

Cyclical Dynamics of Formal Private Employment in Argentina: Regional Evidence Based on ARDL Models (1995–2025)¹

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Abstract

This paper analyzes the cyclical dynamics of Argentina's formal private labor market from a subnational perspective over the period 1995-2025. The main objectives are to characterize the comovements between employment levels and the business cycle, identify regional heterogeneity, and quantify short- and long-run adjustment mechanisms in response to macroeconomic shocks.

The empirical approach combines nonparametric cyclical analysis techniques with autoregressive distributed lag (ARDL) models. This allows for the simultaneous modeling of short-run dynamics and long-run equilibrium relationships among variables. A coincident index of economic activity is used as a reference for the business cycle. The real multilateral exchange rate and the share of public consumption in aggregate demand are also incorporated as additional determinants of regional employment.

The results confirm that, as with the aggregate level, both formal private employment and real salaries in the regions exhibit procyclical behavior with either coincident or slightly lagged synchronizations, though with significant differences in persistence. Similarly, the ARDL models and their error-correction representations reveal cointegration relationships and substantial long-run employment-output elasticities, indicating idiosyncratic behaviors among regions regarding the intensity and speed of adjustment.

JEL classification codes: [E32], [R11], [C22]

Keywords: *business cycles, formal employment, regional labor markets, ARDL models*

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1. Introduction

The labor market is one of the main channels through which the business cycle affects household well-being. In economies characterized by high macroeconomic volatility, such as that of Argentina, fluctuations in activity levels are directly reflected in employment and salaries. However, the intensity, speed of adjustment, and degree of persistence may differ substantially across regions. Understanding these dynamics is crucial for assessing current economic conditions and designing regional economic policies.

The available empirical evidence for Argentina indicates that both registered private employment and real salaries exhibit a procyclical relationship with the level of aggregate economic activity, with characteristics that are either coincident or slightly lagging in terms of timing. Nevertheless, the findings reveal that this aggregate behavior masks significant heterogeneities at the subnational level, associated with differences in the productive structure, exposure to foreign trade, and the relative weight of the public sector in each region.

In this context, the main objective of the research is to study the comovements between labor market variables and a set of relevant macroeconomic variables from a regional perspective. The focus is on both cyclical dynamics and the possible mechanisms of territorial propagation of contractionary and expansionary phases.

The empirical approach adopts a sequential methodology that combines descriptive and econometric tools. In the initial stage, the cyclical behavior of employment is characterized using traditional nonparametric analysis techniques. Subsequently, the study estimates short- and long-run elasticities using an econometric approach based on autoregressive distributed lag (ARDL) models. In particular, the study examines the response of regional employment to shocks in aggregate economic activity, the real multilateral exchange rate, and the relative weight of the state in domestic demand—measured by the share of public consumption in total consumption—by estimating the corresponding elasticities and analyzing the joint dynamics of these variables in each region. This methodological framework is particularly well-suited for studying dynamic relationships among macroeconomic series, as it allows simultaneous modeling of short-run transitory effects and long-run equilibrium relationships. Furthermore, its representation in terms of error correction models (ECMs) enables explicit assessment of the speed of adjustment of regional employment in response to deviations from its equilibrium path.

This study contributes to the literature by supporting the existence of cyclical behavior in registered private employment at the regional level in Argentina, identifying patterns and differences in synchronization and persistence. These results complement the author's previous findings on varying degrees of cyclical sensitivity and vulnerability in formal employment at the provincial level. Additionally, the study quantifies region-specific short- and long-run elasticities to assess the degree of territorial heterogeneity in the transmission of macroeconomic shocks. These results are relevant to the literature on regional labor

markets and to the design of public policies aimed at mitigating the effects of recessions on formal employment.

The remainder of this paper is organized as follows: Section 2 presents the theoretical and methodological framework underlying cyclical analysis and the use of ARDL models. Section 3 describes the data sources and main characteristics of the data used. Section 4 outlines the empirical strategy and results of the analysis, including cyclical characterizations at national and subnational levels, econometric estimates, and a discussion on regional employment elasticities. Finally, Section 5 summarizes the main conclusions and offers concluding remarks.

2. Theoretical framework

2.1. Cyclical analysis of economic variables

To analyze the cyclical behavior of a variable in relation to underlying economic fluctuations, it is first necessary to define a base indicator that serves as a benchmark within the period and geographic area under consideration. This element is technically referred to as the reference cycle.

In academic practice, studies based on quarterly data usually refer to gross domestic product (GDP). However, when monthly data are available, a coincident indicator of economic activity is commonly used instead. This avoids the need to calculate GDP on a monthly basis and allows for a more precise identification of the start and end of the various phases of the cycle. These indicators began developing in the mid-20th century and gradually became established in specialized literature. As Boschan and Banerji (2002) note, the first advances were sectoral diffusion indices. Over time, these indices evolved into composite economic activity indices and became widely used from the 1980s onward.

Once the reference cycle has been defined, as reported by *The Conference Board* (2001), the economic variables under analysis can be classified as procyclical, countercyclical, or acyclical. The classification depends on whether they generally accompany economic fluctuations positively or negatively, or show no synchronization with the cycle. A second classification, of particular relevance, relates to the temporal dynamics of each variable with respect to the reference cycle. Depending on whether their movements tend to anticipate, occur simultaneously with, or follow the turning points of the business cycle, time series can be classified as leading, coincident, or lagging. From a practical standpoint, leading indicators are the most useful because they provide early warning signals that anticipate the onset of contractionary phases.

The long-run relationships between the economic variables under analysis and the reference cycle are referred to as stylized facts. In the economic literature, this concept refers to recurrent and robust empirical regularities observed in the data, which hold over time and across different contexts regardless of specific conjunctural episodes. As Lucas (1977) points out, stylized facts constitute a fundamental starting point for macroeconomic analysis, as they allow for the synthesis of persistent patterns of behavior among variables and serve as a reference for the evaluation and validation of theoretical models.

2.2. Turning points and cyclical phases

The traditional approach to identifying turning points and defining cyclical phases is based on identifying the relative peaks and troughs reached by indicators within a given context.² Alternatively, the so-called growth approach defines turning points based on deviations of each indicator from its long-run trend. Both are nonparametric methods widely used in business cycle analysis.

There are also methods for identifying the phases or states of an indicator. These approaches provide greater theoretical support for determining turning points, given that the identification arises endogenously from the model itself. However, these methods are not widely used. This is partly because of their greater computational complexity and partly because, as Anas and Ferrara (2002) point out, comparisons show that the resulting dates are very similar to those obtained using nonparametric methods.

On the other hand, a complete cycle under any of the aforementioned approaches consists of two consecutive phases that can be defined from either peak to peak or trough to trough. In this study, nonparametric approaches are used to identify turning points.³

2.3. Filtering of raw data, long-run trends, and deviations from the trend

Time series exhibiting intra-annual patterns are first deseasonalized and adjusted for extreme irregular values before being used as inputs in subsequent stages of the analysis. Regarding the identification of the long-run trend required by the growth cycle approach, this study follows the proposals of Kydland and Prescott (1990) and Uribe and Schmitt-Grohé (2017), among other authors, who suggest extracting the trend component from each series using the Hodrick-Prescott (HP) filter. [Annex 1](#) presents the specific methodological references associated with both the deseasonalization procedure adopted and the calculation of the HP filter.

Based on the filtered data for each variable and its corresponding long-run trend, trend deviations (TDs) are obtained, defined as the ratio of a time series i in levels to its trend component estimated using the HP filter:

$$TD_i = \frac{variable_i}{trend\ HP_i} \quad (1)$$

² The procedure is typically internalized using the algorithm proposed by Bry and Boschan (1971), which allows for the systematic identification of turning points in a time series without imposing specific assumptions about its behavior. Its implementation is organized into three stages: (i) identification and replacement of extreme values; (ii) determination of the cyclical movements of the series and delineation of relative maxima and minima; and (iii) dating of the turning points on the calendar.

³ According to the European Union and the United Nations (2017), nonparametric methods are still widely used for identifying turning points in business cycle analysis at the international level.

2.4. Amplitude and cyclic synchronization

After identifying the start and end of each cyclical phase according to the selected approach, the behavior of each variable under analysis is compared with the reference cycle. This comparison is based on two fundamental dimensions: amplitude and temporal synchronization.

Within the framework of the growth cycle approach adopted in this study, amplitude refers to the magnitude of deviations from the trend during expansionary and contractionary phases. Temporal synchronization, on the other hand, captures the degree of alignment between the turning points of each series and those of the reference cycle, allowing for the identification of leads, lags, or coincidences. It is also important to consider the duration of the phases, understood as the length of time each variable remains in a given state, measured by the length of the corresponding periods, whether in months or quarters.

2.5. Short- and long-run dynamics based on ARDL models

Autoregressive distributed lag models are a robust econometric tool for analyzing relationships between time series.

In dynamic terms, they simultaneously model short-run interactions, which are viewed as temporary responses to changes in the explanatory variables, and long-run relationships, which reflect structural equilibria among the variables in the system. When cointegration relationships are verified, the general model can be reformulated as an ECM. This allows for the capture of the adjustment process toward the long-run equilibrium following a shock affecting the variables.

From a technical perspective, ARDL models integrate an autoregressive component, which incorporates past values of the dependent variable, with a distributed lag component corresponding to the explanatory variables.

In its early applications, the standard practice was to model seasonally adjusted time series using stationary distributed lag models. Subsequently, Pesaran and Shin (1999) proposed an approach that allows for modeling nonstationary time series under the assumption of a long-run linear relationship between variables. More recently, Pesaran et al. (2001) developed a generalization that uses a cointegration test based on the bounds testing approach. This approach enables the presence of variables with mixed orders of integration, provided that none exceed order one.

Over the past two decades, this approach has expanded with the development of nonlinear variants of the ARDL model designed to analyze long-run relationships. These models, known as nonlinear ARDL (NARDL) models, are better suited to capturing asymmetries and nonlinear behavior in certain empirical contexts.⁴

⁴ For further information on this topic, see Shin et al. (2013) and Cho et al. (2021).

Formulation used in the study

The general form of the ARDL model $(p, q_1, \dots, q_k)$, which allows for the analysis of nonstationary time series as proposed by Pesaran et al. (2001), is adopted in this study:

$$y_t = c_0 + c_1 t + \sum_{i=1}^p b_i y_{t-i} + \sum_{j=1}^k \sum_{l=0}^{q_j} b_{j,l} x_{j,t-l} + \varepsilon_t \quad (2)$$

In expression (2), y_t is the dependent variable; c_0 is the constant; $c_1 t$ is an optional term for the trend; $\sum_{i=1}^p b_i y_{t-i}$ captures autoregressive terms with lags of the dependent variable itself; $\sum_{j=1}^k \sum_{l=0}^{q_j} b_{j,l} x_{j,t-l}$ captures the distributed lags with k explanatory variables; and ε_t is the error term not captured by the model.

Representation of the ARDL model in a restricted error correction model (RECM)

If certain conditions are met,⁵ an ARDL model can be expressed as an RECM, as it imposes a specific structure on the relationship between the variables. Deviations from the long-run relationship are corrected partially in the short run. Additionally, this representation assumes a conditional form, which involves the modeling of the dependent variable as a function of its own lags, the lags of the explanatory variables, and the error correction term (ECT).

The RECM formulation associated with a basic ARDL model is:

$$\Delta y_t = c_0 + c_1 t + \sum_{i=1}^{p-1} \psi_i \Delta y_{t-i} + \sum_{j=1}^k \sum_{l=1}^{q_j-1} \beta_{j,l} \Delta x_{j,t-l} + \sum_{j=1}^k \omega_j \Delta x_{j,t} + \pi_y ECT_t + \varepsilon_t \quad (3)$$

Subject to:

$$\psi_{j,1} = 0 \quad \forall q_j = 1, \quad \beta_{j,1} = \omega_j = 0 \quad \forall q_j = 0$$

In expression (3), Δy_t is the first difference of the dependent variable; c_0 is the constant; $c_1 t$ is the optional trend term; $\sum_{i=1}^{p-1} \psi_i \Delta y_{t-i}$ are the lags of the first difference of y_t . This captures the short-run dynamic effect of the dependent variable itself; $\sum_{j=1}^k \sum_{l=1}^{q_j-1} \beta_{j,l} \Delta x_{j,t-l}$ captures the short-run effect of the lags of each explanatory variable; $\sum_{j=1}^k \omega_j \Delta x_{j,t}$ reflects the immediate—contemporary—impact of each explanatory variable; $\pi_y ECT_t$ represents the deviation from the long-run relationship between the variables; and π_y is the adjustment coefficient (negative and significant if cointegration exists). This term forces Δy_t to partially correct deviations from the long-run equilibrium in each period.

⁵ An ARDL model can be expressed as an RECM if the included variables are of order zero or one, but not two, and if there is a cointegration relationship between them.

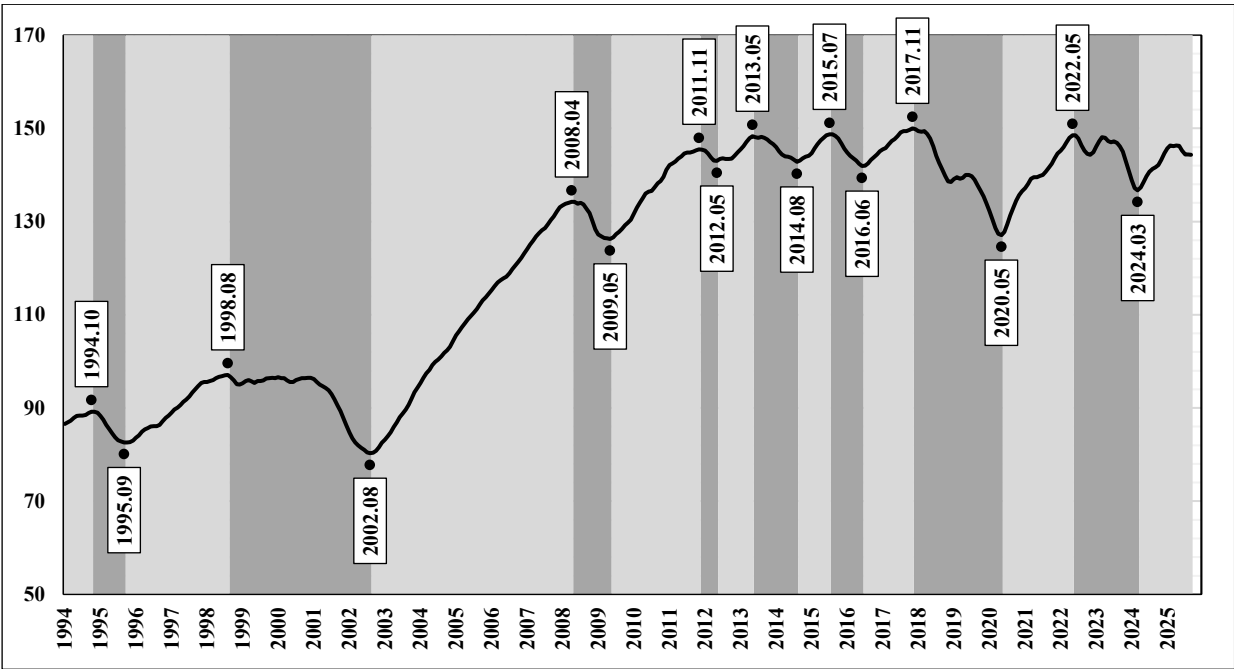
3. Descriptive data and statistics

3.1. The business cycle in Argentina

The reference cycle used is the composite coincident index of economic activity for Argentina (ICA-ARG, for its acronym in Spanish). This index was developed on an ad hoc basis to monitor the country's phases of economic contraction and expansion.

The series is compiled and published by the Centro de Investigación del Ciclo Económico (CICEc) on a monthly basis, seasonally adjusted series, and in real terms, on the basis of 2004 = 100. The coincident index encompasses data from January 1994 onward (see [Figure 1](#)).

Figure 1 | Coincident index of economic activity for Argentina (ICA-ARG, for its acronym in Spanish)
Seasonally adjusted series, base 2004 = 100



Note: The turning points were identified using traditional criteria—relative maxima and minima. The dark gray areas indicate periods of recession in Argentina; the lighter shaded areas refer to periods of expansion.

Source: Author's own elaboration based on data from the Centro de Investigación del Ciclo Económico (CICEc).

Consistent with the timeframe of this study, the analyzed period begins with the recession that affected Latin America in the mid-1990s. This recession is referred to as the “Tequila Effect” due to the contagion caused by Mexico’s economic contraction, which impacted the Argentine economy between 1994 and 1995. The second contractionary phase corresponds to a prolonged recession that began in 1998 and gradually deepened until it culminated in an economic and social crisis in 2001–2002.

After the economic activity began to recover, the country entered a period of expansion from 2002 to 2008, driven by sustained increases in export commodity prices. From that point onward, the Argentine

economy entered a period of stagnation and experienced six classic recessions⁶ and six recovery phases that failed to take hold over time and resulted in minimal net growth. The penultimate contractionary phase began in November 2017 and deepened in 2020 due to the overlapping adverse effects of the COVID-19 pandemic.⁷

3.2. Level of employment and salaries in subnational areas in Argentina

Regarding the labor market at the subnational level, the analysis considers a dataset comprising two series: (1) *registered private-sector employees* and (2) *average gross salaries*. Both series are disaggregated by jurisdiction on a monthly basis.

The primary source of this database is the Argentine social security system, which regularly collects information on companies and workers who contribute to the system. To extend the time series back to January 1995, data from various official sources were cross-referenced, as outlined below:

- 1995.01–2007.12 | Dirección Nacional de Programación Macroeconómica, Secretaría de Política Económica, based on data from the Integrated Retirement and Pension System (SIJP, for its acronym in Spanish), provided by the Administración Federal de Ingresos Públicos (AFIP).
- 2008.01–2008.12 | AFIP quarterly reports (2008 and 2009), prepared based on the SIJP.
- 2009.01–2025.08 | Secretaría de Seguridad Social, Políticas de Empleo y Economía del Ministerio de Trabajo, Empleo y Seguridad Social (SSPEyE-MTEySS), Observatorio de Empleo y Dinámica Empresarial, based on the Argentine Integrated Social Security System (SIPA, for its acronym in Spanish; formerly SIJP), provided by the Agencia de Recaudación y Control Aduanero (ARCA, for its acronym in Spanish; formerly AFIP).
- In terms of the scope of the data, the variable for registered salaried workers is constrained to formal private sector employees on a permanent basis. In this regard, the database under consideration excludes public sector employees and domestic workers. Additionally, it does not encompass self-employed workers, including the self-employed, monotaxpayers, and social monotaxpayers (see [Table 1](#)).

Regarding salaries, the average values by jurisdiction are used for what is known as “total compensation.” The source defines total compensation as the gross amount reported by the employer for all items.

With regard to the unit of measurement, registered employment is expressed in thousands of workers, while gross salaries are reported in current pesos. Consequently, the latter variable is deflated using a

⁶ Classic in the sense that they involve absolute declines in the level of activity.

⁷ Argentina underwent an extended period of lockdown and business closures. Decree 297/2020 established the measure known as “Preventive and Mandatory Social Isolation” (ASPO, for its acronym in Spanish) in mid-March 2020. The measure was eased in early 2021; however, economic activity did not return to normal until the second half of the year.

consumer price index,⁸ to express it in real terms, in constant pesos. The base year is defined as 2004 = 100. Subsequently, both variables are seasonally adjusted and stripped of outliers (see [Section 2.3](#)) with the aim of extracting the cycle-trend component from each series.

In many sections of this paper, provincial data are presented in aggregated form at the regional level. To this end, a territorial classification similar to that proposed by Argentina’s National Institute of Statistics and Censuses (INDEC, for its acronym in Spanish) is adopted, grouping jurisdictions into six regions. The only adjustment made, based on the availability of statistical data, is to treat the entire province of Buenos Aires together with the Autonomous City of Buenos Aires (CABA) as a single Metropolitan Region.

3.2.1. A brief descriptive analysis of registered employment and real salaries in Argentina

By the end of 2025, formal employment in Argentina stood at approximately 12.8 million people, according to official sources. This figure includes both salaried workers—in the private and public sectors and in domestic service—and self-employed workers who contribute to the social security system. Private-sector salaried workers accounted for 48.3% of total formal employment, constituting the largest occupational category in the Argentine labor market.

Table 1: Registered workers in Argentina by employment category
Data as of September 2025

Employment category	Thousands of people	Share (%)
Salaried workers	10,049.8	78.3%
Private-sector employees	6,198.4	48.3%
Public-sector employees	3,414.2	26.6%
Domestic workers	437.2	3.4%
Nonsalaried workers	2,789.0	21.7%
Monotax workers	2,163.9	16.8%
Self-employed workers	384.2	3.0%
Social monotax workers	240.9	1.9%
Total registered workers	12,838.8	100.0%

Source: Secretaría de Trabajo, Empleo y Seguridad Social (STEySS).

⁸ Due to methodological changes in the measurement of retail inflation over the analysis period, as well as inconsistencies in official statistics between 2007 and 2017, an ad hoc splicing of the consumer price index is used, constructed from various official and alternative sources. Specifically, the following indices were utilized: the CPI-GBA (Greater Buenos Aires) for the period 1994.01–2006.09; the CPI-BA City (Buenos Aires City), compiled by the statistics center of the Autonomous City of Buenos Aires (CABA, for its acronym in Spanish), for 2006.10–2010.11; the Santa Fe CPI, published by the Instituto Provincial de Estadística y Censos (IPEC), for 2010.12–2011.04; and the CPI-Congress, released by a group of national legislators, for 2011.05–2017. From 2018.01 onward, official INDEC statistics were once again employed via the National CPI. The data were linked using exchange rates, and then an index base centered on 2004 = 100 was applied.

Including registered private-sector employees, formal domestic workers, and formal self-employed workers in these figures reveals that the private sector remains the primary source of job creation in Argentina, despite the growing share of public-sector employment in recent years. According to statistics from the same database, the number of public-sector employees has increased by more than 30.0% from 2012 to present, while private-sector employment has remained stagnant with virtually no change over the past decade.

It is also crucial to acknowledge that labor market statistics compiled by INDEC based on the Permanent Household Survey (EPH, for its acronym in Spanish) reveal a significant prevalence of informal employment among salaried workers. Specifically, the report for the fourth quarter of 2024 shows that 35.8% of the salary-earning population is in an informal employment situation. This aspect of the labor market is not included in SIPA's administrative records. Therefore, it is excluded from the scope of analysis considered in this study.

[Table 2](#) shows the distribution of employment levels and average real salaries by region. The data is from September 2025.

The figures reveal a significant concentration of employment and population in two regions of the country: the Metropolitan and Pampas regions. Together, these regions account for 75.4% of formal private-sector salaried workers and 61.9% of the total population. The regional distribution of employment varies slightly but remains consistent with the relative size of the population in each region.

Table 2 | Formal private-sector employment and real salaries by region
Data as of September 2025

Registered private-sector workers (thousands of people and share %)				% population	Average real salary (constant 2004 pesos)	
Metropolitan Region	3,491	55.8%		45.0%	Patagonia Region	\$ 2,356
Pampas Region	1,073	17.2%		16.9%	Metropolitan Region	\$ 1,711
Northwest Region	458	7.3%		12.8%	Pampas Region	\$ 1,383
Patagonia Region	441	7.0%		12.3%	Cuyo Region	\$ 1,307
Northeast Region	415	6.6%		7.4%	Northwest Region	\$ 1,176
Cuyo Region	378	6.0%		5.6%	Northeast Region	\$ 1,131
Totals	6,256	100,0%		100,0%	Totals	\$ 1,499

Source: Author's own elaboration based on data from the Argentine integrated social security system (SIPA, for its acronym in Spanish).

Average real salaries, measured in constant 2004 pesos, reveal substantial structural differences in levels, highlighting disparities in relative purchasing power across regions. Lower values are observed in the northern regions of the country. In contrast, the average real salary in the Patagonia Region is 57.2% above the national average. This is primarily due to the high proportion of industries with above-average salaries, such as hydrocarbon extraction and mining. It is also due to special labor regimes and additional salary incentives designed to encourage relocation to this area.

3.3. Additional variables

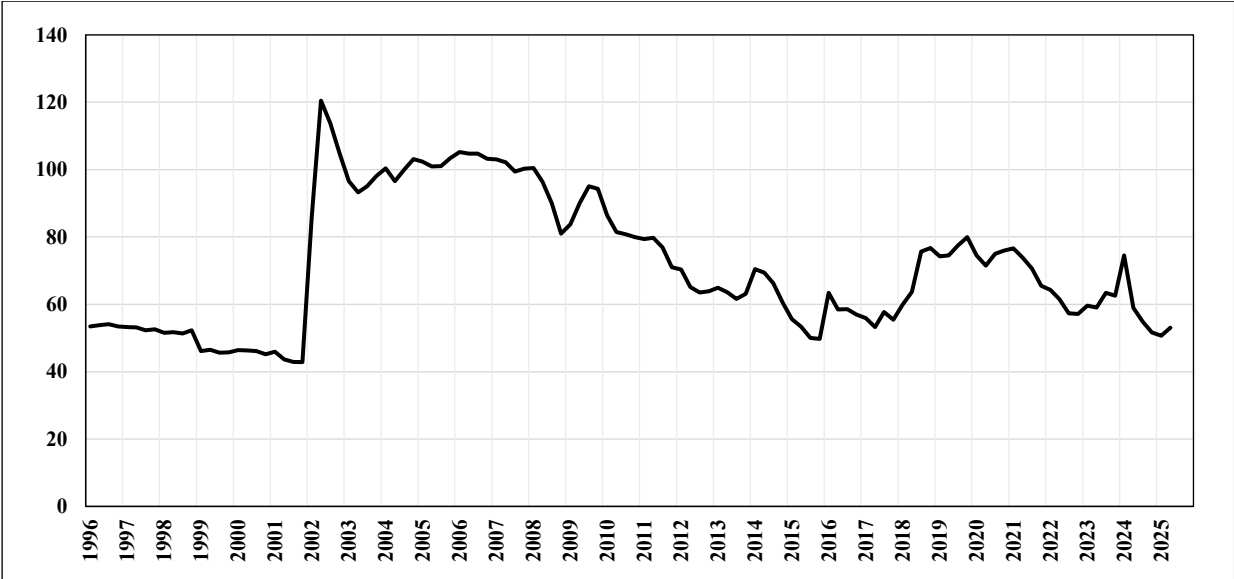
[Section 4.3](#) presents econometric estimates that incorporate two additional variables as inputs: Argentina’s real multilateral exchange rate and the relative weight of the public sector in domestic consumption. The scope of each of these variables is detailed below:

- Multilateral real exchange rate in Argentina

The multilateral real exchange rate index (ITCRM, for its acronym in Spanish) is an indicator compiled and published daily by the Central Bank of Argentina (BCRA, for its acronym in Spanish), with a base of 12-17-2015 = 100. It approximates the relative price of goods and services in the Argentine economy compared to those of its main trading partners, taking into account twelve countries weighted according to trade flows. From an analytical standpoint, it constitutes a broad measure of external competitiveness based on prices.

Figure 2 | Multilateral real exchange rate in Argentina

Base index 2004 = 100



Source: Author's own elaboration based on data from the Central Bank of Argentina (BCRA, for its acronym in Spanish).

To include this variable in the econometric analysis, the published daily index values are averaged within each month. Then, a simple average is calculated for the three months that make up each quarter. Finally, the resulting quarterly series is rebased to 2004 = 100 to align with the base of the reference cycle used.

- Relative size of the public sector in GDP

Although the size of the public sector in the economy does not directly impact private employment in the short run, its influence on the composition of aggregate demand affects the long-run structure of the labor market. In this context, the proposed ARDL models include an indicator variable that measures the share of public consumption in total consumption as recorded in GDP, defined as the sum of public and private consumption.

Public-sector share in investment levels could also be considered. However, the official statistics available in the National Accounts, published by INDEC under the aggregate “gross fixed capital formation,” do not allow for direct identification of this breakdown.

The corresponding time series are published quarterly, in both constant and current values. Since the variable is defined as a ratio, the choice of either unit of measurement makes no difference. Before calculating the ratio, the time series are seasonally adjusted.

4. Empirical strategy

This section presents a variety of methodological tools that are used to systematically and sequentially analyze the key aspects of the research. The results of the research are then integrated comprehensively in accordance with the proposed objectives.

4.1. Cyclical classification of registered private employment and salaries in Argentina

4.1.1. Evidence at the national level

Data from recent decades suggests that both registered private-sector employment and salaries in Argentina exhibit a procyclical relationship with economic fluctuations. From a dynamic perspective, these two variables mostly follow the business cycle synchronously. They are strictly coincident in some phases and exhibit moderate lags in others.

To verify these relationships within the sample used, cross-correlations are performed between the monthly changes in each specific variable and the monthly changes in the reference cycle. Correlation coefficients are calculated contemporaneously (month 0) and with months of lead and lag, which allows the variables to be classified as leading, coincident, or lagging. In particular, when the maximum coefficients are concentrated within a range of ± 2 months, the variable is considered coincident. Leading indicators show signals that precede the cycle, with higher coefficients in the preceding months, while lagging indicators react after cyclical fluctuations, showing their strongest correlations in the subsequent months. Furthermore, the sign of the coefficients indicates whether the relationship is procyclical (positive coefficients) or countercyclical (negative coefficients).

[Annex 2](#) presents the results for Argentina, based on the available data for each variable over the period analyzed. The coefficient map confirms a procyclical and largely coincident relationship for both registered private employment and real salaries in the national aggregate. However, while salaries behave as a strictly coincident variable, registered private employment exhibits significant coefficients both in the coincident range and in subsequent months. This suggests a behavior that lies between coincident and lagged.

In terms of intensity, employment exhibits slightly higher correlation coefficients than salaries, implying that employment is more sensitive to fluctuations in the business cycle than salaries. This finding is consistent with the presence of downward salary rigidity, as salaries tend to adjust primarily in real terms

through inflationary processes or changes in international purchasing power associated with episodes of local currency depreciation.

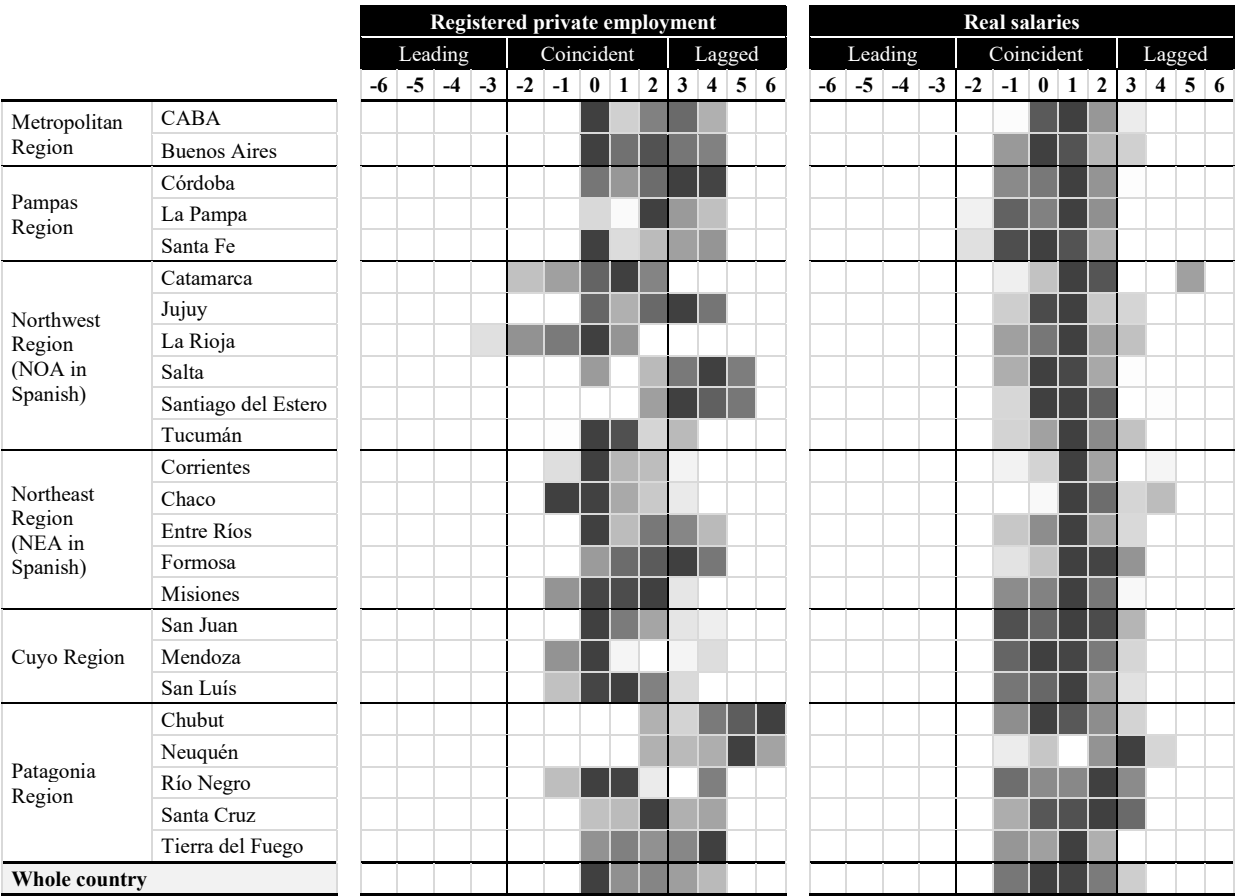
4.1.2. Evidence at the subnational level

It is worth asking whether the pattern described in the previous section for Argentina as a whole also applies at the subnational level. For reference, prior evidence shows that cyclical volatility in Argentina’s labor market varies substantially across subnational regions in terms of amplitude, reflecting different degrees of vulnerability to the business cycle (Cohan, 2024).

Figure 3 shows the cross-correlations between formal private-sector employment and real salaries at the subnational level in Argentina, as opposed to the level of economic activity. The data are presented for each of the 24 provincial jurisdictions and are disaggregated by region.

With regard to the calculations, 367 monthly observations covering the period 1995.02–2025.08 were used for the first variable, and 365 observations for the second (since it has two fewer monthly observations). The coefficients were estimated using seasonally adjusted series expressed as monthly rates of change.

Figure 3 | Cross-correlations between each variable and the level of economic activity in Argentina
Regional and provincial disaggregation



Methodological note: The results are presented for a range of lead and lag periods from −6 to +6 months. Since the aim is not to compare amplitudes, a color intensity scale is used that highlights the top 40.0% of values within each row. The base correlation

coefficients are estimated from seasonally adjusted series, expressed as monthly rates of change. The ICA-ARG coincident index, described in the theoretical framework, is used as a reference for the business cycle.

Only the estimated coefficients that fall between the 60th and 100th percentiles are displayed in grayscale for the graphical representation. Darker shades correspond to greater magnitude. While this presentation method prevents direct comparison of coefficients across spaces, it is useful for classifying variables according to their cyclical behavior, which is the objective of the analysis. Therefore, the numerical values of the coefficients are not shown.

The results clearly reveal that the classification for Argentina as a whole is consistently replicated at the subnational level. Formal private employment exhibits procyclical characteristics ranging from coincident to lagging in nearly all provinces. The provinces of the Patagonia Region, Formosa in the Northeast Region, and Jujuy, Salta, and Santiago del Estero in the Northwest Region exhibit more lagging characteristics than the rest.

Note that no subnational area reports preliminary leading indicators based on the results obtained for the employment level.

On the other hand, the cross-correlations for real salaries offer a more consistent perspective. The variable is classified as strictly coincident in almost all subnational areas, which strengthens the hypothesis that downward nominal salary rigidity and inflation as a common factor across the entire country act transversely throughout the national territory.

Although much less evident than in the case of employment levels, the Patagonia Region shows some signs of lagging behind in terms of real salaries. Furthermore, there is no evidence that any province is showing signs of leading the national business cycle.

To conclude this section and summarize the findings presented so far, the evidence suggests that the cyclical adjustment mechanism of Argentina's formal private labor market operates through both the level of employment and real salaries. Both components track fluctuations in the business cycle largely synchronously, reinforcing the procyclical nature of the aggregate labor market.

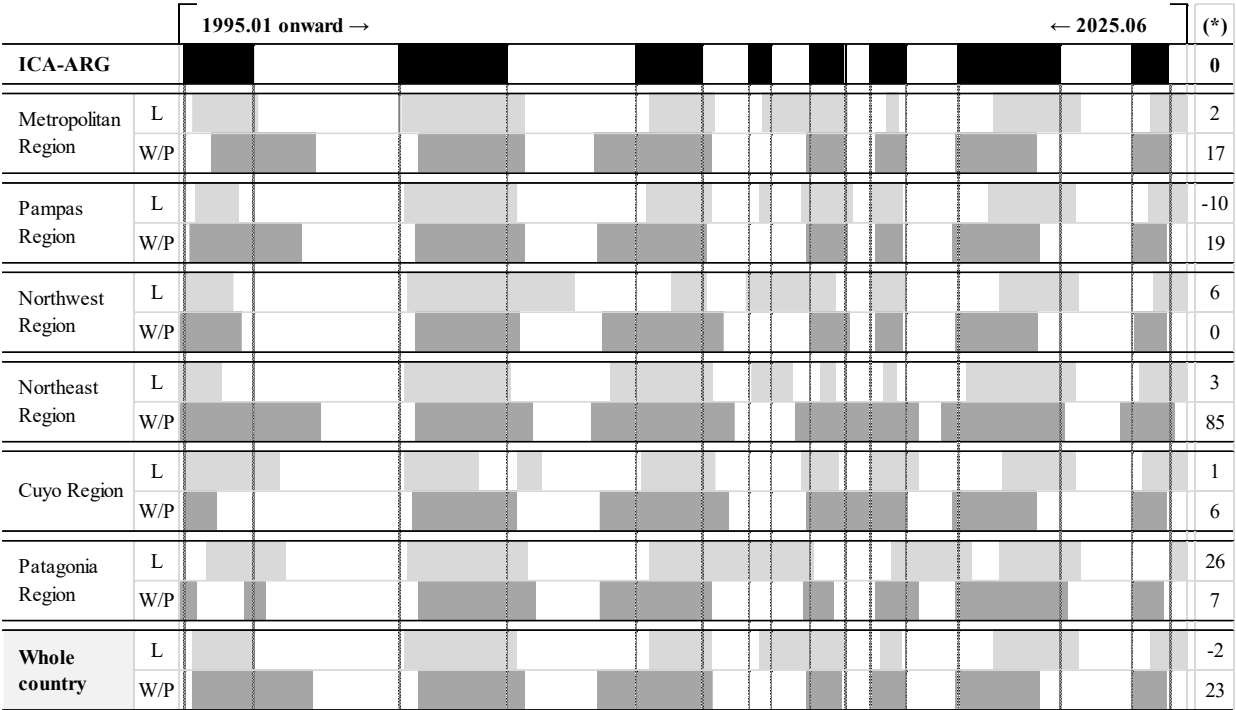
However, the evidence also reveals some important nuances. While salaries tend to behave as a variable that strictly coincides with the business cycle, the adjustment in employment shows, on average, a pattern that lags slightly behind. This behavior is more pronounced in some provinces.

4.2. Regional spread and persistence of the contractionary phases

A second key aspect of this study is assessing how the variables synchronize with the identified phases of the Argentine economy across different segments of the analysis period. In the previous section, cross-correlations were calculated on the entire dataset without distinguishing subperiods. This allowed for an overall characterization and verification of the main cyclical characteristics of the series. In this section, we examine the evolution of the data over the entire time span to avoid generalizations and delve deeper into the underlying dynamics, assessing the possible existence of regional propagation mechanisms.

Figure 4 shows the negative trend deviations for each variable over the period 1995.01-2025.06. For each region, the figure considers both formal private employment (row L) and real salaries (row W/P). Additionally, the row corresponding to ICA-ARG identifies the negative trend deviations of the Argentine economy. Note that this analysis is framed within a growth cycle approach, as detailed in Section 2.3. It should also be emphasized that, using this criterion, the identified negative phases do not coincide exactly with the classical recessions dated by the reference cycle.

Figure 4 | Cyclical dynamics of formal private employment (L) and real salaries (W/P) by region
Shaded areas identify periods with negative trend deviations



Methodological note: DTs are calculated as the ratio of seasonally adjusted monthly series to their trend (HP filter), minus 1. The reference business cycle was incorporated using the ICA-ARG coincident index, as detailed in the theoretical framework.

Regarding the information presented in the figure, we chose to omit statistics related to the magnitude of the deviations and treat them in a simple binary manner. Each row corresponds to a dummy variable that takes the value of 1 when the deviation is negative and the value of 0 when the deviation is positive. For this reason, the shaded areas precisely identify the months in which the deviations from the trend were negative.

The first variable, the level of formal employment in the private sector, exhibits similar trends in all regions during the eight phases of negative deviations identified for the Argentine economy within the period. This suggests a high degree of cyclical synchronization in the labor market throughout the country. Furthermore, no stable propagation pattern is apparent, nor are there regions with characteristics that warrant special treatment. These results reinforce the idea that Argentina's labor market exhibits homogeneous dynamic behavior primarily explained by systemic factors rather than idiosyncratic determinants specific to each region.

In contrast, with regard to real salaries, significant changes in behavior are observed around the period under analysis. During the first two phases, real salaries reacted downward after the level of economic activity (lagging). In the third phase, they exhibited a leading behavior, and from then on, they became essentially coincident. However, from a regional perspective, the trend is also homogeneous, and the variable does not present any particular issues worth noting.

When considering these results alongside previous evidence, we can conclude that differences in regional economic structure largely influence the severity of the impact of recessions on the labor market. However, these differences are not pronounced enough to alter the overall trajectory of the variables analyzed in terms of temporal synchronization, nor to generate a persistent decoupling—whether positive or negative—from aggregate behavior at the national level. In turn, salaries follow the trend in registered employment, exhibiting a pattern that is clearly independent of each region’s labor market. This pattern is consistent with Argentina’s federal and sector-based labor union framework, as opposed to systems that allow for negotiations based on company or geographic location.

In terms of persistence, economic activity has recorded 172 months of negative deviations, representing approximately 47.1% of the 365 data points considered in this analysis. Regarding formal private employment, four out of the six regions have shown a similar number of months in a contractionary phase to that observed in the reference cycle. However, the Patagonia Region exhibits a longer duration of contractionary phases, with 198 months of negative deviations—26 months more than the baseline. In contrast, the Pampas Region shows a shorter duration, with 162 months of negative deviations—10 months less than the reference value.

In general, real salaries accumulate a greater number of months with negative deviations than the employment level. In particular, the Northwest (0), Cuyo (6), and Patagonia (7) regions show values close to those of the reference cycle, while the Northeast (85), Metropolitan (17), and Pampas (19) regions exhibit more pronounced differences.

4.3. ARDL models applied to formal private-sector employment in each region

4.3.1. Econometric specification

The study takes as its starting point the proposal by Trombetta et al (2022), who developed various variants of ARDL models to examine the relationship between formal private employment—both as a single variable and disaggregated by productive sector—and the Argentine business cycle. Their baseline specification includes as explanatory variables lags of registered employment at the aggregate and sectoral levels, a monthly economic activity indicator—used as a proxy for the reference cycle—and Argentina’s real multilateral exchange rate index, with the aim of capturing external competitiveness conditions.

The results of that study indicate that formal employment is relatively insensitive to economic activity in the short run but becomes considerably sensitive in the long run, with statistically significant and economically relevant employment-output elasticities. Additionally, although the aggregate elasticity with respect to the real exchange rate is small and sometimes insignificant, the sectoral analysis reveals

significant heterogeneity with differentiated responses among exporting, importing, and nontradable goods-producing sectors.

Although a sectoral analysis in the strict sense goes beyond the scope of this study, previous evidence on the importance of the productive structure and relative prices in the dynamics of formal employment constitutes a key empirical foundation. For this reason, these factors are incorporated into the regional analysis⁹ proposed here. Within this framework, the various modeled specifications aim to capture the dynamics of formal private-sector employment in each Argentine region based on its main macroeconomic determinants. These specifications also incorporate variables that impact each region due to its specific characteristics.

After considering various combinations, the use of real salaries was ruled out.¹⁰ It was decided that registered private employment (EPR, for its acronym in Spanish) would be modeled based on its own lags and three additional explanatory variables: (i) Argentina's coincident economic activity index as the reference cycle, (ii) Argentina's real multilateral exchange rate index to replicate the baseline proposal, and (iii) the Cpub/Ctot ratio to measure the proportion of public consumption (Cpub) to total consumption (Ctot) in aggregate demand. The aim of incorporating this variable, along with the proposal by Trombetta et al. (2022), is to regulate the structure of public consumption at the aggregate level. This is based on the assumption that labor markets in certain regions exhibit a significant response to fluctuations in public expenditure.¹¹

Given that the variables are expressed in different units of measurement and have varying amplitudes, we have chosen to use natural logarithms for the transformation of the variables. This transformation standardizes the variance and makes the results easier to interpret. The estimated coefficients can then be interpreted as elasticities of the dependent variable with respect to percentage variations in the explanatory variables.

In mathematical terms, the econometric specification of the ARDL model for registered private employment at the regional level is expressed as follows:

$$\begin{aligned} \log(EPR_{r,t}) = & c_0 + c_1 t + \sum_{i=1}^p b_i \log(EPR_{r,t-i}) + \sum_{l=0}^{q_1} b_{1,l} \log(ICAARG_{t-l}) \\ & + \sum_{l=0}^{q_2} b_{2,l} \log(ITCRM_{t-l}) + \sum_{l=0}^{q_3} b_{3,l} \log\left(\frac{C_{t-l}^{pub}}{C_{t-l}^{tot}}\right) + \varepsilon_t \end{aligned} \quad (4)$$

In expression (4), EPR represents registered private employment in region r ; ICAARG is the coincident index of economic activity in Argentina used as the reference cycle; ITCRM corresponds to the index of

⁹ Calculated as the sum of registered private employment in the provinces that comprise each region.

¹⁰ Because it leads to overestimation and breaks the long-run cointegration relationship in some regions.

¹¹ The results presented in the following sections support this idea.

Argentina's real multilateral exchange rate against its main trading partners; and the ratio C_{pub}/C_{tot} measures the share of public consumption in total aggregate demand consumption.

Econometric approach

The empirical analysis was conducted using a dataset with quarterly data covering the period 1996 Q1-2025 Q2. This resulted in 118 observations per series. This frequency is appropriate for both the economic interpretation of the results and standard conventions in the analysis of macroeconomic variables. Series originally available on a monthly basis were converted to a quarterly basis by calculating the simple average of the three months comprising each quarter.

Based on this data structure, the estimation was implemented using the R package (ARDL: ARDL, ECM and Bounds-Test for Cointegration)¹² developed by Kleanthis Natsiopoulou and Nikolaos Tzeremes in 2021 and originally released in 2023. The implementation of ARDL models, boundary cointegration tests, and conditional RECMs provided by the library strictly adheres to the previously selected theoretical framework.¹³ Indeed, the package also allows for a more general formulation based on the unrestricted error correction model (UECM). This could be used to verify the existence of cointegration without requiring the variables to be purely $I(1)$ or explicitly constructing the ECT.

Despite the points made in the previous paragraph, subsequent calculations are based on the conditional RECM specification because it provides a more structured and parsimonious representation of the adjustment process. This is achieved by explicitly modeling the mechanism through which the dependent variable corrects long-run imbalances. Regarding the estimation of RECMs, the library includes five alternative variants. This paper adopts the variant corresponding to case 2, “constrained constant and without trend,” which implies assuming that:

$$c_0 = c_1 = 0 \quad y \quad ECT_t = y_{t-1} - \left(\mu + \sum_{j=1}^k \theta_j x_{j,t-1} \right) \quad (5)$$

4.3.2. Preliminary tests and estimation of ARDL models

Before estimating the ARDL models, the order of integration of the included variables is verified to confirm that they are not integrated at a higher order than one. Specifically, the study examines the presence of unit roots in the series levels, expressed in logarithms, and the stationarity of their first differences.

¹² The calculations shown in this paper were performed using version 0.2.4 of the library.

¹³ In this regard, the authors of the library have recently replicated and validated the main results of Pesaran et al. (2001), which supports the correct implementation of the econometric procedures and guarantees the methodological soundness of the exercises performed (see Natsiopoulou and Tzeremes, 2021).

The evaluation is performed using the Phillips-Perron (PP) test, which tests the presence of a unit root in the analyzed series as the null hypothesis. Unlike other parametric tests, the PP test incorporates nonparametric corrections that allow for controlling autocorrelation and heteroscedasticity of unknown order in the error terms, without requiring the explicit inclusion of additional lags in the test equation.

The results indicate that there is insufficient evidence to reject the null hypothesis when considering the stationarity of the variables at different levels; therefore, these are identified as integrated of order one (I(1)). However, when evaluating the variables at first differences, the test rejects the null hypothesis in all cases, confirming the stationarity of these transformations (see [Annex 3](#)). Thus, we can affirm that the series considered meet the necessary conditions described in the theoretical framework to be included in the models.

Selection of the optimal order of variables in each regional model

A second element to consider before making the estimates is identifying the optimal order of lags for each variable within the models. To that end, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were used. The exercise is performed allowing a maximum order of four quarters for each variable, respecting a one-year timeframe.

[Table 4](#) shows the results obtained for each region. The Bayesian information criterion selects simpler models in all cases, except in the Northwest Region, where the optimal selection of lags coincides under both information criteria used.

Table 4 | ARDL models determined for each region, according to information criteria

Region	Log (EPRr)	Log (ICAARG)	Log (ITCRM)	Log (Cpub / Ctot)	AIC	BIC
Metropolitan Region	2	2	1	0	-1,106.6	
	2	1	0	0		-1,080.2
Cuyo Region	2	2	2	2	-1,003.7	
	2	1	1	2		-972.6
Northwest Region	2	0	1	2	-1,007.9	
	2	0	1	2		-980.4
Northeast Region	2	1	1	0	-910.3	
	2	0	0	1		-883.6
Pampas Region	2	1	2	2	-1,080.9	
	2	1	1	0		-1,055.1
Patagonia Region	2	1	2	2	-942.6	
	2	1	2	0		-916.5

Note: The information criteria, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), are presented in levels. Their absolute magnitude has no economic interpretation; they are only relevant for comparing alternative specifications.

Following a parsimony principle, and given that the central objective of the exercise is the identification of long-run relationships, the final specifications of the ARDL models are chosen based on the BIC. Unlike the AIC, the BIC incorporates a more severe penalty for including additional parameters, thus reducing

the risk of overparameterization. This property is key to ensuring the correct identification of the ECT,¹⁴ improving the stability of the estimated coefficients, and minimizing multicollinearity problems.

Cointegration of models and speed of adjustment

As mentioned previously, the existence of cointegration in ARDL models is a necessary condition for the validity of RECMs. In economic terms, cointegration implies that the set of variables forms a system with a long-run equilibrium relationship and that, in each period, deviations from this equilibrium are partially corrected through the error term of the model.

[Table 5](#) presents the results of the Wald test with limits for the absence of cointegration, applied to each of the six regional models. The null hypothesis of the test states that there is no cointegration between the model variables; therefore, its rejection provides evidence in favor of the existence of a long-run relationship. Additionally, the estimated ECT for each regional RECM is presented, along with the corresponding quarterly speed of adjustment for each case.

Table 5 | Wald test with limits for absence of cointegration and adjustment rates

H₀: There is no cointegration between the variables of the model

Region	Optimal model	Wald F statistics	p-value of the test	Cointegration at 5%	ECT coefficients for each RECM	Quarterly speed of adjustment
Northeast	ARDL (2, 1, 0, 0)	11.958	0.000	yes	-0.229 ***	22.9%
Northwest	ARDL (2, 1, 1, 2)	14.644	0.000	yes	-0.144 ***	14.4%
Metropolitan	ARDL (2, 0, 1, 2)	6.693	0.001	yes	-0.116 ***	11.6%
Cuyo	ARDL (2, 0, 0, 1)	5.110	0.004	yes	-0.109 ***	10.9%
Pampas	ARDL (2, 1, 1, 0)	7.186	0.001	yes	-0.086 ***	8.6%
Patagonia	ARDL (2, 1, 2, 0)	3.638	0.052	at the limit	-0.051 ***	5.1%

Notes: (1) Wald test: p-values < 0.05 indicate rejection of the null hypothesis for absence of cointegration; (2) Significance of the error correction term (ECT): *** p < 0.001, ** p < 0.01, * p < 0.05

The test results indicate significant cointegration in five out of the six regions analyzed. Specifically, the Northeast, Northwest, Metropolitan, Cuyo, and Pampas regions show F-statistics clearly exceeding the critical value at 5.0%, with p-values close to zero, allowing the null hypothesis of no cointegration to be rejected with a high degree of statistical significance. In the case of the Patagonia region, the p-value slightly exceeds the 5.0% threshold, also suggesting a long-run relationship, but a weaker one compared to the other regions.

¹⁴ Cointegration tests were performed for different model specifications. The results indicate that using the lag orders recommended by the BIC criterion provides stronger evidence of cointegration than using the orders determined by the AIC criterion.

On the other hand, the ECTs estimated in the RECMs are negative and statistically significant in all cases, which confirms the presence of adjustment mechanisms toward the long-run equilibrium. The quarterly speed of adjustment demonstrates significant regional variation: the Northeast and Northwest regions correct between 14.4% and 22.9% of the deviations per quarter, whereas the Pampas and Patagonia regions exhibit slower adjustment processes with rates below 10.0%. This indicates more gradual convergence dynamics. The Cuyo and Metropolitan regions occupy an intermediate position, with moderate speed of adjustment reflecting convergence processes that are neither as rapid as in the northern regions nor as persistent as in the regions with slower adjustments.

Short- and long-run elasticities determined for each region

The final consideration is the estimation of the elasticities between registered private employment in each region and shocks to the explanatory variables. Since all variables are expressed in logarithms from the base econometric specification, the short- and long-run multipliers can be derived directly from the ARDL models selected in [Section 4.3.2](#).

In the context of [equation \(4\)](#), the **short-run multiplier**, which captures the contemporary impact of a change in the explanatory variable X_j on employment, is defined as:

$$\frac{\partial \log(EPR_{r,t})}{\partial \log(X_{j,t})} = b_{j,0}, j \in \{1, \dots, k\} \quad (6)$$

The **long-run multiplier**, which measures the permanent effect of the shock on X_j once the system has converged to its new equilibrium, is given by:

$$\frac{\partial \log(EPR_{r,t+\infty})}{\partial \log(X_{j,t})} = \theta_j = \frac{\sum_{l=0}^{q_j} b_{j,l}}{1 - \sum_{i=1}^p b_{y,i}}, j \in \{1, \dots, k\} \quad (7)$$

In this regard, [expression \(7\)](#) reflects long-run equilibrium elasticity resulting from accumulated short-run dynamic effects and the equilibrium correction mechanism incorporated into the ARDL structure. The twelve-quarter dynamic multiplier trajectory for each of the regional models is detailed in [Annex 4. Table 6](#), in turn, presents the point estimates of the short- and long-run multipliers associated with each explanatory variable. These estimates were obtained from the ARDL models selected for each region.

The variable linked to national economic activity exhibits positive and statistically significant short- and long-run elasticities, confirming its status as the main determinant of registered private employment at the regional level. Short-run elasticities range from 0.16 to 0.34, reflecting a partial and immediate employment response to variations in aggregate activity. Long-run elasticities converge to values close to or above one in most regions, suggesting a strong adjustment process toward equilibrium.

On the other hand, the multilateral real exchange rate generally exhibits smaller effects. In the short run, elasticities are low and negative in some regions, suggesting temporary contractionary effects. In the long

run, however, the impact of the ITCRM becomes positive in all regions, albeit with significant variation in magnitude. This impact is particularly notable in the Pampas and Patagonia regions.

Table 6 | Short- and long-run elasticities
Multipliers derived from the ARDL model selected for each region

		National economic activity		Multilateral real exchange rate		Public consumption relative to total consumption	
		<i>log_icaarg</i>		<i>log_itcrm</i>		<i>log_cpub/ctot</i>	
Metropolitan Region <i>log_epr_metro</i>	Short run	0.2785	***	0.0085	***	0.0045	***
	Long run	1.0267	***	0.0738	***	0.0386	***
Cuyo Region <i>log_epr_cuyo</i>	Short run	0.3394	***	-0.0216	***	0.0375	***
	Long run	0.8005	***	0.0596	***	-0.0254	***
Northwest Region <i>log_epr_noa</i>	Short run	0.1559	***	-0.0252	***	0.0697	***
	Long run	1.0793	***	0.0694	***	0.5572	***
Northeast Region <i>log_epr_nea</i>	Short run	0.2887	***	0.0045	***	0.0316	***
	Long run	1.2588	***	0.0196	***	0.6588	***
Pampas Region <i>log_epr_pamp</i>	Short run	0.2750	***	-0.0037	***	0.0342	***
	Long run	1.1708	***	0.1600	***	0.3956	***
Patagonia Region <i>log_epr_pamp</i>	Short run	0.3030	***	-0.0224	***	0.0369	***
	Long run	1.5128	***	0.2499	***	0.7282	***

Notes: (1) Gray-colored cells identify economically significant elasticities; (2) Statistical significance of multipliers: *** p < 0.001, ** p < 0.01, * p < 0.05.

It is worth noting that the remarks provided for both the first and second variables are consistent with the results obtained by Trombetta et al. (2022).

Finally, regarding the variable associated with the evolution of public consumption, the estimates reveal a more heterogeneous pattern. Although short-run multipliers are positive and statistically significant in all regions, long-run elasticities vary substantially by territory. The Northeast, Northwest, and Patagonia regions have particularly high values. This behavior demonstrates that public expenditure primarily affects private employment through structural and persistent channels rather than through immediate contemporary effects. The intensity of this impact depends significantly on the productive and fiscal characteristics of each region.

5. Conclusions

The analysis conducted in this study enabled the characterization of the cyclical dynamics of formal private employment in Argentina from a regional perspective. This analysis combined nonparametric business cycle tools with ARDL econometric models estimated using quarterly data for the period 1996–2025. Thus, both the comovements between employment and the national business cycle and the short- and long-run adjustment mechanisms in response to macroeconomic shocks were evaluated, with a particular focus on territorial heterogeneities.

From a descriptive standpoint, the results confirm that formal private employment exhibits a clearly procyclical behavior pattern across the country. At both the aggregate and subnational levels, employment exhibits a dynamic relationship with the business cycle, fluctuating in a pattern that is somewhere between coincident and lagging, with no systematic leading signals in any region. This pattern is consistent with previous evidence for the Argentine economy, reinforcing the characterization of the formal labor market as a more reactive than anticipatory channel for transmitting the business cycle.

Furthermore, when analyzing the timing of the contractionary phases, a high degree of homogeneity is observed in the trajectory of regional employment in relation to national recessions. During periods of negative deviations from the reference cycle, all regions exhibit similar movements in formal private employment, without any clear patterns of territorial spread or persistent decoupling from aggregate performance. However, differences in the duration of contractionary phases are observed, suggesting that while the impact of the cycle is widespread, the persistence of adjustment varies by region. This finding is consistent with the subnational heterogeneity identified in previous studies regarding cyclical intensity and accounts for the varying degrees of relative vulnerability of regional economies to fluctuations in the business cycle.

Regarding real salaries, and despite marked differences in purchasing power across jurisdictions, empirical evidence shows that their dynamic behavior is remarkably homogeneous and even less sensitive to territorial heterogeneity than that observed for employment levels. At both the aggregate and subnational levels, real salaries exhibit a clearly procyclical pattern, mostly coincident with the reference business cycle, with little evidence of systematic interactions between regions. During the analyzed period, the correspondence between the variable and the cycle changed significantly but consistently across all regions. Such behavior supports the hypothesis that salary adjustment mechanisms operate uniformly throughout the country. This is consistent with the existence of federal labor institutions and predominantly sectoral negotiation schemes, which tend to mitigate regional differences in the salary response to cyclical fluctuations.

On the other hand, estimates based on ARDL models enabled a more thorough analysis of this diagnosis by distinguishing between short-run transient responses and the long-run convergence process toward equilibrium. The existence of cointegration relationships between regional-level formal private employment and its main macroeconomic determinants was verified, which supports the characterization of a long-run joint dynamic among the variables. Within this framework, national economic activity emerges as the primary determinant of regional employment with positive, statistically significant short- and long-run elasticities.

In dynamic terms, the results show that the contemporary response of employment to variations in economic activity is partial, but that the cumulative adjustment in the long run is considerable. In several regions, long-run employment-output elasticities reach values close to or above one, suggesting that fluctuations in the level of economic activity have persistent effects on the level of formal employment. This finding is particularly relevant in a context characterized by recurrent recessionary episodes, since it

implies that declines in economic activity not only generate temporary job losses but also affect the long-run trajectory of the regional labor market.

Significant differences are also identified in the speed of adjustment toward the long-run equilibrium. The northern regions of the country exhibit relatively faster correction processes, while the Pampas and Patagonia regions show slower adjustment dynamics. These heterogeneities suggest that, in the face of the same macroeconomic shock, the time required to restore the level of formal private employment varies considerably across subnational areas.

Regarding the multilateral real exchange rate, the estimates reveal smaller effects but also identify jurisdictional differences. Although the immediate impact is limited, positive elasticities are observed in most regions over the long run, especially in regions with greater exposure to tradable activities.

On the other hand, the share of public consumption in aggregate demand appears to be associated with positive and persistent effects on formal private employment in some regions. This suggests that the role of the public sector can influence employment dynamics through structural rather than cyclical channels, with an intensity that depends on the productive and fiscal characteristics of each region.

In summary, the results obtained reinforce the importance of considering the territorial dimension in labor market analysis. They also suggest that policies aimed at mitigating the effects of recessions on formal employment should account for these differences to be more effective.

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7. Annexes

Annex 1 | Deseasonalization process and considerations regarding the Hodrick and Prescott (HP) filter

- **Deseasonalization process**

The United States Census Bureau's X13ARIMA-SEATS software is used. This free program can generate seasonal adjustments based on Autoregressive Integrated Moving Average (ARIMA) models using a version of the SEATS software,¹⁵ originally developed in the 1980s by Víctor Gómez and Agustín Maravall at the Bank of Spain, as well as nonparametric adjustments using the X-11 procedure.¹⁶ This program is implemented in the R environment, using the seasonal library developed by Christoph Sax and Dirk Eddelbuettel (see <https://www.seasonal.website>). This tool enables the application of the X-11 kernel-based decomposition method and the SEATS method. In both cases, additive (NIV) and multiplicative (LOG) specifications are evaluated. Through an iterative model sweep, the specification that best fits the data in terms of parsimony and stability is selected based on the lowest volatility of the rates of change in the seasonally adjusted series.

- **Hodrick and Prescott filter as a long-run trend**

The HP filter identifies the cyclical component y_t^c and the trend component y_t^s , of a given series for $t = 1, 2, \dots, T$, as the solution to the following minimization problem:

$$\min_{\{y_t^c, y_t^s\}_{t=1}^T} \left\{ \sum_{t=1}^T (y_t^c)^2 + \lambda \sum_{t=2}^{T-1} [(y_{t+1}^s - y_t^s) - (y_t^s - y_{t-1}^s)]^2 \right\} \quad (8)$$

subject to

$$y_t = y_t^c + y_t^s \quad (9)$$

According to this formula, the HP trend results from a trade-off between minimizing the variance of the cyclical component and maintaining a constant trend growth rate. This trade-off is governed by the parameter λ , known as the smoothing parameter. The larger λ is, the more changes in the trend growth rate are penalized. At the limit as λ approaches infinity, the trend component associated with the HP filter coincides with the linear trend. At the other extreme, when λ approaches zero, all the variation in the time series is attributed to the trend, and the cyclical component is zero.

¹⁵ SEATS stands for “Signal Extraction in ARIMA Time Series.” It is a parametric method developed to seasonally adjust and decompose time series using ARIMA (Autoregressive Integrated Moving Average) models. Like more traditional methods, it allows a series to be broken down into: trend-cycle (long-run component and business cycle); seasonality (recurring periodic fluctuations); and irregular residual (nonsystematic component, noise, or random variations).

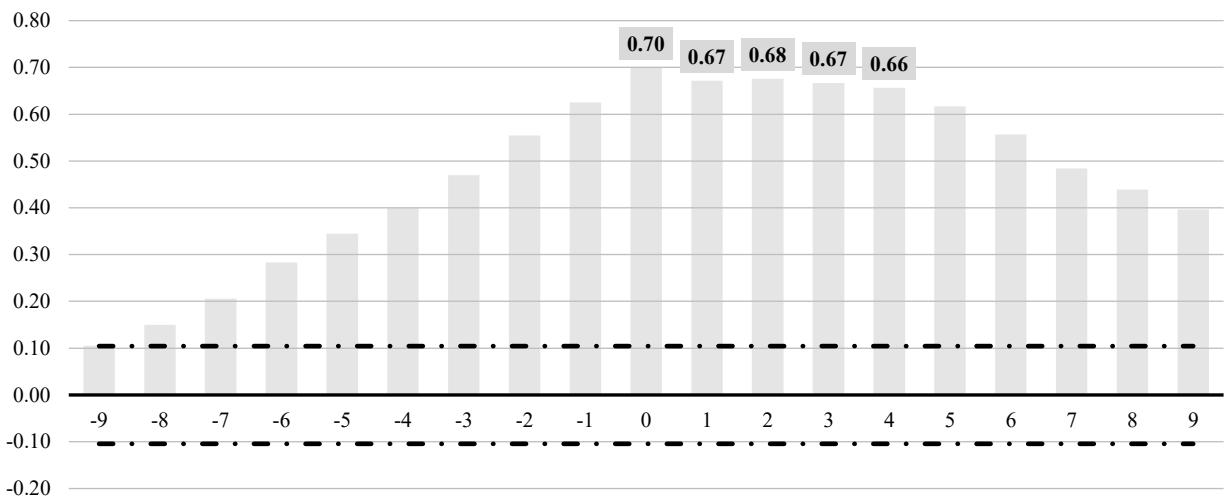
¹⁶ This method has been the predominant approach for decades. The model is based on a sequence of iterative moving filters that decompose the series into trend-cycle, seasonal, and irregular components. Its strength lies in its robustness in adjusting for seasonality in data series without imposing strong assumptions about their structure (for further information, see *U.S. Census Bureau, 2023, X-13ARIMA-SEATS Reference Manual*).

It is worth mentioning that a wide range of filters can be applied to decompose time series and that the properties of the cycles can depend on the filter used to remove the trend. However, none of the filters are superior to the others since they all have limitations, as Casanova (1998) points out. The HP filter is no exception and has faced criticism. Nevertheless, Zumendi, Rojas, and Zilio (2009) argue that the HP filter has become the standard procedure for obtaining cyclical and trend components and is widely accepted in academia. Additionally, Ravn and Uhlig (2002) suggest that none of the undesirable properties of the HP filter are particularly problematic and that it has stood the test of time.

Annex 2 | Cyclical classification of formal private employment and real salaries in Argentina

Figure A1 shows the correlation coefficients for leadings and lags ranging from -9 to +9 months between the number of formal private-sector employees in Argentina and the level of economic activity captured by the coincident ICA-ARG index, as defined in the theoretical framework. Monthly observations for the period 1995.02-2025.08 were used (n = 367). The coefficients were calculated from seasonally adjusted series expressed as monthly rates of change.

Figure A1 | Cross-correlations between formal private employment in Argentina and ICA-ARG

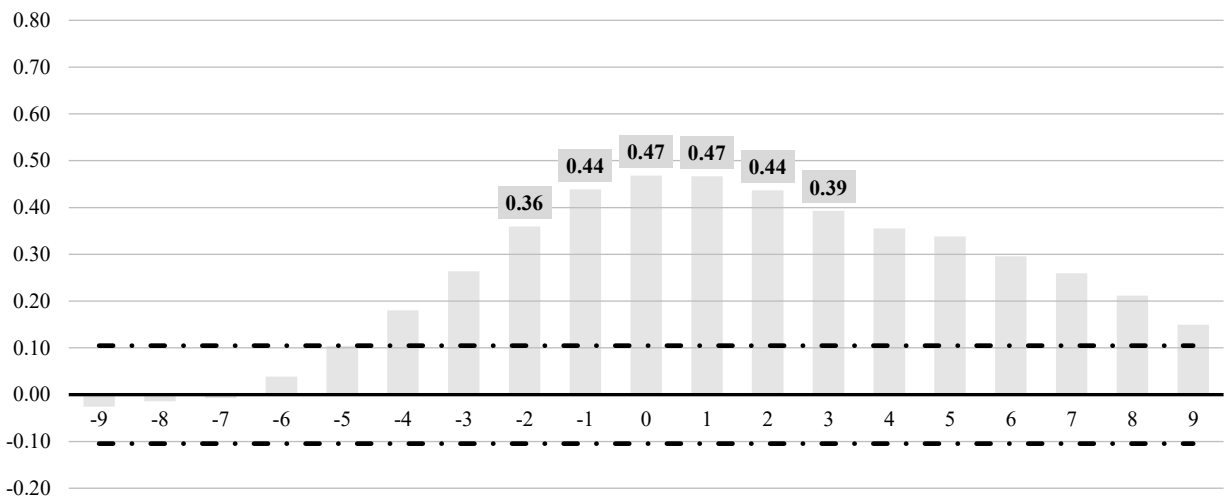


Methodological note: The dash-dotted lines indicate the 95.0% critical value obtained using the Fisher transformation.

Source: Author's own elaboration based on data from ARCA-SIPA and CICEc.

Figure A2 replicates the preceding exercise for the case of real salaries in Argentina, using information corresponding to the period 1995.02–2025.06, with a total of 365 monthly observations (n = 365).

Figure A2 | Cross-correlations between real salaries in Argentina and ICA-ARG



Methodological note: The dash-dotted lines indicate the 95.0% critical value obtained using the Fisher transformation.

Source: Author's own elaboration based on data from ARCA-SIPA and CICEc.

Annex 3 | Unit root tests

The stationarity of the variables is evaluated using the Phillips-Perron (PP) test, which tests as a null hypothesis the existence of a unit root in the analyzed series.

The p-values obtained by the test are presented in [Table A1](#), which shows the results for each variable at levels and in their first difference. Rejection of the null hypothesis indicates that the series is stationary, that is, integrated of order zero (I(0)). Nonrejection implies the presence of a unit root and, therefore, that the series is integrated of order one (I(1)).

Table A1 | PP test for unit root
H₀: the series has a unit root (it is nonstationary)

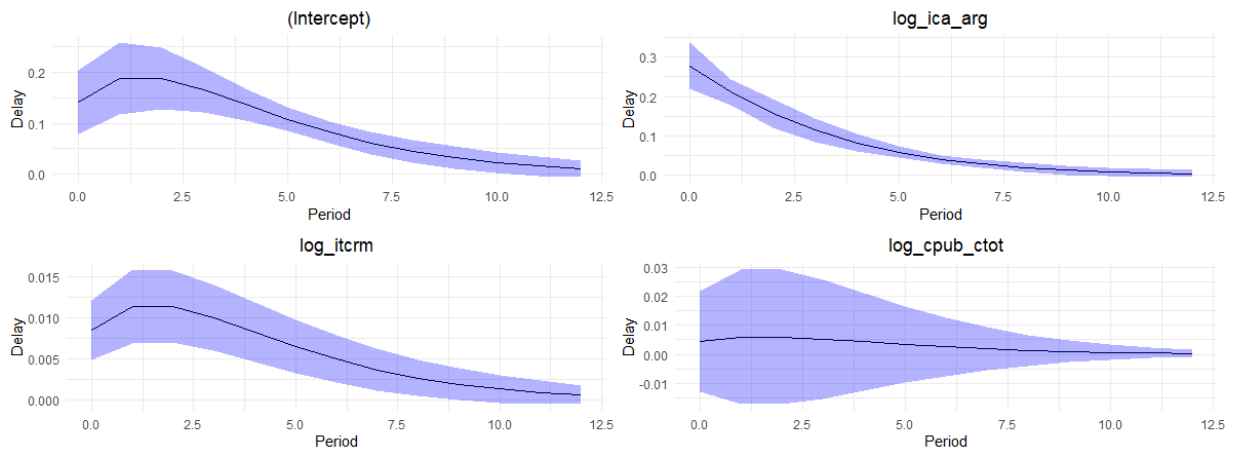
Variable (X)	PP: log (X) p-value and rejection condition	PP: Δ log (X) p-value and rejection condition
Metropolitan EPR	0.949 Nonrejection	0.048 Rejection
Pampas EPR	0.955 Nonrejection	0.018 Rejection
Northwest EPR	0.826 Nonrejection	0.01 Rejection
Northeast EPR	0.915 Nonrejection	0.01 Rejection
Cuyo EPR	0.864 Nonrejection	0.01 Rejection
Patagonia EPR	0.974 Nonrejection	0.01 Rejection
ICA-ARG	0.850 Nonrejection	0.01 Rejection
ITCRM	0.662 Nonrejection	0.01 Rejection
Cpub/Ctot	0.332 Nonrejection	0.01 Rejection

Note: p-values < 0.05 indicate rejection of the null hypothesis of a unit root in the PP test.

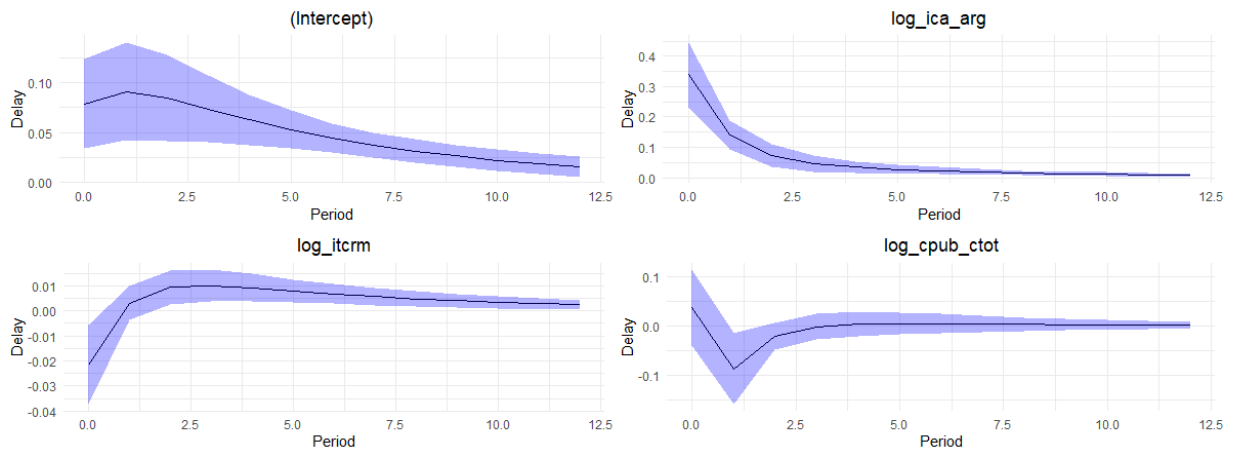
Annex 4 | Dynamic multipliers to twelve quarters

This annex presents the graphs of the dynamic multipliers derived for the six ARDL models selected for registered private employment in each Argentine region. The trajectory is limited to twelve quarterly periods. Confidence intervals, estimated based on their standard errors, are also presented.

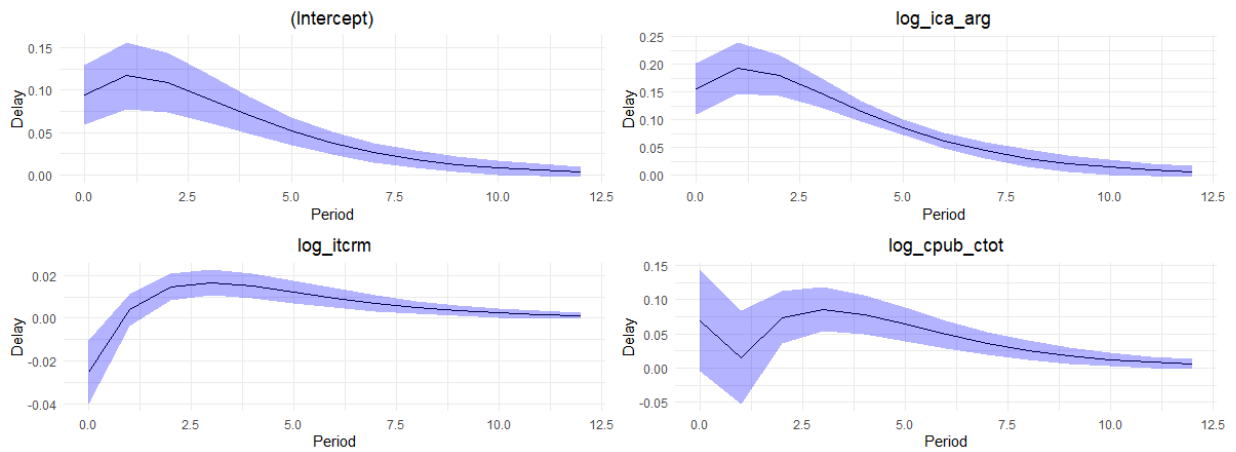
Metropolitan Region: dynamic multipliers for log_epr_metro



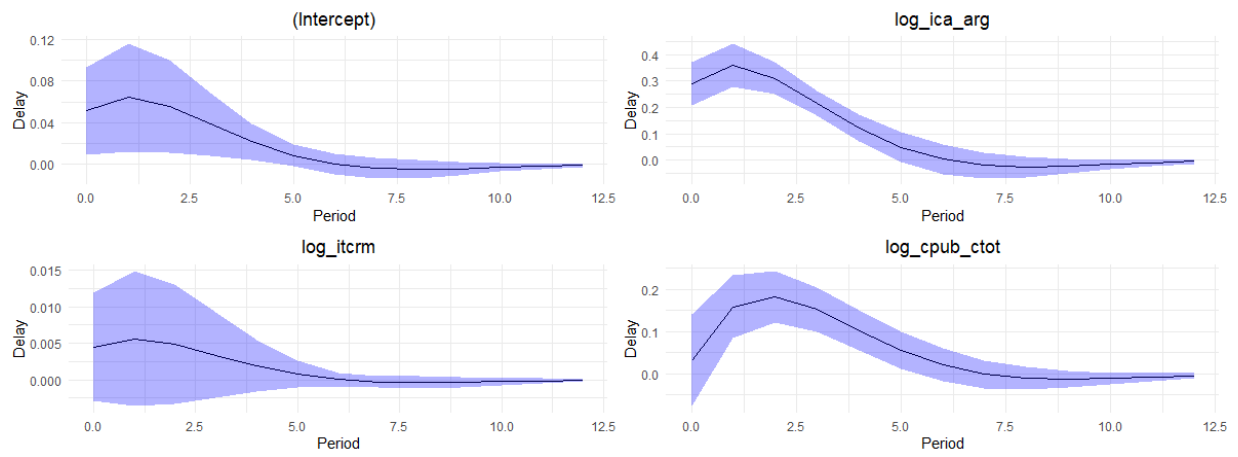
Cuyo Region: dynamic multipliers for log_epr_cuyo



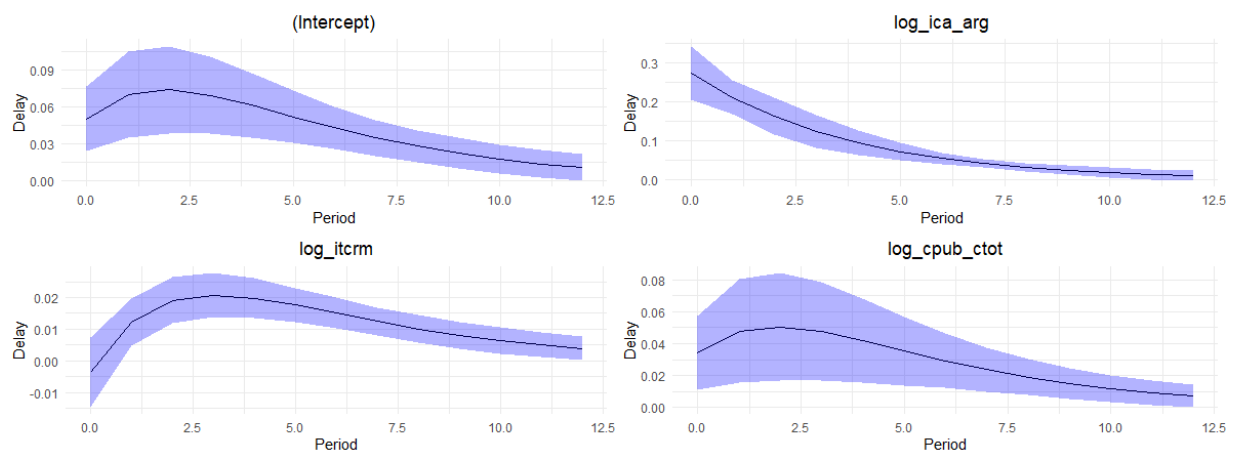
Northwest Region: dynamic multipliers for log_epr_noa



Northeast Region: dynamic multipliers for log_epr_nea



Pampas Region: dynamic multipliers for log_epr_pamp



Patagonia Region: dynamic multipliers for log_epr_pata

