	-0.2160
		6	-0.0263	-0.1733
		7	0.0690	-0.0163
		8	0.1233	-0.1370
		9	0.0120	0.2144
		10	-0.1781	0.0974
		11	-0.0616	-0.1219
		12	-0.0235	-0.1556

(b) $MEEAsa$ & $MDIL6$ Cross correlation



(c) $MEEAsa$ & $MFDIL6$ (standardized)

Sample: 2017M01 2022M12
Included observations: 61
Correlations are asymptotically consistent approximations

RMEEAsa,RFDIL6(-i)	RMEEAsa,RFDIL6(+i)	i	lag	lead
		0	0.2395	0.2395
		1	0.4223	0.1297
		2	0.1096	-0.0426
		3	0.0080	-0.1329
		4	0.1700	-0.1773
		5	-0.0892	-0.3212
		6	-0.0187	-0.1710
		7	0.0426	-0.1712
		8	0.0839	-0.3545
		9	0.1629	0.0388
		10	-0.1589	0.0617
		11	-0.1129	-0.0651
		12	-0.1349	-0.0488

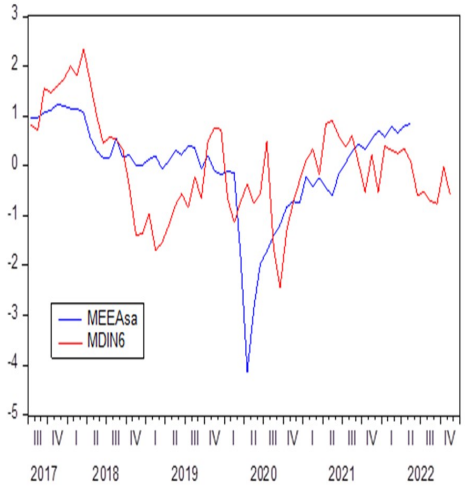
(d) $MEEAsa$ & $MFDIL6$ Cross correlation

4.2 Relative performance of "prospective" $MDIL6$ & $MFDIL6$ vs $MEEAsa$

The Figure 4a displays the relationship between the participant perspectives for the next 6 months as captured by the $MDIN6$ and the $MEEAsa$. The econometric analysis indicates a strong and statistically significant relationship between the MDI for the next 6 months and the $MEEAsa$. The cross correlation analysis between the properly treated series, in Figure 4b, indicates a 5 periods statistically significant relationship between the perspective and the actual $MEEAsa$. The lag is reflecting that the firms consider the $MEEAsa$ as a key ingredient in their 6 months expectations formation process. Indeed, the result indicates that the economic activity level, measured by the $MEEAsa$, plays a significant role in the firm's planning process. It should be noted that a six months period may be short as planning program and may be reflecting the firm's reaction to the overall volatility of the Argentinean economy. In addition, the correlation confirms the fact that the firms answer the question regarding the economic situation of the firm by considering mostly the aggregate activity level captured by the $MEEAsa$.

In turn, the Figure 4c shows the relationship between the $MFDIN6$ and the seasonally adjusted economic indicator, $MEEAsa$. As can be noted in the Figure, the $MFDIN6$ seems to present sharper changes during recoveries comparing with the $MDIN6$. In fact, the $MFDIN6$ shows a stronger statistical relationship for the 5 period lead as compared with the $MDIN6$. See the cross correlation between the series, in Figure 4d. Again, the $MEEAsa$ seems to play a significant role in firm's expectation formation (at least for a relatively short run planning) and seems to be better captured, at least in relative terms by the $MFDIN6$ comparing with the $MDIN6$.

Figure 4: $MEEAsa$ vs MDI & $MFDI$ for the next 6 months.

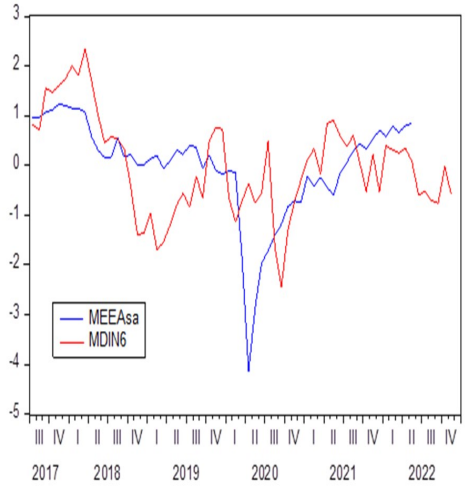


(a) $MEEAsa$ & $MDIN6$ (standardized)

Sample: 2017M01 2022M12
Included observations: 57
Correlations are asymptotically consistent approximations

RMEECsa,RMDIN&(-i)	RMEECsa,RMDIN6(+i)	i	lag	lead
		0	-0.0473	-0.0473
		1	0.0149	0.0609
		2	0.2121	0.0834
		3	0.1890	-0.1786
		4	-0.1036	0.2310
		5	-0.2251	0.5187
		6	-0.1329	-0.0035
		7	0.0286	-0.1755
		8	-0.0786	-0.1009
		9	0.0746	-0.1214
		10	-0.0836	-0.0303
		11	-0.0497	-0.0334
		12	-0.0939	-0.0601

(b) $MEEAsa$ & $MDIN6$ Cross correlation



(c) $MEEAsa$ & $MFDIN6$ (standardized)

Sample: 2017M01 2022M12
Included observations: 55
Correlations are asymptotically consistent approximations

RMEEAsa,RFDIP6(-i)	RMEEAsa,RFDIP6(+i)	i	lag	lead
		0	-0.0603	-0.0603
		1	0.0419	0.1248
		2	0.2085	0.0228
		3	0.1565	-0.0962
		4	-0.2064	0.2214
		5	-0.2385	0.5077
		6	-0.1699	-0.0021
		7	0.0577	-0.1073
		8	-0.0923	-0.1188
		9	0.0734	-0.1800
		10	-0.0534	0.0195
		11	0.0432	-0.0489
		12	-0.0831	-0.0816

(d) $MEEAsa$ & $MFDIN6$ Cross correlation

In addition, the Table 3 summarizes the transfer function model describing the close relationship between the adjusted *white-noise* residual of MDI for the last 6 months and the economic activity. The dependent variable is given by the *white-noise* adjusted $MEEAsa$ and the significant explanatory variables are the *white-noise* adjusted contemporaneous and one period lagged $MDIL6$.

Table 3: Transfer Function Model with white noise residuals

Dependent Variable: $MEEAsa$ w.n. res.
Sample (adjusted): 2017M01 2022M03
Included obs. 63 after adjustments

Variable	Coefficient	Std. Error	t-statistic	Prob
$MDIL6$ w.n. res.	0.0915	0.02676	3.4199	0.0011
$MDIL6(-1)$ w.n. res.	0.0778	0.02708	2.8759	0.0055
R-squared	0.2743			
Adjusted R-squared	0.2624			
Durbin-Watson stat	1.8908			

Finally, the transfer model corresponding to the $MFDIN6$ with the $MEEAsa$ in Table 4, captures the two-way relationship between the economic activity indicator and the firm's perspectives for the next six months. It seems that the companies use the $MEEAsa$ indicator as an important variable in the planning and forecasting process for their future operations.[21] The dependent variable in the model is the *white noise* $MFDN6$ residual whereas the explanatory variable corresponds to the $MEEAsa$ *white-noise* residual. The statistically significant coefficient corresponds to five month's lag.

Table 4: Transfer Function Model with white noise residuals

Dependent Variable: $MFDIN6$ w.n. res.
Sample (adjusted): 2017M01 2022M03
Included obs. 60 after adjustments

Variable	Coefficient	Std. Error	t-statistic	Prob
$RDMEEAsa(-5)$ w.n. res.	2.0116	0.4480	4.4898	0.0000
R-squared	0.2541			
Adjusted R-squared	0.2541			
Durbin-Watson stat	2.2376			

[21] In fact, this is also revealed during the Survey follow-up interviews with the companies.

5 Conclusions

The Covid-19 pandemic had a strong impact on the Argentinean economic activity and was captured in real time and with at least one month lead by DIs based on the *Survey of Business Economic Perspectives*. The paper analyzes the econometric property of two diffusion indexes in assessing the actual business cycle behaviour as reflected by the official economic activity statistics. The analysis is based on an econometric procedure including series seasonality and stationary analysis, whitening (considering structural breaks) as well as cross correlation analysis.

The analyzed DIs includes the Marginal Diffusion Index (MDI), based on the balance of responses and de-trended by the participant's average response during the business cycle. Therefore, the MDI de-trends the company and/or sector potential bias. However, by updating the indicator backward each period, it may overestimate past optimism during negative shocks events or underestimate pessimism under positive shocks. Therefore, a variation of the MDI, called Fixed Marginal Diffusion Index $(MFDI)$ is introduced, that solves the latter potential bias by fixing the marginal comparison between the actual observation and the average trend in each period. The $MFDI$ allows a more accurate perspective of the companies' vision in each period, complementing the conclusions derived from the MDI.

The econometric analysis indicates that the DIs do not require seasonality adjustment reflecting that the seasonality is already incorporated in the answers completed by the companies.[22] Also, the results indicate that the proposed DIs are leading indicators of the economic business cycle. In addition, the marginal and fixed marginal DIs show several interesting econometric properties including a strong contemporaneous correlation with economic activity changes (one month ahead in real time).

The MDI and $MFDI$ indexes show important discrepancies during some periods, reflecting the considerable changes in the mood of firms as new information arrives in a context of a particularly volatile economic environment. Indeed, for the early periods, the $MFDI$ reflects a different estimation of the breadth of change comparing with the MDI and should be considering, at least as complementary information, in the case of important volatility in the economic business cycle. Both indicators have similar goodness of fit with respect to the level of activity, especially in relation to the observed periods, and even the $MFDI$ seems to have better forecasting properties comparing with the MDI.

The global results underline the relevance of the Survey and the value of strengthening it for policy decision making. The DI based on the qualitative information from the *Survey of Business Economic Perspectives* are an important complement for the real time assessment of the Argentinean business cycle. The future research agenda includes the evaluation of the potential impact of incorporating the proposed DIs indexes in the Argentinean Central Bank nowcasting indicators.

[22] It should be not a surprise that no one knows better the seasonality of their own business than the companies.

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6 Annex

6.1 Industrial Sector Analysis

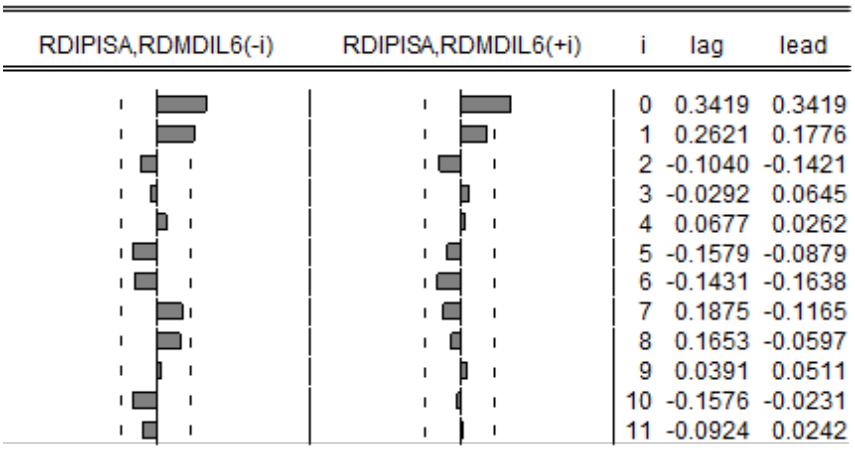
The sub-sample corresponding to the industrial sector firms is analyzed with the same diffusion indexes formula and econometric tools. The Table 5 shows the series structural breaks and integration.

Table 5: Series structural breaks and integration

Series	Seasonality	Structural Breaks	Integration Order
$MDIL6$ (ind)	non-identifiable	March 2020	I(1)
$MDIN6$ (ind)	non-identifiable	September 2020	I(1)
$MFDIL6$ (ind)	non-identifiable	March 2020	I(1)
$MFDIN6$ (ind)	non-identifiable	September 2020	I(1)
IPI	identifiable	August 2020	I(1)
$IPIsa$	adjusted	August 2020	I(1)

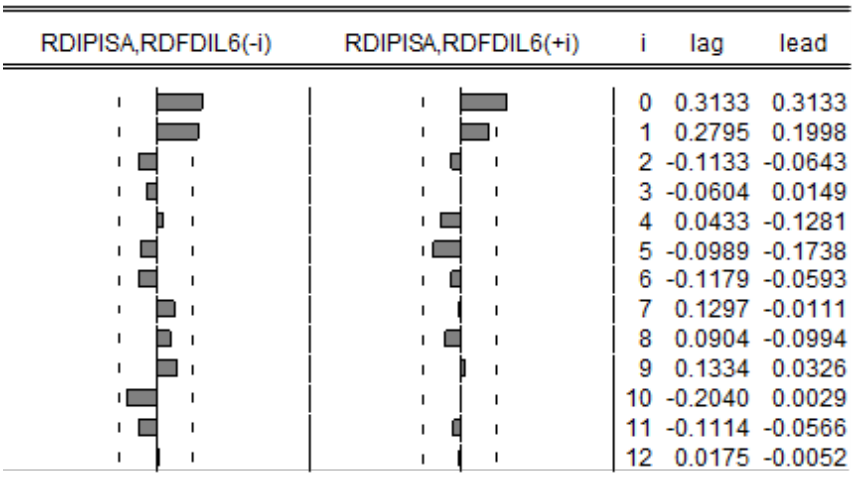
The Figure 5a displays the cross-correlogram between the $MDIL6$ for the industrial sector and the $IPIsa$. The results indicates that the $MDIL6$ anticipates the $IPIsa$ in one period. The cross correlation between the properly treated $IPIsa$ series and the $MFDIL6$ is shown in Figure 5b. Again, the $MFDIL6$ anticipates $IPIsa$ by one period.

Figure 5: Cross correlation.



RDIPISA,RDMDIL6(-i)	RDIPISA,RDMDIL6(+i)	i	lag	lead
		0	0.3419	0.3419
		1	0.2621	0.1776
		2	-0.1040	-0.1421
		3	-0.0292	0.0645
		4	0.0677	0.0262
		5	-0.1579	-0.0879
		6	-0.1431	-0.1638
		7	0.1875	-0.1165
		8	0.1653	-0.0597
		9	0.0391	0.0511
		10	-0.1576	-0.0231
		11	-0.0924	0.0242

(a) $IPIsa$ & $MDIL6$ (ind.) Cross correlation

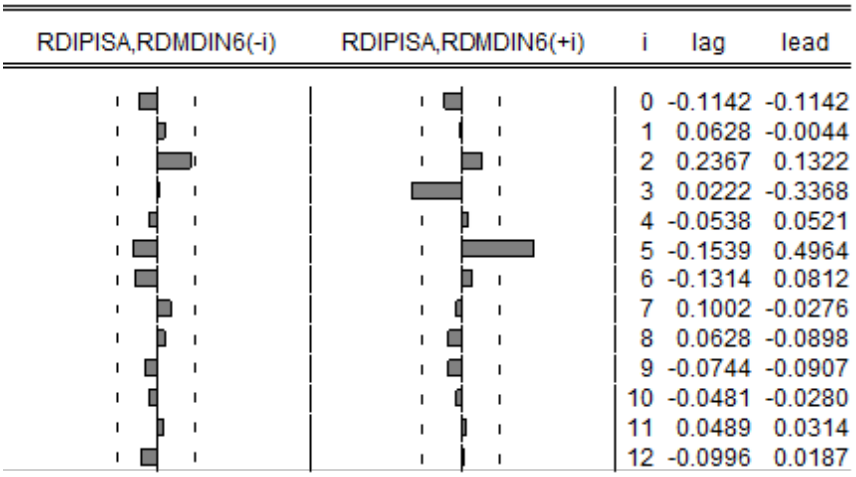


RDIPISA,RDFDIL6(-i)	RDIPISA,RDFDIL6(+i)	i	lag	lead
		0	0.3133	0.3133
		1	0.2795	0.1998
		2	-0.1133	-0.0643
		3	-0.0604	0.0149
		4	0.0433	-0.1281
		5	-0.0989	-0.1738
		6	-0.1179	-0.0593
		7	0.1297	-0.0111
		8	0.0904	-0.0994
		9	0.1334	0.0326
		10	-0.2040	0.0029
		11	-0.1114	-0.0566
		12	0.0175	-0.0052

(b) $IPIsa$ & $MFDIL6$ (ind.) Cross correlation

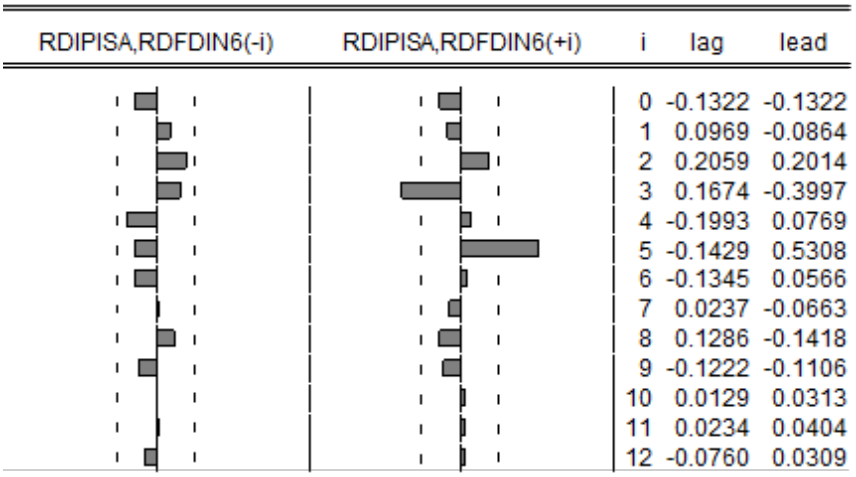
Meanwhile, the Figure 6a displays the cross-correlogram between the $MDIN6$ for the industrial sector and the $IPIsa$. The results indicates a high correlation among the $MDIN6$ and the $IPIsa$ with 3 and 5 lags. The cross-correlation between the properly treated $IPIsa$ series and the $MFDIN6$ is shown in Figure 6b. Again, the $MFDIN6$ significantly anticipates $IPIsa$ by one period.

Figure 6: Cross correlation.



RDIPISA,RDMDIN6(-i)	RDIPISA,RDMDIN6(+i)	i	lag	lead
		0	-0.1142	-0.1142
		1	0.0628	-0.0044
		2	0.2367	0.1322
		3	0.0222	-0.3368
		4	-0.0538	0.0521
		5	-0.1539	0.4964
		6	-0.1314	0.0812
		7	0.1002	-0.0276
		8	0.0628	-0.0898
		9	-0.0744	-0.0907
		10	-0.0481	-0.0280
		11	0.0489	0.0314
		12	-0.0996	0.0187

(a) $IPIsa$ & $MDIN6$ (ind.) Cross correlation



RDIPISA,RDFDIN6(-i)	RDIPISA,RDFDIN6(+i)	i	lag	lead
		0	-0.1322	-0.1322
		1	0.0969	-0.0864
		2	0.2059	0.2014
		3	0.1674	-0.3997
		4	-0.1993	0.0769
		5	-0.1429	0.5308
		6	-0.1345	0.0566
		7	0.0237	-0.0663
		8	0.1286	-0.1418
		9	-0.1222	-0.1106
		10	0.0129	0.0313
		11	0.0234	0.0404
		12	-0.0760	0.0309

(b) $IPIsa$ & $MFDIN6$ (ind.) Cross correlation