Research Article

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Revealing the New Nexus in Urban Unemployment Dynamics: The Relationship between Institutional Variables and Long-Term Unemployment in Colombia

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Abstract: The aim of this study is to assess the impact of various institutional variables on the long-term unemployment rate (LAPU) in the Colombian urban labor market. Vector autoregressive models are estimated using microdata from the Great Integrated Household Survey (GEIH), which has national coverage. Monthly data were analyzed for the 13 major capital cities and their metropolitan areas, as well as for the group of 11 intermediate capital cities, resulting in a total of 24 main urban labor markets in Colombia. The dataset includes unionized individuals, individuals with verbal and written contracts, non-labor income, unemployed individuals with subsidies, and individuals receiving severance payments. The results indicate that the growth in the number of unionized employees and non-labor income contributes to increasing the persistence in the duration of unemployment in Colombia. A key finding is that a positive growth in the ratio – gap between individuals with written contracts versus verbal contracts reduces LAPU. This provides evidence of how reducing information asymmetries in the Colombian labor market can improve labor market outcomes and contribute to medium- and long-term social welfare in Colombian urban centers.

Keywords: institutions, contracts, non-labor income, unemployment benefits, unemployment duration, VAR

JEL Classification: J01, J08, J41, J64, J65

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1 Introduction

Long-term unemployment in Colombia, defined as lasting 52 weeks or more, aligns with International Labour Organization (ILO) standards. This type of unemployment predominantly affects older individuals and those with lower educational attainment (ILO, 2015). This study aims to explore institutional factors that influence unemployment persistence in Colombia, an area underexplored in Latin America. Existing global research is scarce, particularly in North American and Asian contexts, and lacks specific analysis on how contract types and unemployment benefits affect unemployment persistence. Webster (2005) criticizes government policies for focusing on employability improvements without addressing the root causes of prolonged unemployment. Such persistence not only impacts industries but also jeopardizes individuals' prospects for future employment opportunities.

According to ILO data (2022) for Pacific Alliance countries, Colombia exhibits a long-term unemployment rate (LAPU) of 14% relative to the total unemployed during 2010–2021, with Chile at 12% and Mexico at 2%. Over the same period, the average duration of unemployment in Colombia was notably high at approximately 121 weeks, according to the Great Integrated Household Survey. This extended duration, coupled with a high informality rate of around 47.8% among the employed underscores structural labor market challenges.

Additionally, Table 1 shows the historical average number of unemployed at 6 and 12 months as a proportion of the total long-term unemployed in 2019 (pre-pandemic), based on ILO data. It highlights Colombia's position in comparison to Chile, Mexico, and Costa Rica (OECD members in Latin America and the Caribbean) and to Poland and Estonia (OECD members in Eastern Europe). Colombia ranks among the top countries with a higher proportion of long-term unemployed compared to this subset of emerging

Table 1: Unemployed 12–6 months as a percentage of total long-term unemployment

Region	Country	% 12 months	% 6 months
LA	Costa Rica	25.56	65.22
LA	Colombia	18.37	76.78
EEU	Poland	18.24	51.11
EEU	Estonia	17.31	53.50
LA	Chile	15.50	67.08
LA	Mexico	1.75	96.77

Source: Own elaboration based on ILO database for long-term unemployment. Note: Region LA for Latin America and the Caribbean and EEU for Eastern Europe.

OECD countries with similar economic structures and development conditions.

In the Employment Mission report for Colombia, Meléndez et al. (2021) attribute the high informality to deficiencies in the design of the contributory social security system and labor market regulations. Moreover, the country has seen minimal reduction in informality despite economic growth, likely due to these persistent structural issues.

Colombia's unemployment has persisted even during economic expansions, illustrating market inertia (Knight, 2018; Lartey, 2018). Comparatively, Colombia's Non-Accelerating Inflation Rate of Unemployment (NAIRU) stands at approximately 13.10%, higher than Chile, Peru, and Mexico, as noted by Cardona and Sierra (2020). This high NAIRU suggests structural unemployment and labor market rigidities, making Colombia an important case for studying unemployment dynamics, as highlighted by Arango and Flórez (2020), Constantinescu and Nguyen (2018), and Otoiu and Titan (2012).

This article aims to analyze the impact of labor regulations and institutions on Colombia's LAPU from January 2010 to October 2021. Using long-term unemployment data from GEIH, it constructs an indicator of unemployment duration persistence, drawing on Webster's framework (2005, p. 99). Vector autoregressive (VAR) models are employed to examine how this indicator responds to variables representing labor institutions and regulations in Colombia. Key variables include unionization rates, disparities between workers with written and verbal contracts, and monetary transfers under labor regulations for unemployed individuals receiving benefits or severance pay.

Furthermore, the article decomposes LAPU variability to assess whether institutional or regulatory mechanisms have greater explanatory power over the LAPU. Colombian labor legislation includes provisions such as indemnity payments for unjust dismissals and benefits for both fixed-term and indefinite contracts, developed over the past two decades. Additionally, Colombia provides unemployment subsidies through the social protection system, established by Law 789 of December 2002 and further enhanced by Law 1636 of June 2013, administered by the family compensation fund (Londoño & Mejía, 2019).

Arango and Flórez (2020) recently explored the factors influencing structural unemployment in Colombia, highlighting health and pension costs, marginal benefits, and dismissal regulations as significant non-wage labor costs. They identified distortions in public labor policies that hinder job creation and the introduction of employment protections that increase payroll costs, exacerbating the rigidity of Colombia's labor market.

Recent international studies underscore that higher unemployment benefits or monetary transfers tend to prolong unemployment durations (Kyyrä et al., 2013; Martins, 2021; Szydłowski, 2017). Additionally, You and Wang (2018) found that contract laws in China contribute to longer periods of short-term unemployment. These findings illustrate the unique societal challenges posed by long-term unemployment. Overall, models suggest that unemployment insurance systems can extend periods of unemployment for individuals who have depleted their savings or other sources of income.

The study conducted by Clavijo-Cortes (2021) for Colombia, Chile, Peru, and Mexico concludes that all four countries in the sample exhibit a high degree of persistent unemployment, with Colombia and Mexico experiencing periods of explosiveness associated with crises and institutional changes. Apart from the previously mentioned study, the Latin American and Colombian literature presents few studies focused on the determinants of unemployment duration, making the analysis of the role of institutional agreements and labor market regulations relevant and necessary. The present study introduces a novel indicator, LAPU, to measure the persistence of unemployment duration, revealing insights beyond cyclical labor market conditions. It systematically utilizes GEIH data to construct historical series for various variables, including unionized workers, individuals with written and verbal contracts, recipients of unemployment benefits, and those receiving severance payments.

VAR models estimate the impact of Colombian labor market institutions and regulations, incorporating variables like unionization rates and contract types, which can influence unemployment duration. Research by Nickell (1997) suggests that union benefits and labor market rigidity may prolong unemployment periods. Recent literature has also scrutinized the effects of unions on unemployment and wages (Krussell & Rudanko, 2016), indicating ongoing relevance and research interest. Additionally, variables such as

unemployment benefit recipients and severance payment recipients are analyzed. The inclusion of non-labor income variables is crucial for understanding unemployment duration, as emphasized by Blanchard (2018) and Cardona-Arenas and Sierra-Suarez (2023).

This study conducts an extensive review of existing literature, examining the determinants associated with long-term unemployment. This research significantly contributes to the scientific literature as one of the few studies that calculates a persistence indicator in unemployment duration for a developing country, assessing the impact of institutional variables on this measure. This analysis is based on microdata from a comprehensive integrated household survey and employs a longitudinal approach. The article begins with the literature review section. The second section provides a detailed description of the methodology, including a comprehensive analysis of variables, sources, and data. In the third section, we present the research findings, and in the fourth, we outline the study's overall conclusions.

2 Literature Review

Countries with higher incomes often deploy monetary benefits during periods of high unemployment, a trend observed in OECD countries where such benefits are associated with prolonged unemployment durations (OECD, 2020). This policy is seen as a response to, rather than a cause of, extended unemployment (Narendranathan et al., 1985), a viewpoint supported by OECD reports from 1991 and 1993.

The literature review highlights determinants of unemployment duration categorized into spatial, macroeconomic, and institutional factors. Spatial aspects lack a solid theoretical framework, with notable contributions from Dawkins et al. (2005) and Rogers (1997) exploring spatial relationships between labor supply and demand, displacement, and residential segregation in the United States. Macroeconomic factors analyze economic cycles during crises and recessions, while institutional and regulatory determinants reflect theoretical depth with limited empirical application due to challenges in obtaining longitudinal quantitative data.

Therefore, studying the relationship between unemployment duration and its determinants necessitates rigorous data collection efforts concerning policy implementation, regulations, and labor laws – a methodological approach adopted in this study. From the literature review, two main categories of unemployment duration analysis emerge: institutional determinants, which include contract theory and unions, and factors related to regulations and labor policy, particularly focusing on labor protection and monetary transfers. However, a gap exists as no studies have empirically analyzed the effects of implicit and explicit hiring or the increase in unionization on unemployment duration.

Studies specific to Colombia suggest a significant relationship between non-labor income and unemployment duration (Castellar & Uribe, 2003; Núñez & Bernal, 1997). Conversely, other research indicates that formal job search channels are more effective in reducing unemployment duration, particularly benefiting younger individuals and informal workers (Martínez, 2003; Viáfara & Uribe, 2008). Additionally, Hernández and García (2017) find that years of education influence unemployment duration in Cali and its metropolitan area. Overall, studies on unemployment duration in Colombia are limited, underscoring the need for further empirical research in this area.

From the literature review, two primary categories emerge in the analysis of unemployment duration: institutional determinants with a focus on contract theory and unions, and factors associated with regulations and labor policy, particularly labor protection and monetary transfers. However, a gap remains as no studies have empirically analyzed the effects of implicit and explicit hiring, or the impact of unionization on unemployment duration.

Research in Colombia indicates a significant relationship between non-labor income and unemployment duration (Castellar & Uribe, 2003; Núñez & Bernal, 1997). On the other hand, other studies suggest that formal job search methods more effectively reduce unemployment duration, benefiting younger individuals and informal workers (Martínez, 2003; Viáfara & Uribe, 2008). Furthermore, Hernández and García (2017) found that years of education influence unemployment duration in Cali and its metropolitan area. Despite these findings, studies on unemployment duration in Colombia remain limited.

Labor market institutions, according to Freeman (2007), are agreements that influence market outcomes by altering decision-makers' objectives, enhancing worker rewards, and affecting both labor supply and demand. Labor policies, as noted by Estevão (2007), respond to institutional conditions, shaping the workforce and impacting labor costs and job search efficiency. Initial analyses of unemployment duration linked to regulatory interventions date back to Topel and Welch (1980), who examined how government assistance affects transitions from employment to unemployment. Rosenzweig (1998) underscores the importance of government interventions in modern labor economics theory.

Historically, England established the world's first national compulsory unemployment insurance system in 1911, marking a shift in state support for the impoverished population

(Flora & Heidenheimer, 1981). Similar schemes were later introduced in Austria, Germany, Ireland, and Italy. In Latin America, unemployment insurance became more prevalent in structural reforms toward the late twentieth century, yet little attention has been given to understanding the impact of labor market regulations and institutions on unemployment duration. Zamanzadeh et al. (2019) argue that labor policies aim to enhance job creation by strengthening the rule of law institutions. The World Bank (2012) stresses the progressive effectiveness of labor rights to ensure economic growth does not coexist with unacceptable employment practices.

In a study by Murtin and Robin (2018), unemployment dynamics across nine OECD countries were examined, using regular contracts as an indicator of employment protection. They suggested that reducing unemployment insurance benefits could help decrease unemployment. Chodorow-Reich and Coglianese (2021) analyzed the US labor market during the COVID-19 recession and found that state unemployment benefits extended in duration. Conversely, Howell et al. (2007) argue that protective legislation, including unemployment benefits and employment protection laws, may negatively impact employment.

Studies indicate an inverse relationship between unemployment monetary transfers and institutional rigidities affecting unemployment duration. Carling et al. (1994) studied unemployment transitions in Sweden, finding that transition rates to employment increase as subsidies or benefits near exhaustion, thus reducing unemployment duration. Boeri (1999) contends that strict labor security systems in OECD countries often delay layoffs and lead to short-term contracts, influencing unemployment turnover. Kupets (2006) observed in Ukraine that benefits tend to prolong unemployment periods.

In the context of more flexible labor markets, Kyyrä et al. (2013) find in Denmark that extended periods of unemployment benefit assistance correlate with longer durations of unemployment. Similarly, Szydłowski (2017) observes in the United States that a 10% increase in weekly unemployment benefits leads to an average duration increase ranging from 0.6 to 7.9%. Martins (2021) utilizes regression discontinuity models to show in Portugal that access to benefits and subsidies increases transitions into unemployment. Meanwhile, You and Wang (2018) demonstrate in China that contract law contributes to longer periods of short-term unemployment, particularly affecting migrants.

The "institutional" category of the labor market encompasses government regulations and factors influencing union organization. Government mandates and labor regulations, such as employee protection measures and anti-discrimination policies, can impact employability and decrease workers' demand for unionism (Hirsch, 2008). Theoretical models of trade unions are crucial in the analysis of unemployment, particularly when contrasted and complemented with other approaches (Lindbeck, 1994).

Union theories have also influenced the development of wage determination models, including the "insider-outsider" theory by Layard and Nickell (1986). This theory examines the impact of insider workers on wage negotiations and the externalities generated for outsiders or the unemployed. Under the assumption of a fully unionized economy, the aggregate unemployment rate can be significantly higher, as firms and unions jointly determine employment and wages (Layard & Nickell, 1990). In the previous study, demonstrate that union coverage affects unemployment.

Recent studies delve into the impact of unions on labor market dynamics. Açıkgöz and Kaymak (2014) find that low productivity among unionized workers can deter hiring, contributing to labor market rigidities and higher unemployment rates. It is widely acknowledged that unions generate labor demand externalities (Bhattacharyya & Gupta, 2021; Pencavel & Hartsog, 1984). Devicienti et al. (2017) suggest unions may negatively affect firm profitability, though their impact on productivity remains uncertain.

In examining labor flexibility, research distinguishes between explicit (written) and implicit (verbal) contracts (Azariadis, 1975). Implicit contracts, prevalent in uncertain conditions, can promote market self-regulation (MacLeod & Malcomson, 1989). Explicit contracts offer greater information completeness compared to implicit ones (Ehrenberg et al., 2021). The key distinction between them lies in the level of detail provided, with written contracts being more comprehensive (Ehrenberg et al., 2021). Regarding contract types in Colombia, Restrepo and Salgado (2013) note that written contracts offer better social security benefits and are typically associated with larger companies. In contrast, verbal contracts, more common in informal enterprises, result in lower absenteeism rates due to the fear of job loss. Overall, workers generally prefer written contracts over verbal ones. However, the likelihood of formalizing contracts depends primarily on the formal characteristics of the companies rather than other factors.

On the other hand, Weller (2014) highlights for the context of Latin American countries that changes in labor institutions have contributed to the evolution of labor indicators and specifically in the behavior of unemployment. In this same line, Clavijo-Cortes (2021) discusses how labor market institutions, particularly trade unions, moderate macroeconomic shocks affecting labor dynamics. Higher union density correlates with more stable labor market responses during recessions and economic expansions (Bachmann & Felder, 2021).

Blanchard and Landier (2002) highlight that allowing firms to use fixed-term contracts can have adverse effects on the labor market, as seen in their study on young workers in France during the 1980s. They found increased turnover without a significant reduction in unemployment duration. Güell (2003) similarly examines fixed-term contracts in Spain from 1980 to 1994, revealing that their introduction led to higher long-term unemployment.

Nickell (1997) contributes insights on the impact of unemployment benefits on unemployment duration, suggesting potential increases over time. His analysis of market rigidities indicates that factors such as generous unemployment benefits, high unionization, high minimum wages, high taxes, and low education standards correlate with higher unemployment rates and longer durations.

A recent study by Cardona-Arenas and Sierra-Suarez (2023) highlights how non-labor income impacts the duration of unemployment in Colombia, demonstrating a hysteresis effect in this issue. However, the authors emphasize the importance of further exploring institutional hypotheses that influence the persistence of unemployment duration in the country (Cardona-Arenas & Sierra-Suarez, 2023). This new line of research directly motivates the focus, context, and analysis of results in the present work, contributing to the theoretical construct of labor market literature by opening up a more specific debate in the context of developing countries with high levels of unemployment duration.

Finally, this study offers an innovative approach by analyzing the impact of labor market regulations and institutions on the Long-Term Average Unemployment Rate (LAPU) in Colombia, standing out for its emphasis on labor formalization, contract clarity, and the effects of unionization. Unlike previous literature that focuses on monetary benefits and other types of regulations, this study presents evidence that unionization and non-labor income can increase unemployment persistence due to collective bargaining processes and structural issues. Furthermore, this study proposes concrete policies, such as monitoring programs and incentives for written contracts, and suggests the need for further research on how labor reforms and training impact unemployment duration throughout the economic cycle.

3 Methodology

In this section, a clear and detailed description of the variables to be analyzed in this study and the data analysis methods to be used (econometric models, preliminary tests, robustness analysis) will be made. This research seeks to determine the impact that shocks have on non-labor income, the number of people with unemployment benefits, the number of people with verbal and written contracts, severance payments, and unionized employees on the persistence of duration of unemployment measured by the LAPU in Colombia in recent periods. Similarly, the estimates include the variable of Economic Monitor Index/ Monitoring Indicator to Economy ISE economy to control the effect of the economic cycle and thus to isolate the short-term response of LAPU with respect to the structural one explained by the regulatory and institutional variables.

3.1 Specification and Estimation of Autoregressive Vector Models – VAR

For this type of analysis, the estimation of Autoregressive Vector models consistent with the original proposal of Sims (1986) is considered. A model is then specified where $Y_t = (x_1, x_2, x_3, ..., x_4)$ is a vector of $(nx1)$ series of variables, where Y_t corresponds to the set of endogenous variables integrated I(0) and I(1) and seasonally adjusted in period (t). The model is suitable as it assumes that the endogenous variables within the system are influenced by the lagged values of all variables in the system. This approach helps us avoid issues of endogeneity since the VAR model treats the entire system as one of endogenous variables. This is particularly appropriate in contexts where there is no theoretical consensus that allows us to confidently infer exogeneity conditions or correct endogeneity problems. These models offer a more practical and consistent alternative to traditional multi-equational models. To begin with, let's examine a version of a lower triangular reduce vector autoregressive form model in – Var (1):

$$Y_t = \sum_{i=1}^{\rho} \beta_i Y_{t-i} + \epsilon_t, \tag{1}$$

where i is the number of lags, and ϵ_t is a vector n $x1$ of innovations or processes without serial autocorrelation, white noise and with zero expectation and matrix of variances $\sigma_{\varepsilon i}^2$ and covariances σ_{ij} constant over time. Thus, the residuals are distributed as white noise identically in time with zero mean and constant variance: $\varepsilon_t \sim N(0, \sigma^2)$, $\text{cov}(\varepsilon_{ti}, \varepsilon_{tj}) = 0$, $\forall t_i \neq t_j$. (see Section 4.2. Robustness tests) This model representation helps address bias issues in estimation and mitigates potential identification problems. It explains how the estimated shock in each endogenous variable is incorporated into the impulse response function, assuming that all variables in the system are endogenous (Beaton et al., 2009). Now, the immediate reactions and the subsequent effects following the shock in the endogenous variables can be examined

through the impulse-response functions, typically represented as:

$$\mathrm{IRF}_t = \sum_{j=1}^{n}\left[\sum_{i=1}^{m} r_{t,jt-i}\right], \tag{2}$$

where $r_{t,jt-i}$ measures the response of the variation in the LAPU to each endogenous variable j of the system in the previous periods, that is, in its lags corresponding to the vector $Y_t = (x1, x2, x3, \ldots, x4)$, each of the variables is expressed as a function of the accumulated random disturbances. Hence, for every shock, there exist as many accumulated impulse-response functions as there are variables. In this study, we estimate the generalized impulse-response functions developed by Pesaran and Shin (1998), which generate impulse-response functions wherein the ordering of variables in the VAR does not affect the outcomes. Consequently, the identification issue in this study adheres to Sims' (1986) perspective, wherein no arbitrary restrictions are imposed on the model. This approach considers that none of the variables in the system of equations within the estimated VAR model possess adequate theoretical or empirical support to be deemed exogenous.

The analysis of decomposition of variance will be carried out considering its usefulness to get the proportion of the movements in the explained variables due to their "own" shocks, compared to the shocks of other endogenous variables[1].

A crash in the *i*th variable will directly affect that variable, by its auto-regressive component, but it will also be transmitted to all other variables of the system through the dynamic structure of VAR. Two models are estimated: VAR 1 and VAR 2. In the first model, the vector of endogenous variables of the system of equations is composed by: LAPU, the ratio – gap between people with written contracts and people with verbal contracts, non-labor income, unemployed people with subsidies and unemployed people, people with severance payments, and unionized employed people, and one control variable: Control economic monitor CEM – as follows for VAR_1:

$$\begin{aligned} Y_t = (&\mathrm{LAPU}_1,\ \mathrm{contracts}_2, \mathrm{nonlabor\ income}_3,\\ &\mathrm{severance\ payments}_4, \mathrm{unemployment\ subsidies}_5,\\ &\mathrm{unionized}_6, \mathrm{CEM}_4). \end{aligned} \tag{3}$$

An additional model (VAR 2) is estimated that will only include variables that capture cash transfers: unemployed people with subsidies and people who receive severance payments, to determine their impact on LAPU, and one control variable: Control economic monitor CEM- as follows:

$$\begin{aligned} Y_t = (&\mathrm{LAPU}_1, \mathrm{unemployment\ subsidies}_2,\\ &\mathrm{severance\ payments}_3\ \mathrm{CEM}_4). \end{aligned} \tag{4}$$

The series that showed signs of seasonality were seasonally adjusted with the TRAMO-SEATS method[2]. Dickey-Fuller and Phillips-Perron unit tests have been implemented at the level and in the first difference with tendency and intercept for effects of greater rigor in the results. See Appendix 1. Similarly, the order of lags for VAR 1, VAR 2 and 14 and 2, respectively, has been determined considering the lag inclusion test based on AKAIKE information criterion (Appendix 2). Appendix 3 presents the LM Test serial self-correlation test. None of the models have serial auto-correlation problems.

Hypothesis 1 for VAR Model 1. Shocks in the vector of endogenous variables $Y_t(x1, x2, x3, \ldots, x6)$ corresponding to institutional variables impact the duration of unemployment in Colombia and the LAPU. In this hypothesis, it is anticipated that a positive shock in the number of unionized individuals, the gap ratio between individuals with written and verbal contracts, non-monetary income, and individuals receiving unemployment benefits will affect LAPU.

Hypothesis 2 for the VAR Model 2. Shocks in the vector of endogenous variables $Y_t = (x1, x2 \ldots, x4)$ corresponding to cash transfers of employment protection impact the LAPU. The hypothesis predicts that positive shocks in monetary transfers related to labor market regulations, such as severance payments and unemployment benefits, will affect LAPU.

3.2 Variables and Data

Machin and Manning (1999) identify two primary sources for unemployment duration data: labor force surveys and administrative records. They suggest that administrative measurements may be influenced by idiosyncratic factors, making population and labor force surveys more reliable.

1 The shocks or innovations introduced into the system of equations for each variable are measured in one standard deviation of the unit of measure of the respective endogenous variable. The confidence intervals are typically constructed as ±2 standard errors around the point estimate of the response. This range indicates that, on average, the true value of the response is expected to fall within this interval 95% of the time.

2 The TRAMO-SEATS method allows for the seasonal adjustment of time series by correcting for outliers through the modeling of an ARIMA structure, and then decomposing the adjusted series into seasonal and non-seasonal components, producing a seasonally adjusted series.

This study systematically organizes microdata from DANE's Great Integrated Household Survey (GEIH) to analyze the Colombian labor market from 2010 to 2021. The research focuses on 24 main urban labor markets in Colombia, including major capital cities and metropolitan areas. The GEIH database has evolved methodologically over time to adhere to international standards set by the International Conference of Labor Statistics (ICLS) and the International Labor Organization (ILO). The dataset includes information on employment duration, collected consistently across various survey modules. The data are weighted to ensure the representativeness of the target population, accounting for dwelling density in surveyed segments at the time of data collection.

The current research takes the period January 2010 to October 2021 as a sample to perform the econometric analyses. It avoids potential biases due to the methodological changes reported by DANE. The variables that report the number of people are expressed in thousands. Table 2 lists the variables by category, source, and estimated model. In this same way, it is a synthesis of data treatment and calculation of variables.

The construction of the long-term unemployment variable is derived from question Q7320 of the unemployed people's module of the Great Integrated Household Survey of DANE (GEIH)[3]: "How long ago did you stop working?" In Colombia, people are considered to be long-term unemployed when they have been unemployed for more than 52 weeks. Therefore, a filter is applied to the monthly microdata provided by question Q7320 to identify all individuals with a total of 52 weeks or more of unemployment.

The LAPU variable is then measured as the total number of people who have been unemployed for 1 year or more over the total number of people unemployed a year ago. The indicator measures the percentage of people who were unemployed a year ago and are still unemployed 1 year later (Webster, 2005). The calculation of this indicator is as follows:

$$\mathrm{LAPU}_t = \frac{\mathrm{LTU}_t}{\text{Unemployed people}Q7320_{t-52}}. \tag{5}$$

Table 3 provides a summary of the central tendency, dispersion, and range of values for each variable. Each variable has monthly observations for the analysis period. The average duration of long-term unemployment is approximately 120 weeks, with moderate variability indicated by a standard deviation of around 10.44 weeks. However, there is a considerable range between the minimum and maximum durations, spanning about 53 weeks, highlighting significant variation in long-term unemployment durations. Notably, the mean duration accounts for roughly 19.79% of total unemployed respondents who reported their last employment status, indicating a substantial proportion of long-term unemployed individuals among surveyed Colombian households.

Figure 1 shows an increase in the number of long-term unemployed and LAPU because of the recent pandemic crisis in contrast to a decrease in the average number of weeks in long-term unemployment. This decrease could be explained by the transition of the unemployed to inactivity resulting from the sharp contraction in economic activity that worsens the situation of the unemployed in Colombia.

Figure 1 reveals a significant increase in the gap between individuals with written contracts and those with verbal contracts since 2014. However, during the recent COVID-19 crisis, this gap notably reduced, suggesting an interesting procyclical behavior – greater formalization during periods of growth compared to periods of crisis.

From 2012 to 2014, the number of unionized workers grew steadily, thanks to an increase in collective bargaining agreements (Urrea-Giraldo et al., 2020). This growth coincided with the rise in the unionization rate that began with Juan Manuel Santos's presidential term in 2010. However, a subsequent negative trend suggests a decline in unionization. This could possibly reflect corporate governance policies that oppose collective bargaining processes. Figure 1 also highlights a marked fluctuation and increase in the number of unemployed individuals receiving unemployment benefits from 2014 to 2021. In contrast, non-labor income showed a downward trend, with a brief recovery between 2018 and January 2020, followed by a contraction likely caused by COVID-19 containment measures.

4 Results and Discussion

4.1 Impulse-response Functions and Variance Decomposition

Considering the hypotheses formulated in the methodology section, the impulse-response functions that measure the reaction of each variable to a shock in each of the endogenous variables are presented below (refer to Figure 2). In this system of interrelationships, the number of impulse-

3 The long-term unemployment variable, derived from question Q7320 of the unemployed module in the GEIH microdata, had two missing values in April and March 2020. This was attributed to limitations in DANE's reports and databases during the COVID-19 contingency. To address this, imputation was performed using the Nearest Neighbor Imputation (NNI) method, taking the mean into account.

Table 2: Variables by category and model

Variable	Category	Measurement	Source
LAPU	Persistence	Percentage of people unemployed for 52 weeks or more with respect to the total unemployed 52 weeks before	(DANE, 2022a)
Other incomes	Other non-labor income[a]	Other "income" corresponds to the sum of different questions of the module of "other income" Deflated 2018 = 100	(DANE, 2022b)
Number of unionized employees	Institutional	Number of people who answered question Q7320 of the same module. "Are you a member or do you belong to a trade union or association?"	(DANE, 2022c)
Ratio – gap between written and verbal contracts[b]	Institutional	The ratio-gap is derived from question Q6450, which asks whether the contract is verbal or written. It is calculated by subtracting the number of individuals with a verbal contract from those with a written contract.	(DANE, 2022d)
Number of unemployed people with allowance	Money transfers due to labor regulations	Individuals receiving unemployment benefits is based on question Q9460 in the module for unemployed individuals	(DANE, 2022a)
Severance pay	Money transfer due to labor regulations	Individuals receiving grant income or interest from grants is based on question Q7510S6 in the other income module	(DANE, 2022b)
Economic Monitor Index/ Control economic monitor	CEM	Economic Monitor that is time-stationarity adjusted by a log-differencing transformation to achieve stationarity	System of National Accounts of (DANE, 2022c)

Source: Authors' Elaboration.

[a]The other non-labor income variable comprises the sum of various sources, including alimony and child support, money received from other households within the country, income from leasing real estate properties, vehicles, and equipment, pension or retirement income, interest earned on loans or savings deposits, and income from severance pay.

[b]"Number of employees with a contract" variable, derived from question Q6440 in the GEIH of the DANE, indicates whether an individual has an employment contract, with a value of 1 for yes and 0 for no. Subsequently, the "total number of people working with a contract" variable is created, filtering data on verbal or written contracts based on question Q6450. This variable takes a value of 1 for verbal contracts and 0 for written contracts.

Table 3: Statistical description 2010M1–2020M12

Variable	Unit of measurement	Media	Max.	Min.	Std. Dev.	Obs.
LAPU	Proportion	0.197891	0.243180	0.153676	0.019611	118
Time in long-term unemployment	Weeks	120.0324	141.0992	88.09779	10.43889	118
Contracts ratio – gap	Number of people in thousands with contracts	6323.320	7507.960	4790.960	752.1479	118
Unionized	Number of people unionized in thousands	889.5157	1342.481	552.3716	175.0187	118
Total unemployment	Number of people unemployed in thousands	3700.186	6916.000	3115.000	678.4396	118
Umeployment benefits	Number of people in thousands receiving severance payments	17.03239	42.45714	0.641345	9.632615	118
Long-term unemployment	Number of people in thousands in long-term unemployment situation	732.5507	1319.123	447.9684	160.1043	118
Non labor income	Thousands of pesos – Deflated 2018=100.	247.000.000	410.000.000	180.000.000	41.782.000	118
Severance payments	Number of people in thousands who have received severance payments	1404.985	1994.170	966.6322	238.1155	118
CEM	Index	99.46279	116.6000	82.80000	8.235091	118

Source: Own elaboration, sample that includes the years 118 month and 2 degrees freedom.

response functions equals the number of endogenous variables. These functions depend on the elapsed time, and the size of the shock is conventionally one standard deviation.

Therefore, in the case of a one standard deviation shock, the size of the effect on the system of endogenous variables is given in the unit of measurement of the considered variable. Specifically, in terms of the LAPU on the ordinate axis, a significant and positive response (0.02 LTUR measurement unit) is evident to a one standard deviation shock in itself between periods 1 and 5 after

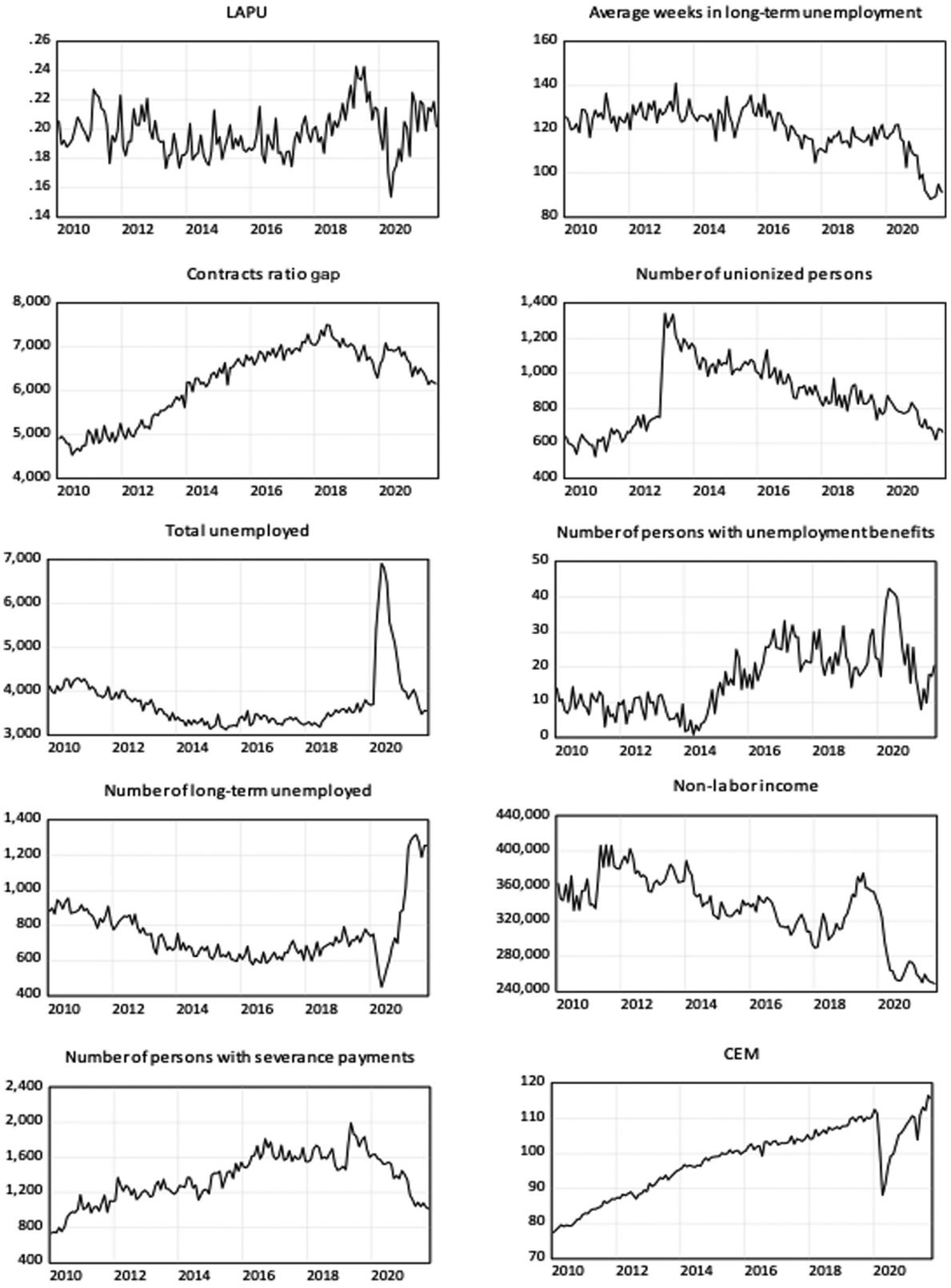

Figure 1: Time series at the level. Source: The data used in this study was obtained from the Great Integrated Household Survey (GEIH) conducted by DANE. However, data for certain variables such as rental payments, unemployment benefits, written and verbal contracts, and unionized employees was not available for March, April, May, June, and July 2020 due to limitations in survey application caused by the COVID-19 pandemic. As a result, missing values were imputed using the Nearest Neighbor Imputation method.

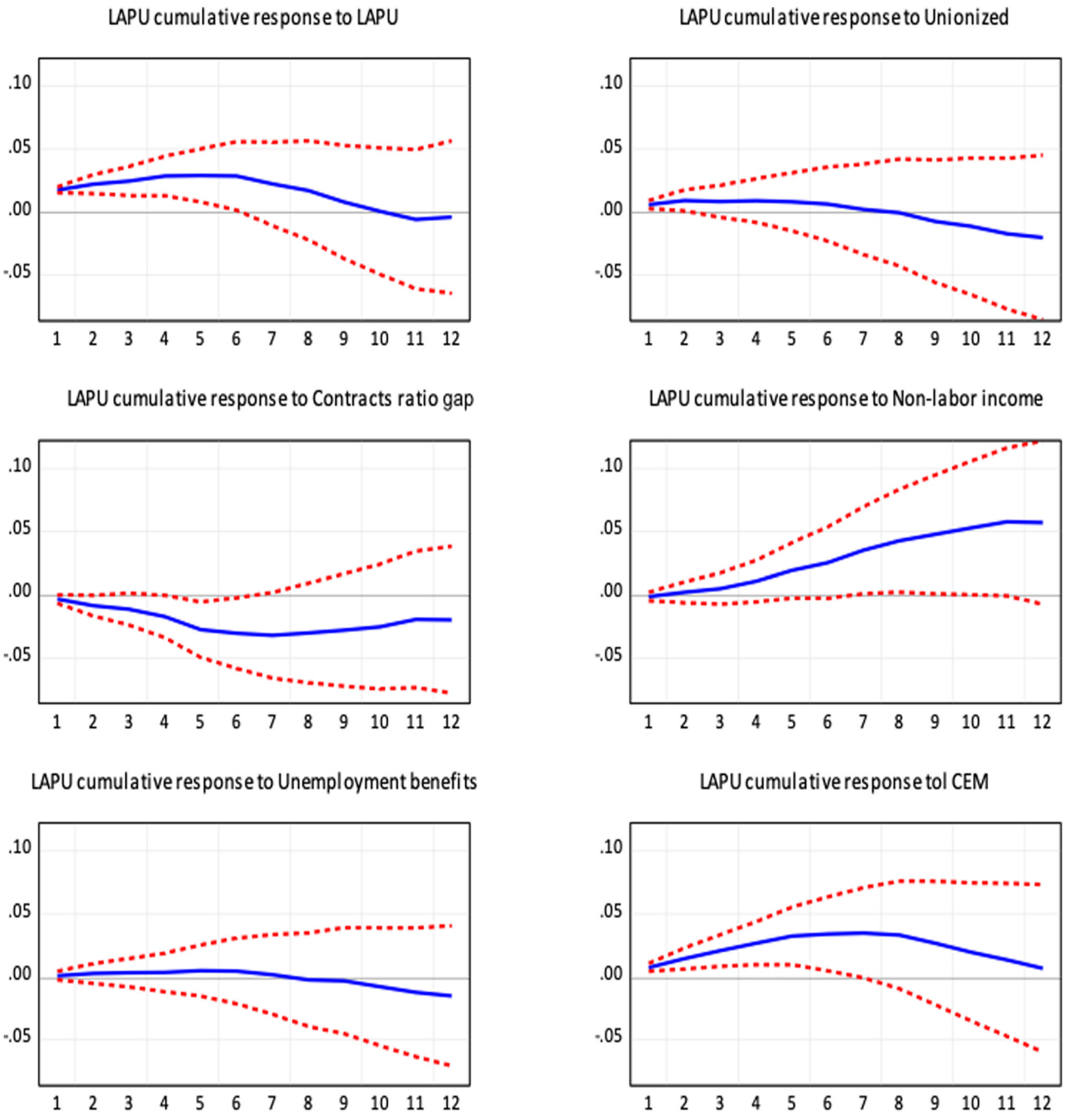

Figure 2: Generalized impulse-response functions accumulated to a standard deviation. Source: Authors' own elaboration based on VAR 1 estimation. Note: The time horizon for analysis in the impulse response function is 12 periods.

the shock. The blue line represents the response, while the red line represents the 95% confidence interval[4].

It's important to note that our interest lies in showing the direction of the effect. Given that in this type of VAR model, the logarithmic differentiation of the variables

4 A statistically significant effect is identified if both the response and the confidence intervals are statistically different from zero. To calculate the confidence intervals, methods like Monte Carlo Simulation or Bootstrap are used. These involve generating multiple random samples from the original data and recalculating the impulse-response functions for each sample. The percentiles of these distributions are then calculated, with the 2.5 and 97.5 percentiles used for a 95% confidence interval.

complicates the interpretation of the magnitude of the effect in terms of a unit of measurement. Therefore, the analysis ultimately focuses on the direction of the effect and its statistical significance.

The results reveal that the LAPU exhibits relatively inertial behavior, responding positively and significantly to shocks to itself approximately between periods 1 and 6; this is not surprising given that it is a measure of persistence in unemployment duration, in which the variability of the long-term unemployment ratio to total unemployment is very limited and low (Webster, 2005). Secondly, the LTUR responds negatively and significantly to a positive shock in the growth of the gap between the number of employed individuals with written contracts versus verbal contracts between periods 4 and 7 after the shock.

This finding allows inferring that explicit contracting mechanisms, such as written contracts, prevail as effective means to reduce the persistence of unemployment duration in Colombia. In conclusion, this study underscores the importance of labor formalization through written contracts as a means to reduce unemployment persistence in Colombia. This is consistent with Clark et al. (2009), who point out that labor market failures often stem from the security conditions of the labor market. The evidence indicates that addressing information asymmetries through transparent contracts can significantly enhance labor market efficiency by encouraging unemployed individuals to seek formal employment opportunities.

Third, LAPU responds positively and significantly to a shock in non-labor income growth between periods 7 and 10 after the shock. These findings reveal that the LAPU in Colombia responds positively and significantly to growth in non-labor income. This result is consistent with previous research such as that of Cardona-Arenas and Sierra-Suarez (2023) and Webster (2005), the latter of which suggests that income from activities other than primary employment may contribute to prolonging the duration of unemployment (e.g., remittances, rents, and transfers). This finding underscores the importance of considering not only variables directly related to the labor market, but also other socioeconomic aspects that may influence the dynamics of long-term unemployment, such as the effect that non-labor income has on reservation wages.

On the other hand, the VAR estimation results indicate that LAPU responds positively to shocks from unionized personnel in periods 1 and 3. Similarly, unionized personnel respond positively to LAPU in periods 2 and 11, demonstrating a co-movement. This is consistent with Hirsch's (2008) assertion that if high union labor compensation does not lead to higher productivity or product prices, union profits can act as a "tax" on company profits, thereby limiting market competitiveness.

This dynamic impacts labor demand, as companies can only thrive with higher union costs if they can pass these cost increases onto consumers – a strategy that is often impractical. This situation can hinder companies with collective union bargaining. As a result, collective bargaining processes may introduce rigidity in Colombia, affecting the persistence of unemployment duration.

Contrary to expectations, the estimation shows that LAPU does not significantly respond to growth shocks among those receiving unemployment benefits. This suggests that it is not a determinant of unemployment duration persistence – at least at the time of the estimations.

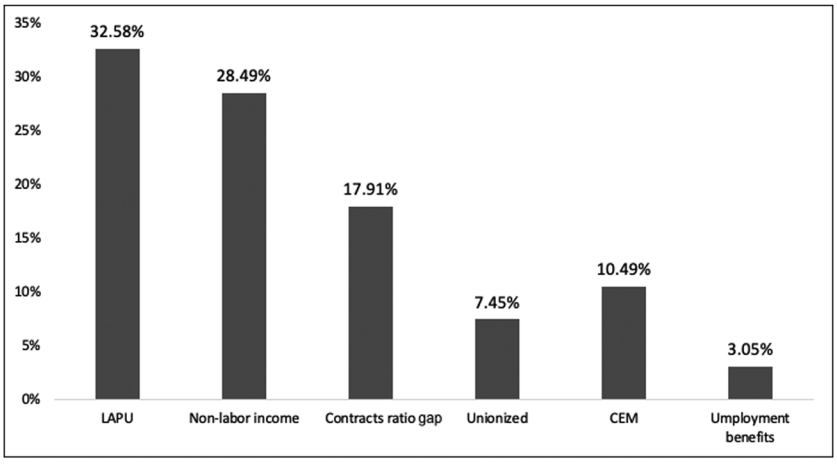

Figure 3: Variance Decomposition of LAPU at $T = 20$. Source: Authors' own elaboration based on VAR1 estimation. $T = 20$ period in which the variance stabilizes. Cholesky's order of the system: DLOG (CEM), DLOG (Non-labor income), DLOG (unionized), DLOG (Contract ratio – gap), DLOG (Unemployment benefits), LAPU. Note: The time horizon for variance decomposition analysis is 20 periods.

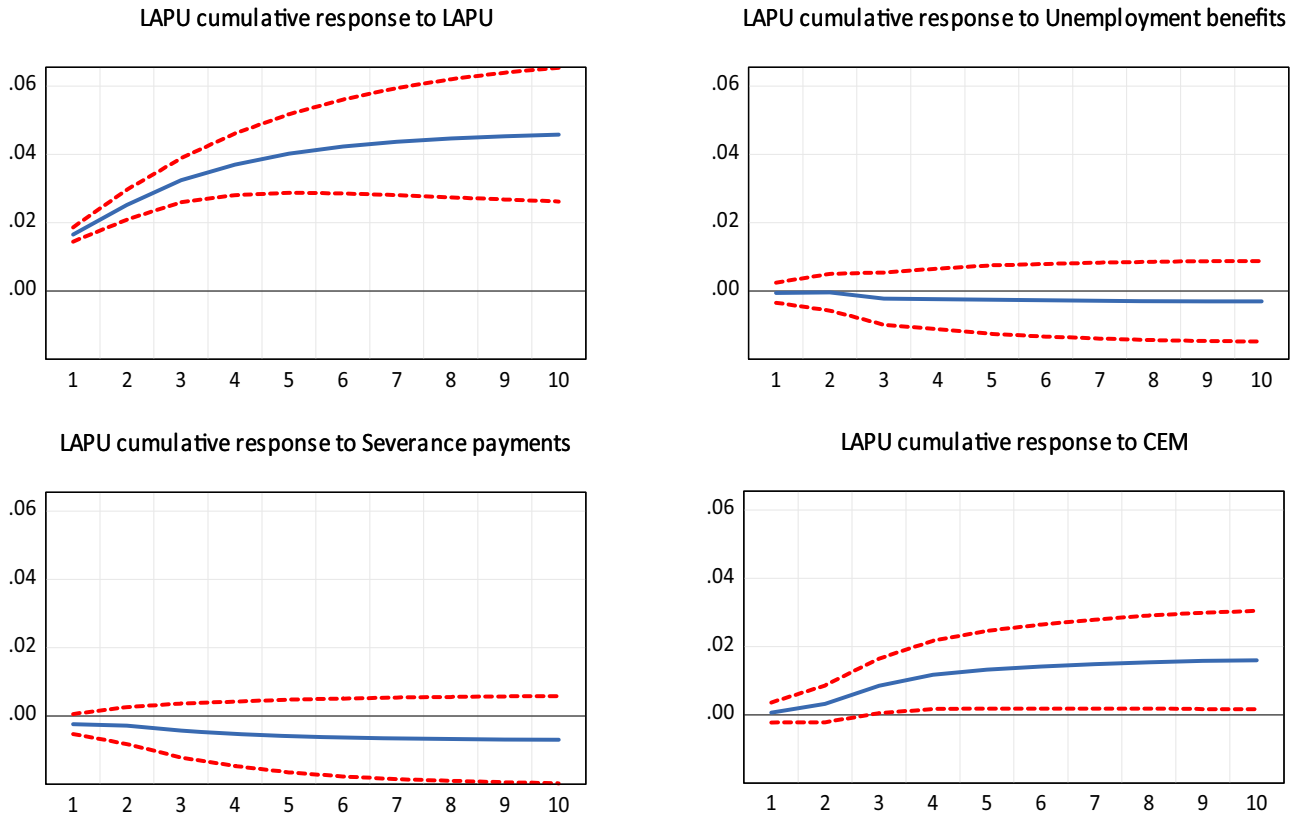

Figure 4: Generalized impulse-response functions accumulated to a standard deviation. Source: Authors' own elaboration based on the VAR 2 estimation. Note: The time horizon for analysis in the impulse response function VAR 2 is 10 periods.

Figure 2 presents the generalized impulse response functions of the VAR_1 model.

The results of the variance decomposition of LAPU (see Figure 3 below) reveal that non-labor income explains 28.49% of the variance, while the number of unionized individuals explains 7.45%, and the contract ratio gap explains approximately 17.91%. These findings provide evidence of the significant effect of institutional variables in the labor market on the persistence of unemployment duration in emerging countries like Colombia. According to the established variable system, approximately 53.85% of the LAPU variance is explained by this set of institutional variables. Finally, the ISE, a variable included as a control capturing the effect of the economic cycle, explains 10.49% of the variability of LAPU.

The results of the monetary transfer model are presented below (refer to Figure 4). These findings suggest that unemployment subsidies and severance payments do not influence the persistence of unemployment duration in Colombia. It's important to note that the null effect of unemployment benefits on LAPU could be attributed to the low coverage of this unemployment protection benefit among the total number of unemployed individuals.

In this study, we calculated the average percentage of unemployed individuals who have received unemployment benefits, compared to the total number of unemployed individuals reported by the GEIH. The mean is 0.04%, the maximum value is 1%, and the minimum value is 0.002%. This calculation is based on a total of 142 observations in the time series. Given that these results are not significant, the variance decomposition analysis of the monetary transfer model is not carried out.

Taking into account the results of the VAR 2 model, the variance decomposition process agrees robustly with the results of the impulse response functions, since the variables that correspond to monetary transfers such as severance payments and unemployment benefits do not show significant effects on the LAPU; it is correct to indicate that the percentage of the variance of the LAPU that is explained by the growth in people receiving unemployment benefits and growth of people receiving severance payments is very low, that is, 4.63 and 2.29%, respectively; however, the growth of the ISE in this case explains about 21.09%, showing that cyclical economic activity has a greater impact on the LAPU than the variables corresponding to monetary transfers.

4.2 Robustness Checks

In the context of vector model estimation, the behavior of residuals is of utmost relevance as they depict the differences between observed and predicted values of the studied phenomenon. In our case, these residuals provide important information about the goodness of fit of the model and allow us to discard potential specification issues. In the case of VAR estimation in this study, we can infer from Figure 5 that the residuals exhibit a random behavior without discernible patterns, which is ideal as it implies the absence of serial autocorrelation, as further evidenced in Appendix 4 with the Breusch-Godfrey LM Test for the serial autocorrelation of VAR residuals. In conclusion, we can confidently affirm, based on our estimation, that there is no systematic relationship between residuals across different time periods. Additionally, as observed in Figure 3, residuals should exhibit a mean close to zero and a relatively constant variance over time. From the foregoing, the validity and reliability of the VAR model results can be assured.

Even when a VAR model is correctly specified, the issue of omitted additional lags may arise. However, this can be addressed by ensuring the normality of the disturbances. At a 99% confidence level and a 0.01 significance level, the null hypothesis that "The residuals are normally distributed" is accepted, as shown in Appendix 5. Additionally, the residual plot indicates a random walk process without discernible

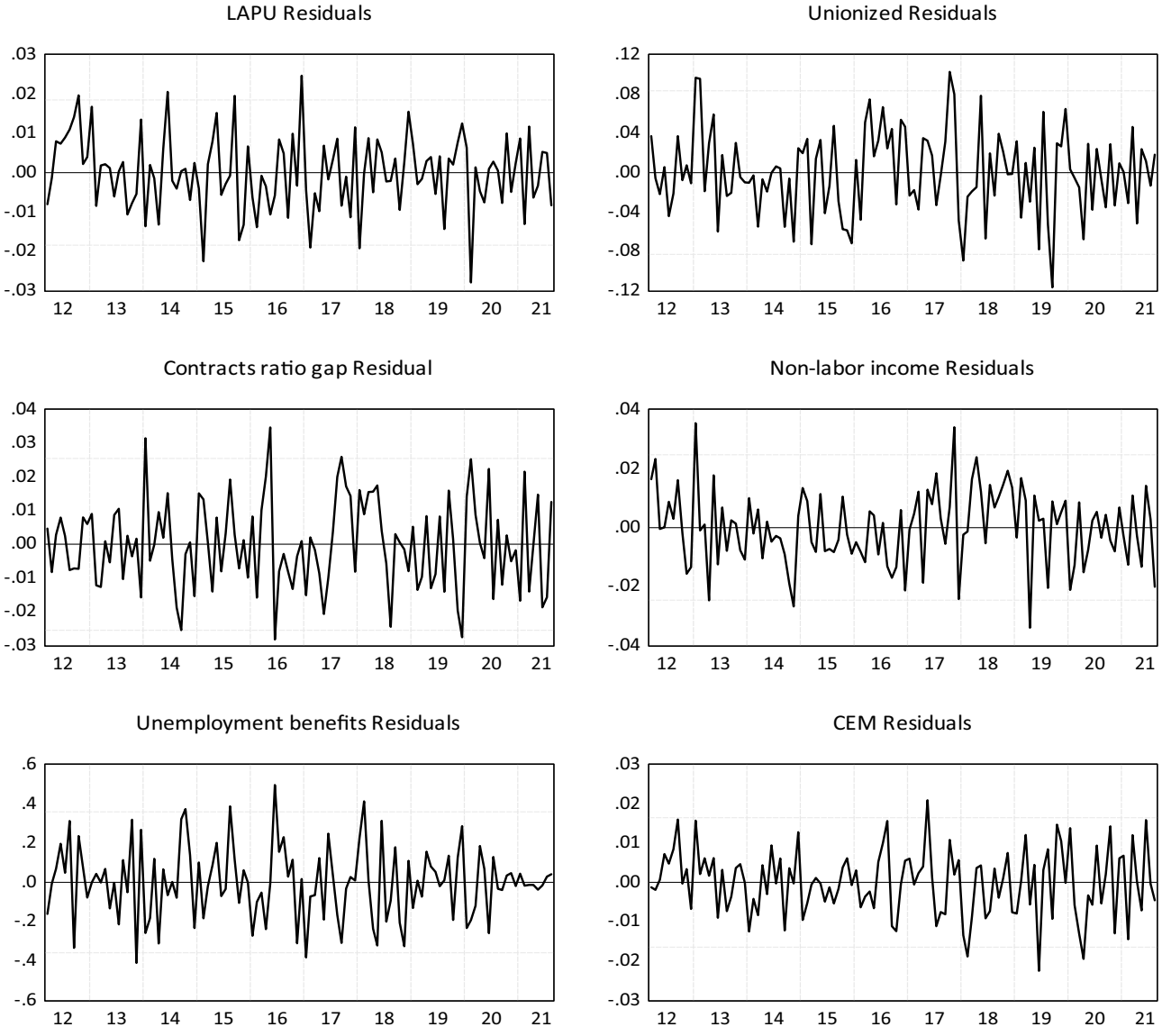

Figure 5: VAR residuals. Source: Authors own elaboration based on VAR estimations.

patterns. In empirical VAR model estimations, one should not assume transitive causal effects without a sufficient theoretical basis. Therefore, Granger causality tests (Granger, 1969) are useful for confirming or refuting unidirectional causality. The causality test results indicate no unidirectional causality, consistent with the model specification and the impulse-response function findings, affirming the endogeneity of these variables (Appendix 4).

We also included the historical variance decomposition of the variable of interest, "LAPU." In the Figure 6, the historical decomposition shows the accumulated contribution of the *j*th shock to the variable of interest in the VAR over time. This analysis allows us to infer how changes in the variable of interest are explained by shocks in the system's endogenous variables. In this case, based on the red line (baseline + variable behavior), we observe that

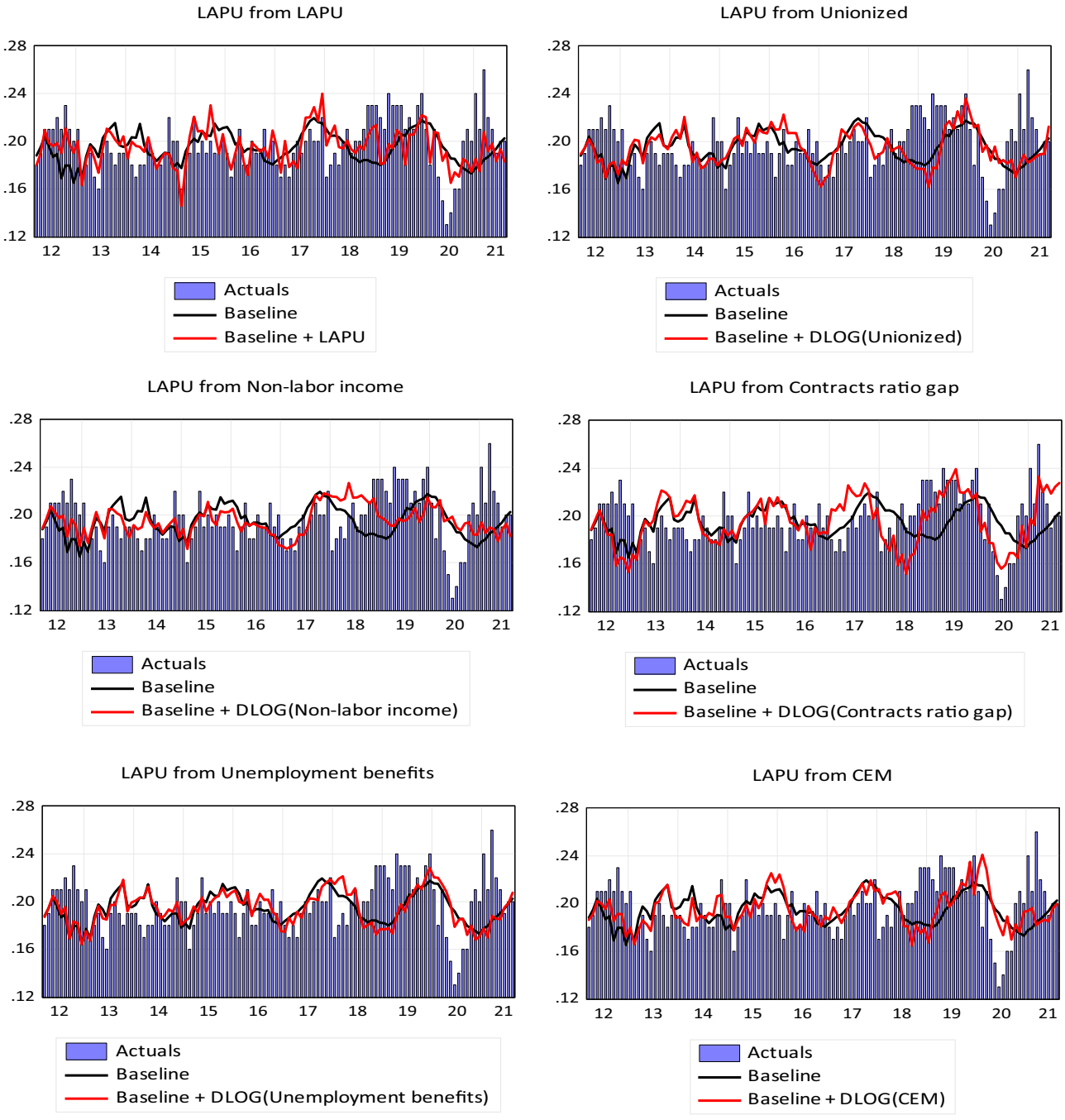

Figure 6: Historical decomposition. Source: Authors own elaboration based on VAR estimations.

non-labor income, unionization, and the contracts ratio closely and accurately explain the historical behavior of the LAPU variable.

5 Conclusions

The objective of this study is to measure the impact of various institutional variables on the Long-Term Average Unemployment Rate (LAPU) in the Colombian urban labor market during the period from January 2010 (2010M1) to October 2021 (2021M10). To achieve this, we collected and analyzed data on long-term unemployment from the Integrated Household Survey and developed an indicator of persistence in unemployment duration to evaluate the LAPU.

This study stands out for its innovative focus on analyzing the impact of labor market regulations and institutions on the LAPU in Colombia. The results of this study contribute to the literature by providing a detailed and more precise understanding of how labor institutions affect the dynamics of the country's labor market. It offers valuable insights into the relevance of labor formalization and the relationship between less formal employment and non-labor income. By emphasizing the importance of transparent and well-defined contracts to mitigate information asymmetries, this study adds significant value to existing literature. It highlights the need to improve labor market outcomes and promote greater employment formalization. Furthermore, this research opens new avenues for understanding the determinants of long-term unemployment in Colombia, with potential applications for other developing countries.

Our findings reveal a significant sensitivity of this indicator to changes in variables that capture the effect of labor market institutions and regulations in Colombia. According to the results obtained through impulse-response functions for the estimated models, it can be concluded that the path toward labor formalization is relevant. This conclusion arises from the increase in the gap between explicit (written) contracts and implicit (verbal) contracts, which reduces the LAPU. This result is noteworthy because it demonstrates the possibility of simultaneously reducing labor vulnerability and long-term unemployment without necessarily modifying the typology of contracts. Instead, emphasizing explicit contract agreements can achieve this goal.

Furthermore, the positive and significant response of the contract gap to an increase in total non-labor income confirms the existence of a latent link between employment, informality dynamics, and non-labor income generation. This finding supports the hypothesis of a deepening process of structural issues in the Colombian labor market. While it may lead to rent-seeking activities in the best-case scenario, in other cases, it can directly contribute to informal activities, exacerbating a vicious cycle of implicit contract subscriptions without sufficient guarantees of compliance or complete information for market agents. It is important to remember that non-labor income comes from sources other than formal employment, such as rents, investments, or government transfers. Therefore, its growth may limit the possibility of generating value added through factor payments. This leads us to conclude that informality and non-labor income are influenced by structural factors. However, it should be noted that the relationship between informality and non-labor income is complex and multifaceted, and it should be evaluated more thoroughly in future research.

In conclusion, the results of this study underscore the importance of prioritizing incentives for subscribing to written contracts as an effective means to reduce the persistence of long-term unemployment. Evidence suggests that mitigating information asymmetries through more transparent and well-defined contracts can significantly improve labor market outcomes by encouraging unemployed individuals to seek formal employment opportunities. This finding reinforces the relevance of contract theories in understanding labor behaviors and emphasizes the need for policies that promote greater employment formalization. Ultimately, implementing measures to ensure compliance with written contracts can contribute to enhancing social welfare by facilitating workers' transition to more stable and secure jobs.

Now, the results of this research indicate that an increase in the number of unionized employees and non-labor income raises the LAPU. Therefore, it can be concluded that the effect of this indicator of an increase in the number of unionized workers is related to collective bargaining processes that can create rigidities in the Colombian labor market and impact unemployment persistence. Hence, it is necessary to propose mechanisms for flexibility in wage negotiations that require further in-depth investigation in future studies. Additionally, this study concludes that the effect of unemployment benefits on the LAPU is limited and insufficient. This is due to their low coverage, which stands at approximately 0.04% for the period from January 2010 (2010M1) to October 2021 (2021M10). This reveals the limited impact of this labor market regulation on the dynamics and duration of unemployment.

The data on informality in Colombia reflects a combined effect of market failures and low productivity that impact the duration of unemployment. This is further compounded by the COVID-19 crisis, which has exacerbated structural issues in the labor market. It is pertinent to

prioritize a policy agenda aimed at reducing the social impact of long-term unemployment. For instance, consider implementing a targeted monitoring program for unemployed individuals approaching the 52-week unemployment period, with assistance from the National Administrative Department of Statistics (DANE). This program could focus on creating a training plan to enhance labor skills and competencies, considering participants' prior work experience. Enrollees would have access to free training, and upon completion, they could benefit from a 6-month employment period. Such initiatives could be established through partnerships with both public and private entities, supported by a system of fiscal incentives.

Secondly, given the negative response of the contract gap to long-term unemployment, I propose the formulation of an incentive system that encourages the subscription of written contracts by providing payroll assistance, at least during the first 6 months of employment. This measure aims to facilitate labor reintegration and reduce long-term unemployment. Furthermore, since evidence reveals a positive and significant relationship between non-labor income and the persistence of unemployment duration, I recommend incentivizing the creation of microbusinesses with venture capital. These incentives could be tied to tax benefits, contingent upon hiring reinserted labor force participants who have completed the previously described training program.

Finally, regarding future lines of research, this study suggests the need to expand research on how labor reforms and training programs impact the dynamics of unemployment duration at different times of the economic cycle. This could provide important information for designing and implementing effective policies that allow for reducing the duration of unemployment. Additionally, exploring the interaction between formal and informal labor markets.

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Article note: As part of the open assessment, reviews and the original submission are available as supplementary files on our website.

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Appendixes

Appendix 1. Unit root tests and order of integration of the series

Augmented Dickey-Fuller test statistic				Phillip-Perron test statistic				Order integration
ADF in levels		ADF in first differences		PP in levels		PP in first differences		
T-stat.	Prob.	T-stat.	Prob.	T-stat.	Prob.	T-stat.	Prob.	I(ρ)
Trend and intercept.								
Number of people with labor contracts								
−3.2	0.088*	−14.823	0.000***	−3.626	0.031**	−14.849	0.000***	I(1)
Number of people working without contracts								
−3.007	0.134	−14.127	0.000***	−2.817	0.193	−14.315	0.000***	I(1)
Number of people working with a written contract								
−0.234	0.991	−13.322	0.000***	−0.818	0.96	−24.843	0.000***	I(1)
Number of people working with a verbal contract								
−4.705	0.001***	−11.971	0.000***	−4.993	0.000***	−11.971	0.000***	I(0)
LAPU								
−3.956	0.012**	−16.592	0.000***	−5.397	0.000***	−23.333	0.000***	I(0)
Average weeks of DLDs								
−2.629	0.268	−9.27	0.000***	−3.984	0.011**	−67.639	0.000***	I(1)
Number of people not receiving unemployment benefits								
−1.874	0.662	−11.673	0.000***	−2.206	0.481	−11.789	0.000***	I(1)
Number of persons in Long-term unemployment (DLD)								
−0.569	0.979	−12.244	0.000***	−0.635	0.975	−12.247	0.000***	I(1)
Unemployed								
−3.202	0.088*	−14.17	0.000***	−3.244	0.08*	−14.137	0.000***	I(1)
Number of people receiving unemployment benefits								
−3.601	0.033**	−16.453	0.000***	−3.444	0.010***	−16.453	0.000***	I(1)
Number of people with labor contracts								
−3.124	0.104	−9.523	0.000***	−2.929	0.156	−9.476	0.000***	I(1)
Total other non-labor income								
−2.069	0.557	−8.899	0.000***	−3.521	0.040**	−20.807	0.000***	I(1)
Number of people receiving severance and/or interest payments								
−1.923	0.637	−14.77	0.000***	−1.372	0.864	−17.432	0.000***	I(1)
Number of persons who belong to a labor union or guild								
−2.044	0.571	−14.142	0.000	−1.881	0.658	−14.286	0.000	I(1)
Economic Monitor Index/Control economic monitor-CEM								
−3.661	0.028	−9.499	0.000	−3.229	0.083	−10.934	0.000	I(1)

Source: Authors' own elaboration. Note: (*P*-value)-Prob based on MacKinnon (1996), one-sided *P*-values. Null Hypothesis: Has a unit root, Lag Length: Automatic Schwartz Info Criterion, (Automatic based on SIC, maxlag = 13). Individual significance at 99% (***), 95% (**), and 90% (*).

Appendix 2.

Akaike's Information Test for Inclusion of VAR 1 and VAR 2 Lags

Akaike's Information Test for Inclusion of VAR 1

VAR Lag Order Selection Criteria
Endogenous variables: LAPU, DLOG (unionized), DLOG (Contract ratio – gap), DLOG (Unemployment benefits), DLOG (Non-labor income), DLOG(CEM)
Exogenous variables: C
Sample: 2010M01 2020M12
Included Observations: 114

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1118.229	NA	1.35×10^{-16}	−19.51279	−19.36878	−19.45435
1	1208.718	169.8655	5.20×10^{-17}*	−20.46874	−19.46067*	−20.05962*
2	1238.905	53.48818*	5.79×10^{-17}	−20.36675	−18.49461	−19.60695
3	1263.007	40.17099	7.22×10^{-17}	−20.15802	−17.42182	−19.04755
4	1290.120	42.33349	8.65×10^{-17}	−20.00210	−16.40184	−18.54096
5	1306.523	23.88581	1.27×10^{-16}	−19.65830	−15.19398	−17.84648
6	1325.047	25.02363	1.84×10^{-16}	−19.35171	−14.02332	−17.18921
7	1359.680	43.13931	2.06×10^{-16}	−19.32772	−13.13527	−16.81455
8	1379.230	22.29403	3.11×10^{-16}	−19.03913	−11.98262	−16.17529
9	1402.639	24.23021	4.57×10^{-16}	−18.81823	−10.89766	−15.60371
10	1443.046	37.57168	5.28×10^{-16}	−18.89555	−10.11092	−15.33036
11	1496.235	43.85700	5.23×10^{-16}	−19.19710	−9.548401	−15.28123
12	1557.572	44.11973	4.92×10^{-16}	−19.64161	−9.128851	−15.37507
13	1616.443	36.14879	5.47×10^{-16}	−20.04286	−8.666031	−15.42564
14	1710.721	47.96595	3.89×10^{-16}	−21.06528*	−8.824388	−16.09739

*Indicates lag order selected by the criterion.
LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; and HQ: Hannan-Quinn information criterion.

Akaike's Information Test for Inclusion of VAR 2

VAR Lag Order Selection Criteria
Endogenous variables: LAPU DLOG(severance payments) DLOG(Unemployment benefits)
Exogenous variables: C
Sample: 2010M01 2020M12
Included Observations: 118

Lag	LogL	LR	FPE	AIC	SC	HQ
0	378.1457	NA	3.48×10^{7}	−6.358401	−6.287960	−6.329800
1	431.2776	102.6617	1.65×10^{7}	−7.106400	−6.824635*	−6.991995*
2	440.9167	18.13460	1.63×10^{7}*	−7.117232*	−6.624144	−6.917024
3	446.2939	9.843002	1.73×10^{7}	−7.055829	−6.351418	−6.769817
4	450.8146	8.045303	1.87×10^{7}	−6.979908	−6.064174	−6.608093
5	456.4736	9,783382	1.99×10^{7}	−6.923282	−5.796223	−6.465663
6	464.0531	12.71814	2.04×10^{7}	−6.899205	−5.560824	−6.355783
7	475.5139	18.64798*	1.97×10^{7}	−6.940913	−5.391208	−6.311687
8	479.3808	6.095292	2.16×10^{7}	−6.853911	−5.092883	−6.138882
9	485.2435	8.943107	2.30×10^{7}	−6.800737	−4.828385	−5.999904
10	488.9343	5.442451	2.54×10^{7}	−6.710751	−4.527076	−5.824115

Source: Authors' own elaboration. * Indicates lag order selected by the criterion; LR: sequential modified LR; test statistic (each test at 5% level); FPE: Final prediction error, AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

Appendix 3.
Serial Autocorrelation Test LM Test VAR 1 and 2
LM TEST VAR 1

VAR Residual Serial Correlation LM Tests
Sample: 2010M01 2020M12
Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	44.20057	36	0.1638	1.271235	(36, 112.5)	0.1718
2	25.06065	36	0.9144	0.667236	(36, 112.5)	0.9175
3	28.11985	36	0.8229	0.757885	(36, 112.5)	0.8285
4	35.06997	36	0.5127	0.971962	(36, 112.5)	0.5230
5	33.93628	36	0.5671	0.936253	(36, 112.5)	0.5770
6	30.96082	36	0.7069	0.844007	(36, 112.5)	0.7150
7	30.26012	36	0.7377	0.822590	(36, 112.5)	0.7452
8	31.59956	36	0.6779	0.863631	(36, 112.5)	0.6865
9	35.17480	36	0.5077	0.975279	(36, 112.5)	0.5180
10	20.42300	36	0.9828	0.533833	(36, 112.5)	0.9835
11	33.08423	36	0.6080	0.909621	(36, 112.5)	0.6175
12	33.88436	36	0.5696	0.934626	(36, 112.5)	0.5795
13	46.18260	36	0.1191	1.339034	(36, 112.5)	0.1258
14	37.22344	36	0.4125	1.040657	(36, 112.5)	0.4232
15	24.84085	36	0.9195	0.660805	(36, 112.5)	0.9224

Source: Authors' own elaboration. No serial correlation at lags 1 to h.

LM TEST VAR2
LM TEST VAR 2

VAR Residual Serial Correlation LM Tests
Sample: 2010M01 2020M12
Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	8.020464	9	0.5321	0.892742	(9, 277.6)	0.5321
2	8.928748	9	0.4439	0.995457	(9, 277.6)	0.4439
3	4.666940	9	0.8623	0.516367	(9, 277.6)	0.8623
4	9.323466	9	0.4080	1.040197	(9, 277.6)	0.4080

Source: Authors' own elaboration. Null hypothesis: No serial correlation at lags 1 to h.

Appendix 4. Granger causality test VAR1
LAPU, DLOG (unionized), DLOG (Contract ratio – gap), DLOG (Unemployment benefits), DLOG (Non-labor income)

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 2010M01 2021M10
Included observations: 114
Dependent variable: LAPU

Excluded	Chi-sq	df	Prob.
DLOG (unionized)	6.886023	14	0.9390
DLOG (Contract ratio – gap)	7.831383	14	0.8979

DLOG (Non-labor income)	8.462621	14	0.8639
DLOG (Unemployment benefits)	4.474130	14	0.9919
DLOG(CEM)	9.273171	14	0.8132
All	50.42891	70	0.9626
Dependent variable: DLOG (unionized)			
Excluded	Chi-sq	df	Prob.
LAPU	17.86509	14	0.2130
DLOG (Contract ratio – gap)	12.10193	14	0.5981
DLOG (Non-labor income)	16.76652	14	0.2688
DLOG (Unemployment benefits)	11.06945	14	0.6806
DLOG(CEM)	6.209833	14	0.9609
All	53.17248	70	0.9329
Dependent variable: DLOG (Contract ratio – gap)			
Excluded	Chi-sq	df	Prob.
LAPU	13.14723	14	0.5150
DLOG (unionized)	10.41788	14	0.7310
DLOG (Non-labor income)	19.07897	14	0.1620
DLOG (Unemployment benefits)	16.62219	14	0.2769
DLOG(CEM)	5.690763	14	0.9737
All	58.34194	70	0.8386
Dependent variable: DLOG (Non-labor income)			
Excluded	Chi-sq	df	Prob.
LAPU	23.87970	14	0.0474
DLOG (unionized)	16.58975	14	0.2787
LOG (Contract ratio – gap)	25.77228	14	0.0277
DLOG (Unemployment benefits)	24.04639	14	0.0452
DLOG (CEM)	22.77309	14	0.0641
All	107.8972	70	0.0025
Dependent variable: DLOG (Unemployment benefits)			
Excluded	Chi-sq	df	Prob.
LAPU	8.878793	14	0.8387
DLOG (unionized)	24.03881	14	0.0453
DLOG (Contract ratio – gap)	16.36743	14	0.2915
DLOG (Non-labor income)	20.99652	14	0.1017
DLOG(CEM)	18.19552	14	0.1980
All	77.06467	70	0.2630
Dependent variable: DLOG(CEM)			
Excluded	Chi-sq	df	Prob.
LAPU	31.19449	14	0.0052
DLOG (unionized)	18.20861	14	0.1974
DLOG (Contract ratio – gap)	42.47343	14	0.0001
DLOG (Non-labor income)	14.85140	14	0.3884
DLOG (Unemployment benefits)	16.02718	14	0.3117
All	135.6644	70	0.0000

Source: Authors' own elaboration.

Appendix 5.

VAR Residual Normality Tests
Orthogonalization: Residual Correlation (Doornik-Hansen)
Null Hypothesis: Residuals are multivariate normal
Sample: 2010M01 2021M10
Included observations: 114

Component	Skewness	Chi-sq	df	Prob.*
1	−0.055420	0.065165	1	0.7985
2	−0.000821	1.43×10^{-5}	1	0.9970
3	0.070382	0.105021	1	0.7459
4	−0.053757	0.061318	1	0.8044
5	0.190258	0.757707	1	0.3840
6	−0.118059	0.294399	1	0.5874
Joint		1.283625	6	0.9726
Component	Kurtosis	Chi-sq	df	Prob.
1	3.270161	1.283132	1	0.2573
2	2.989784	0.237193	1	0.6262
3	2.449590	1.058083	1	0.3037
4	3.085544	0.493843	1	0.4822
5	3.164170	0.473357	1	0.4914
6	2.760837	0.037618	1	0.8462
Joint		3.583227	6	0.7329
Component	Jarque-Bera	df	Prob.	
1	1.348297	2	0.5096	
2	0.237207	2	0.8882	
3	1.163104	2	0.5590	
4	0.555162	2	0.7576	
5	1.231064	2	0.5404	
6	0.332017	2	0.8470	
Joint	4.866852	12	0.9623	

Source: Authors' own elaboration.