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Do Credit and Employment Exhibit Long-Run Convergence? Empirical Evidence from the State of Santa Catarina

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Abstract

Credit and employment are fundamental variables for measuring the socioeconomic development of a region. This study examines the convergence between credit levels and employment in the economy of the state of Santa Catarina, Brazil. A theoretical and empirical review was conducted on the credit market and its connection to economic growth and employment. The initial hypothesis considers that credit and employment exhibit long-run convergence. The methodological approach adopted involves the application of an error correction model (ECM), which provides a comprehensive view of the short- and long-run interactions between employment and credit. In addition, the causality between the variables is assessed. These relationships are crucial for policymakers and economic analysts when making decisions and forecasting economic trends. The results indicate a stable long-run relationship between the variables analyzed. In the short run, credit adjusts more rapidly than employment in response to deviations in the economy of Santa Catarina. The causality effect suggests that employment stock causes credit balances.

Keywords: credit, employment, convergence, Santa Catarina

JEL Classification: J21, O16, C32.

1. Introduction

Credit and employment are essential variables for the socioeconomic development of any region, often regarded as fundamental pillars that support economic growth and social well-being. The relationship between these variables has been the subject of study across various branches of economic theory, with significant contributions from classical authors such as Friedman and Schwartz (1963), Keynes (1936) and Schumpeter (1934). These scholars laid the foundation for understanding how credit impacts employment and, ultimately, economic growth, providing a theoretical framework that guides public policy formulation.

In the context of the credit market, Schumpeter (1934) highlighted the crucial role of credit in innovation and economic growth, arguing that credit is essential for financing innovations, which in turn create jobs and drive development. On the other hand, Keynes (1936) emphasized the importance of credit in stimulating aggregate demand, particularly during economic recessions, when employment growth can be fostered by easier access to credit. Complementing these views, Friedman and Schwartz (1963) suggested that credit supply can influence economic activity by affecting consumption and investment levels, warning of the negative impacts that a restricted credit environment can have on firms' ability to finance expansions and hire workers.

Recently, the importance of credit in job creation has been widely evidenced in empirical studies, employing various methodological approaches. Authors such as (Asaleye et al., 2018; Azolibe et al., 2024; Farooq et al., 2024; Khanday et al., 2024; Lanahan et al., 2021; Machokoto et al., 2022; Shakib et al., 2023; Wen et al., 2022; Yücel & Köseoglu, 2020) highlight through their research how credit can play a central role in promoting employment and economic development, both in developed and developing economies.

The analysis of the relationship between credit and employment is particularly relevant for the state of Santa Catarina, one of the most dynamic and economically diversified states in Brazil. Understanding this relationship in the context of Santa Catarina can provide valuable insights for public policy formulation and economic development strategies. Firstly, credit plays a crucial role in financing investments, which are essential for

business expansion and the creation of new jobs. Without access to credit, companies may face difficulties in growing and innovating, thereby limiting their potential for job creation. Furthermore, employment is a key indicator of the economic well-being of a population. High employment levels are associated with higher incomes and better quality of life, which in turn can stimulate consumption and economic growth.

This study examines the convergence between credit levels and employment in the economy of the state of Santa Catarina, Brazil, utilizing the empirical approach of the error correction model (ECM). This methodology enables the capture of short- and long-run dynamics between these variables, providing guidance for economic policymakers. Through a theoretical and empirical review, it was identified that the hypothesis of long-run convergence between credit and employment is plausible and warrants detailed investigation for the Santa Catarina economy. The empirical analysis of the data allows for the evaluation of the stability of this relationship and provides insights into how short-term deviations adjust, with particular attention to the speed of adjustment of credit compared to employment toward long-run convergence.

The findings of this study are relevant for policymakers and economic analysts, as they can guide strategic decisions to promote sustainable socioeconomic development. Understanding the relationship between credit and employment can help forecast economic trends and implement policies that encourage growth and job creation. This study contributes to empirical literature by providing specific evidence on the economy of Santa Catarina, a region that combines traditional and emerging sectors, diversified agriculture, a robust industrial base, and a growing service sector. These factors make Santa Catarina an interesting and relevant case study for other states and regions with similar economic characteristics.

This research is structured into five main sections. Following this introduction, the second section provides a review of the empirical literature, highlighting key studies that explore the relationship between credit and employment, as well as the different methodological approaches used. The third section outlines the adopted methodology, the proposed model, and the data description. The fourth section presents and discusses empirical results, analyzing the implications of the findings for the economy of Santa Catarina. Finally, the fifth section offers concluding remarks, summarizing the key points and suggesting potential directions for future research.

2. Empirical Literature Evidence

The relationship between credit and employment has long drawn the attention of economic researchers. The studies of Friedman and Schwartz (1963), Keynes (1936) and Schumpeter (1934) are foundational for analyzing the interactions between credit, economic growth, and the labor market. The review of recent empirical literature is organized around key themes to enhance the understanding of the impact of credit on employment. Five themes were identified that, in various ways, relate to the variables of interest in this study.

The first theme concerns the direct relationship between credit, employment, and economic development, as addressed in the studies of (Cordeiro et al., 2023; Duran & Karahasan, 2022; Farooq et al., 2024; Van Doornik et al., 2024). The second central theme emphasizes the role of credit across various specific sectors, such as services (Machokoto et al., 2022), tourism (Khanal et al., 2022), small and medium-sized enterprises (Azolibe et al., 2024), and the real estate market (Bozdereli & Rahmatzada, 2024). Another key theme identified relates to innovations in the credit market, focusing on human capital (Valizadeh et al., 2021) and the economy (Azeez et al., 2022; Lanahan et al., 2021; Shakib et al., 2023; Sovbetov, 2018). The fourth central theme addresses the impact of credit on foreign direct investment (FDI) (Wen et al., 2022) and the transmission channels of monetary policy (Asaleye et al., 2018; Kallianiotis, 2017; Kotz et al., 2018). Finally, the fifth theme relates to studies focused on the Brazilian economy (Chinelatto Neto, 2007; de Matos, 2002; Galeano & Feijó, 2012) and specifically on Santa Catarina (Bachtold, 2012).

Van Doornik et al. (2024) provided empirical evidence on the impact of credit on labor market outcomes, using data from credit lotteries. Their findings show that access to credit can significantly improve employment outcomes. Similarly, Farooq et al. (2024) investigate whether efficient corporate governance can improve financial outcomes in South Asia by facilitating access to credit, which in turn increases employment. The error correction model (ECM), applied by Duran and Karahasan (2022), uses a Vector Autoregressive (VAR) model to explore heterogeneous monetary policy responses. This method allows for capturing the interactions between variables and understanding how short-term deviations adjust in the long run, providing valuable insights into the stability of the relationship between credit and employment. Focusing on understanding how credit policies influence economic development and employment, Cordeiro et al. (2023) discussed the policies of Brazil's national financial system, highlighting the positive impact of credit cooperatives in promoting local economic development and job creation.

The literature also explores the impact of credit on specific sectors of the economy. Machokoto et al. (2022)

analyzed the evolution of trade credit and its impact on employment, highlighting the importance of credit for the development of the service sector. Focusing on job creation in the tourism sector, Khanal et al. (2022) argue that the interaction between credit and tourism development is positive and stimulates job creation in this sector. Concentrating on small and medium-sized enterprises (SMEs) in developing countries, Azolibe et al. (2024) investigated the determinants of unemployment, arguing that a robust credit infrastructure can reduce unemployment by facilitating access to financing for the companies considered in the sample. The relationship between residential property prices and macroeconomic variables was analyzed by Bozdereli and Rahmatzada (2024), demonstrating that real estate credit plays a crucial role in the economy, particularly in the construction sector.

Studies related to innovation, credit, and employment have also been the focus of more recent literature. In this regard, Sovbetov (2018) discussed the impact of the digital economy on female employment, highlighting how digitalization can influence the labor market. Similarly, Azeez et al. (2022) explored the impact of digital payments and economic growth, emphasizing how the digitization of payments can influence employment levels. Focusing on increasing labor productivity through knowledge, Valizadeh et al. (2021) suggest that innovation and human capital are crucial for sustained economic growth. Also considering the importance of the credit market and innovation, Shakib et al. (2023) support the idea that credit for innovation can significantly boost the creation of high-value-added jobs. Lanahan et al. (2021) discussed whether public subsidies for research and development create jobs, using evidence from the SBIR/STTR program in the United States. Overall, these studies indicate that policies facilitating access to credit and promoting innovation can have significant impacts on employment and economic development in the regions where they are implemented.

Other recent studies complement the understanding of the relationship between credit and employment. For instance, Wen et al. (2022) investigated the impact of foreign direct investment (FDI) on employment in developing economies, concluding that FDI can complement domestic credit, facilitating business expansion and the creation of new jobs. Considering financial fragmentation and the monetary transmission mechanism in the eurozone, Kotz et al. (2018) highlighted how credit conditions can influence economic stability. Similarly, Asaleye et al. (2018) examined the impact of monetary policy on credit and employment, while Kallianiotis (2017) discussed the efficiency of central banks in conducting monetary policy and its influence on credit. These analyses are crucial for understanding how different policies and economic conditions affect the relationship between credit and employment.

Among the studies focused on Brazil, specifically addressing the relationship between credit and economic development, Galeano and Feijó (2012) analyzed the relationship between credit, economic growth, and labor productivity, highlighting that credit is essential for stimulating the economy and increasing worker productivity. The authors examined the determinants of credit for companies, using cross-sectional and time series data, and concluded that an increase in business credit supply could reduce social inequalities between regions of the country, supporting the argument that credit is vital for economic development. Using vector autoregressive models with an error correction mechanism, Chinelatto Neto (2007), focusing on Brazil and using Gross Domestic Product (GDP) and credit data, confirmed the importance of credit for economic growth. Furthermore, de Matos (2002) emphasized that economic growth in Brazil is influenced by credit, consumer default levels, and consumption patterns. Similarly, the author employed the methodology used by Chinelatto Neto (2007) to confirm that private credit and agricultural credit have sustainable impacts on Brazilian GDP. In the context of the state of Santa Catarina, Bachtold (2012) aimed to understand the causality between credit and the economy of Santa Catarina, highlighting the financial system's capacity to promote economic growth. Using models based on the ordinary least squares (OLS) regression technique and Granger's (1969) causality test, the study demonstrated a causal relationship between credit and economic growth in Santa Catarina. Bachtold (2012) concluded that credit supply "[...] serves as a strategic tool to face periods of greater economic difficulty by stimulating consumption and investment, as well as leveraging the socioeconomic development of the country."

The review of empirical literature shows that the relationship between credit and employment is multifaceted and depends on several factors, including innovation, public policies, digitalization, distinct sectors, and specific economic conditions. The study considers that both theoretical and empirical research provide a solid foundation for understanding these interactions and suggests that policies facilitating access to credit can have significant impacts on employment and economic development.

3. Methods, Proposed Model, and Data

3.1 Methods

Discussions related to the stationarity of the time series are one of the first steps to be verified when building

models that consider this type of data. The stationarity tests proposed by Dickey and Fuller (1979) and by Phillips (1988) are among the most widely used in empirical literature. In addition to using these unit root tests, this paper also aims to determine the Vector Autoregressive (VAR) model, proposed by Sims (1980), and the Vector Error Correction Model (VECM), developed by Johansen (1988). These models are considered fundamental tools in empirical economic analysis, especially for understanding the dynamic interdependencies between the time series included in the analysis of interest.

Unit root tests are used to determine whether a time series is stationary or possesses a unit root (non-stationary). Introduced by Dickey and Fuller (1979), the Augmented Dickey-Fuller (ADF) test extends the original Dickey-Fuller test by including lagged difference terms to adjust for residual autocorrelation. The null hypothesis of the ADF test is the presence of a unit root. Another test used in this study to verify stationarity is the method proposed by Phillips (1988), which adjusts the regression coefficient values for heteroskedasticity and autocorrelation without adding lagged difference terms. Both tests are applied to ensure the stationarity of the series before estimating the VAR or checking for cointegration between the credit and employment series.

The VAR model is a generalization of univariate autoregressive models, allowing each variable in the system to depend linearly on its own lagged values as well as on the lagged values of all other variables in the system. This approach is particularly useful in economic analyses, where relationships between variables like credit and employment are complex and interdependent. Sims (1980) argued that the symmetry of the VAR eliminates the need for a prior distinction between endogenous and exogenous variables, allowing for more flexible and comprehensive modeling of economic interactions. However, for practical application of the VAR, it is crucial to ensure that the time series are stationary.

If the variables are non-stationary but a linear combination of them is stationary, they are said to be cointegrated, as proposed by Johansen (1988). Cointegration implies a long-term equilibrium relationship between the variables of interest. To test for cointegration, we use the method proposed by Johansen (1988), which considers two main statistics: the trace test and the maximum eigenvalue test. If the variables are cointegrated, it is appropriate to use the VECM model. This model not only captures the short-term dynamics between the variables but also incorporates long-term equilibrium relationships. The VECM can be considered an extension of the VAR that includes an error correction term, representing the adjustment of short-term variables toward long-term equilibrium. This adjustment is crucial for the accurate modeling of cointegrated time series.

3.2 Proposed Model

Initially, a VAR model was considered for two time series—employment and credit—with **p** lags defined. The lags were determined using established selection criteria (Akaike, 1974). In cases where different lags were suggested by the statistics, the Bayesian criterion proposed by Schwarz (1978) was chosen, as it penalizes model complexity more severely than Akaike (1974), which generally results in the selection of simpler models (Claeskens & Hjort, 2008). Equations (1) and (2) present the VAR system for the variables of interest.

$$Employ_t = \alpha_1 + \sum_{i=1}^{p} \beta_{1i} Employ_{t-i} + \sum_{i=1}^{p} \gamma_{1i} Credit_{t-i} + e_{1t} \quad (1)$$

$$Credit_t = \alpha_2 + \sum_{i=1}^{p} \beta_{2i} Employ_{t-i} + \sum_{i=1}^{p} \gamma_{2i} Credit_{t-i} + e_{2t} \quad (2)$$

Where $Employ_t$ is the time series for employment at time *t*; $Credit_t$ is the time series for credit at time **t**; α_1 and α_2 are the model constants; β_{1i} and β_{2i} are the estimated coefficients for the **i**th lag of the $Employ$ variable; γ_{1i} and γ_{2i} are the estimated coefficients for the **i**th lag of the $Credit$ variable; e_{1t} and e_{2t} are the stochastic error terms.

In cases where the series are cointegrated, the VAR model was transformed into an error correction model (ECM) to capture both the long-term relationship and the short-term adjustments. In general terms, considering **p** lags and a cointegration relationship, the error correction model is represented by Equation (3).

$$\Delta y_t = \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t \quad (3)$$

Where Δy_t represents the first differences of the employment and credit series $(\Delta Employ_t, \Delta Credit_t)'$; y_{t-1} represents the lagged levels of the series $(Employ_{t-1}, Credit_{t-1})'$; Π is the long-term impact matrix $\alpha\beta'$, where α are the adjustment coefficients and β are the cointegration coefficients; Γ_i is the matrix of short-term coefficients for the **i**th lag; and e_t is the vector of stochastic error terms $(e_{1t}, e_{2t})'$.

The long-term equation $\beta' y_{t-1}$, for the employment and credit series, can be written as $\beta' y_{t-1} = \beta_1 Employ_{t-1} + \beta_2 Credit_{t-1} + c = 0$. In this sense, the error correction model equations for $Employ$ and $Credit$, with p lags and a cointegration vector, can be specified as shown in Equations (4) and (5), respectively.

$$\Delta Employ_t = \alpha_1(\beta_1 Employ_{t-1} + \beta_2 Credit_{t-1} + c) + \sum_{i=1}^{p-1} \phi_{1i} \Delta Employ_{t-i} + \sum_{i=1}^{p-1} \theta_{1i} \Delta Credit_{t-i} + c_1 + e_{1t} \quad (4)$$

$$\Delta Credit_t = \alpha_2(\beta_1 Employ_{t-1} + \beta_2 Credit_{t-1} + c) + \sum_{i=1}^{p-1} \phi_{2i} \Delta Employ_{t-i} + \sum_{i=1}^{p-1} \theta_{2i} \Delta Credit_{t-i} + c_2 + e_{2t} \quad (5)$$

Where ϕ_{1i} and ϕ_{2i} are the coefficients of the lagged differences for the $Employ$ variable, and θ_{1i} and θ_{2i} are the coefficients of the lagged differences for the $Credit$ variable; c_1 and c_2 are the constants. These equations describe how the $Employ$ and $Credit$ variables adjust both in the short and long run, considering a number of p lags. The error correction model captures the dynamic and equilibrium relationships between these two variables, providing a framework for analyzing cointegration and dynamic adjustments.

To test for causality, as suggested by (Granger, 1969), equations (1) and (2) were used. To verify whether the credit balance Granger-causes employment stock across various sectors, the hypothes is $\gamma_{1i} = 0$ for all i was tested, meaning that the lags of the credit balance do not have a significant impact on employment stock. Conversely, if $\gamma_{1i} \neq 0$, a significant impact on employment stock is observed. Similarly, if $\beta_{2i} = 0$, the lags of employment stock do not Granger-cause the credit balance. In cases where $\beta_{2i} \neq 0$, the lags of employment stock Granger-cause the credit balance in the economy of Santa Catarina.

3.3 Data

The data used was collected from official sources and covered a robust period to ensure the validity and relevance of the analyses. The time series for total credit balances, credit for corporations, and credit for individuals were obtained from the Central Bank of Brazil. These series provide a comprehensive view of the credit supply in the state of Santa Catarina. For the employment series, formal employment stock data were used. These data include the total number of formal jobs and employment stock disaggregated by the main sectors of the economy, according to the classification of the Brazilian Institute of Geography and Statistics (IBGE). This classification allows measuring employment stock in the Industrial, Construction, Trade, Agriculture, and Services sectors. Detailed information on the total employment stock was extracted from the Annual Social Information Report (RAIS), a reliable and widely used source for labor market analyses in Brazil.

All data collected are specific to the state of Santa Catarina and cover the monthly period from January 2004 to December 2019. This time window provides a solid foundation for analyzing the dynamics of credit and employment across different economic cycles, helping to identify effects in periods affected by both employment and credit during the SARS-CoV-2 (Covid-19) shock. For empirical analysis, in addition to logarithmic transformation of the data, the Stata software was used, a powerful and versatile tool for developing the models defined in this methodological section. Stata was employed to conduct unit root tests, cointegration analysis, and estimation of the VAR and VECM models, ensuring precision and efficiency in data manipulation and analysis.

4. Results and Discussion

The cointegration analysis between employment stock and credit balance can provide insights into the long-term relationship between these two variables. The time series related to employment stock and credit balance for Santa Catarina are presented in Figure 1. It is observed that both variables exhibit a clear upward trend over the period analyzed, with credit growing at a faster pace. For employment stock across all sectors, the series starts at a level of 1.31 million jobs and rises to about 2.1 million jobs by the end of the period. Employment growth is relatively stable, though some fluctuations are observed, particularly around the years 2008-2009 and again around 2015, reflecting periods of economic instability during those times. The total available credit in the economy of Santa Catarina begins with a credit balance of approximately R$ 16.3 billion and shows a rising trend, reaching just over R$ 177 billion by the end of the period. This information, particularly regarding the upward trend, suggests the possibility of cointegration between the two series.

The availability of credit appears to play an important role in supporting employment growth, although the analysis of causality and convergence between the two variables requires more robust methodological rigor to infer these results. The importance of credit in stimulating new job opportunities and its role as a driver of economic growth is evident (Bachtold, 2012). The fluctuations observed, especially during periods of crisis, suggest that credit may act as an important stabilizer, helping to smooth out adverse economic impacts and support recovery. Credit stimulates aggregate demand and is crucial during periods of economic crisis Keynes (1936).

In this sense, the analysis suggests that credit expansion may have contributed to employment growth in Santa Catarina, although other factors must also be considered for a complete understanding of this dynamic. If the

series are cointegrated, this would imply that an increase in the available credit in the economy tends to be associated with an increase in employment, despite both showing trends over time. This suggests that, despite short-term variations, such as those observed during periods of crisis or rapid growth, employment and credit have a stable long-term relationship. Policies affecting credit, therefore, have long-term implications for employment.

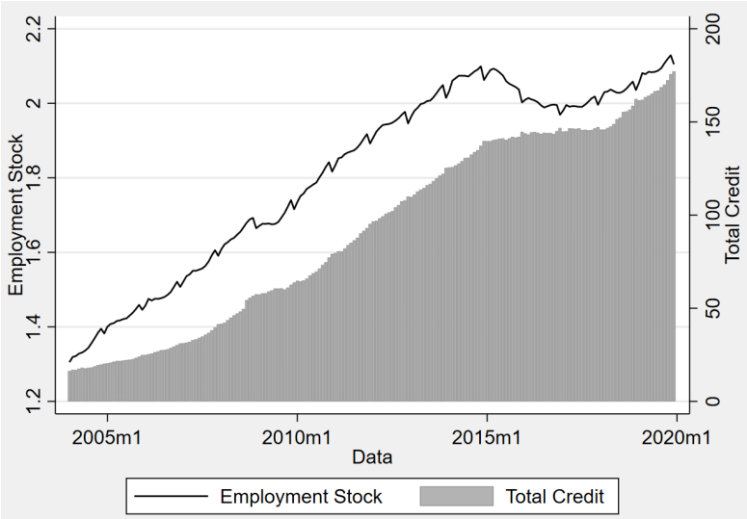

Figure 1. Employment stock and credit balance for Santa Catarina – (January 2004 - December 2019) - employment in millions and credit in billions

Source: RAIS/CAGED and Central Bank of Brazil, elaborated by the author.

Figure 2 presents the series of formal employment stocks by sector in the economy of Santa Catarina. The series are based on a common starting point in the research, and, with the exception of agriculture, a relative growth in employment is observed in each sector over time. Throughout the period, total formal employment stock grew by more than 61%, while the trade and construction sectors experienced growth exceeding 90%. The volatility in construction employment, especially the sharp decline after 2015, suggests a significant impact from the economic crisis that affected Brazil, reflecting the sector's dependence on investment and credit policies. The services sector, despite a slight slowdown in the mid-2010s, showed consistent growth like the total employment stock, reflecting the sector's increasing importance in the modern economy.

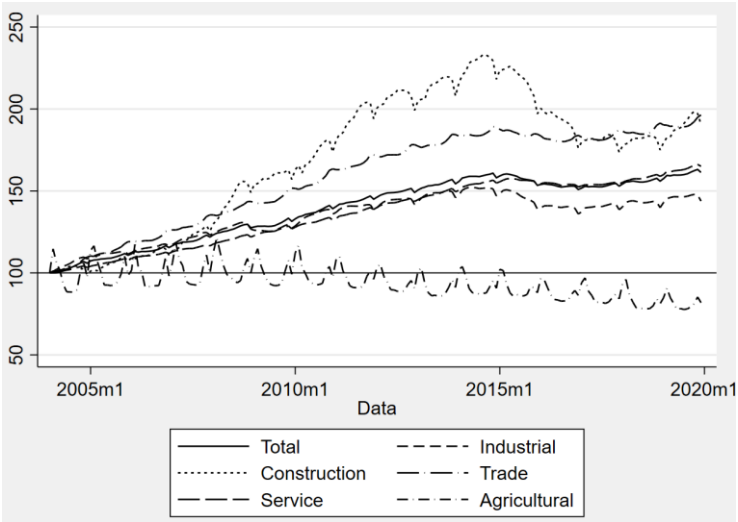

Figure 2. Employment stock by sector for Santa Catarina – (January 2004 - December 2019) – (January 2014 = 100)

Source: RAIS/CAGED, elaborated by the author.

In Table 1, the results of the optimal lag selection used in the VAR and VECM for different employment series in sectors of the Santa Catarina economy are presented. The selection was made using the Akaike (AIC) and Schwarz (BIC) criteria. It is important to note that, in cases where the selected lags differed, the more parsimonious number of lags chosen by the Schwarz criterion was preferred to avoid overfitting. It is also worth noting that the values for the credit balance were not reported because this variable was used in all equations for lag selection. In other words, credit was considered a fundamental determinant of employment in the different economic sectors analyzed in the study.

The fact that the AIC often suggests a greater number of lags indicates that, in many sectors, past variables have a prolonged impact on employment. This may be especially true in sectors such as services and agriculture, where economic dynamics can be slower or dependent on external variables. The BIC, on the other hand, suggests that simpler models may be preferable, particularly when the priority is to avoid overparameterization and ensure that the model is generalizable to new data samples. The decision between following the AIC or BIC depends on the goals of the analysis. If the focus is on capturing maximum complexity and precision, the AIC may be preferable. If the concern is parsimony and model robustness, the BIC may be the better choice, this latter approach was considered in this research.

Table 1. Lag selection

Variables	Akaike		Schwarz	
	Optimal Lag	Value	Optimal Lag	Value
Credit Balance	-	-	-	-
Total Employment	8	-13.9800	2	-13.6908
Industrial Employment	3	-13.1819	2	-12.988
Construction Employment	6	-11.7335	2	-11.4494
Trade Employment	3	-14.4372	3	-14.1926
Service Employment	8	-14.5809	2	-14.1528
Agricultural Employment	8	-9.73424	4	-9.20886

Source: Prepared by the author based on data from RAIS/CAGED and Central Bank of Brazil (2004 to 2019).

Table 2 presents the results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) stationarity tests for various time series of employment and credit balance. The ADF and PP test statistics for all series, except for agricultural employment stock, are greater than the critical values in absolute terms, indicating that the series are non-stationary at level, suggesting that they are integrated of order 1, I(1). After differencing the series, both statistics (ADF and PP) show values significantly lower than the critical values, indicating that the series become stationary at the first difference. This implies that modeling should treat most series in their first differences, except for agricultural employment, which can be used at level.

Table 2. Stationary test

Variables	Augmented Dickey-Fuller		Phillip-Perron	
	Level	First Difference	Level	First Difference
Credit Balance	-0.216	-11.070	-0.165	-149.623
Total Employment	-1.165	-14.885	-1.891	-207.543
Industrial Employment	-1.807	-11.010	-4.006	-153.264
Construction Employment	-0.371	-13.651	-0.590	-191.514
Trade Employment	-1.473	-7.518	-1.710	-88.333
Service Employment	-0.752	-14.606	-1.368	-204.153
Agricultural Employment	-6.044	-13.914	-61.922	-190.672

Source**:** Prepared by the author based on data from RAIS/CAGED and Central Bank of Brazil (2004 to 2019).

Note. ADF Critical Values: 1% -4.010, 5% -3.438, 10% -3.138; PP 1% -28.007, 5% -21.064, 10% -17.803.

Table 3 presents the results of Johansen's cointegration tests, specifically the trace and maximum eigenvalue statistics, for the time series of employment in the various sectors considered and the credit balance. Cointegration vectors were not calculated directly for the credit balance, as this series was used as a reference in the employment stock equations for the sectors.

For all series, both the trace and maximum eigenvalue statistics at rank 0 exceed the critical values of 15.41 and 14.07, suggesting that there is at least one cointegration vector. This indicates a long-term relationship between these variables and the credit balance. However, the results obtained at rank 1 show that employment stock in the construction sector does not have additional cointegration beyond the first vector. This finding is corroborated by the trace and maximum eigenvalue statistics, which are lower than the critical values, as shown in Table 3.

It is worth noting that, despite the values presented for the agriculture sector, which suggests strong cointegration with the credit balance, no conclusions can be drawn regarding the long-term relationship, as reported in Table 2, where this series was found to be stationary at level. In general, Table 3 suggests that there is a long-term relationship between credit and employment in different sectors of the economy, except for the construction sector, which appears to present weaker cointegration, though still with at least one cointegration vector. These long-term relationships should be considered when modeling the economic dynamics in the state and assessing the impacts that credit policies have on the employment stock in various sectors.

Table 3. Cointegration vectors

Variables	Trace Statistic		Max Statistic	
	rank 0	rank 1	rank 0	rank 1
Credit Balance	-	-	-	-
Total Employment	36.6675	6.5086	30.1590	6.5086
Industrial Employment	47.6254	9.6125	38.0129	9.6125
Construction Employment	24.0090	1.0062	23.0028	1.0062
Trade Employment	39.4438	12.8380	26.6058	12.8380
Service Employment	32.5118	4.6602	27.8516	4.6602
Agricultural Employment	54.5476	20.0512	34.4964	20.0512

Source**:** Prepared by the author based on data from RAIS/CAGED and Central Bank of Brazil (2004 to 2019).

Note. 5% Critical Values: Trace Statistic: rank 0 = 15.41, rank 1 = 3.76; Max Statistic: rank 0 = 14.07, rank 1 = 3.76.

The estimated parameter values for the short- and long-term equations, defined in the methodology section, are presented in Table 4. For the long term, the parameters β, α_1 and α_2 represent the cointegration vector and the adjustment coefficients, respectively. The results suggest that, in the long run, there is a stable relationship between total employment stock and total credit balance. Specifically, a 1% increase in the credit balance is associated with an approximately 0.25% increase in total employment stock. In general, the results show that the relationship between credit and employment is inelastic, with construction employment showing the highest value among the sectors analyzed, with an increase of 0.83% for each 1% positive shock in the credit balance.

Based on the adjustment coefficients, it is possible to observe the speed at which each variable returns to long-term equilibrium after a given deviation. It is noted that total employment stock adjusts by approximately 2.93% per period following a deviation from the long-term equilibrium. The total credit balance adjusts more quickly compared to total employment stock in Santa Catarina, with about 8.92% being corrected each period. Among the analyzed sectors, the trade sector, both in terms of employment stock and credit balance, presents the highest adjustment values per period toward the long term, around 1.7% and 11%, respectively. The constant, related to the long term, represents an equilibrium point in the relationship between sectoral employment stock and the total credit balance for the economy of Santa Catarina.

Table 4. Error correction model results - Long-term impacts

Variables	Π Long-term impacts			
	β	α_1	α_2	Cons
Employment	-.25***	.029***	.089***	.6017
Industry	-.21***	.016	.083***	-12.27
Construction	-.83***	.005	.010***	-6.83
Trade	-.31***	.017**	.11***	-11.35
Services	-.15***	-.03***	-.07***	-12.93
Agriculture	.04***	-.41***	.01	-10.76

Source: Prepared by the author based on data from RAIS/CAGED and Central Bank of Brazil (2004 to 2019). ***p<0.01,**p<0.05,*p<0.1.

The estimated short-term coefficients, as shown in Equations 4 and 5 and the results in Table 5, indicate, in

general, relatively low adjustments for the employment difference equation and higher parameters for the credit balance equation. The parameter ϕ_{11} indicates that for each 1% variation in the previous period's total employment stock difference, there is an approximately -0.1% variation in the current employment stock difference for the economy of Santa Catarina. In terms of sectors, the trade sector showed the highest short-term adjustment, around 0.69%. On the other hand, the parameter θ_{11} shows that for each 1% variation in the previous period's total credit balance difference, there is a very small and negative variation, around -0.007%, in the current employment stock difference. For this same coefficient, sectoral analysis shows that the construction sector, among those with long-term convergence, had the highest parameter, around 0.106%. It is worth noting that the θ_{11} parameters were not statistically significant.

Similarly, but considering the short-term impacts on the total credit balance difference, the parameters ϕ_{21} and θ_{21} show a higher short-term interaction between the variables. The estimated value for ϕ_{21} indicates that a 1% variation in the previous period's total employment stock difference results in approximately 0.55% variation in the current total credit balance difference, showing a significant and positive short-term interaction between the variables. The service sector appears to adjust more quickly, around 0.812% of the total credit balance difference. The parameter θ_{21} indicates that a 1% variation in the previous period's credit balance difference results in approximately 0.22% variation in the current credit balance difference. For this coefficient, the service sector also showed the highest variation, around 0.27% for the sectors that exhibit cointegration between employment stock and credit balance series in the economy of Santa Catarina. Machokoto et al. (2022), in analyzing the role of credit in the service sector, report that credit drives development and employment in this sector. The constants for the short-term equations for employment stock and credit balance show small and insignificant values, indicating a neutral adjustment for the sectors that exhibit a long-term relationship.

Table 5. Error correction model results - Short-term coefficients

Variables	Γ_i Short-term coefficients													
	ϕ_{11}	ϕ_{12}	ϕ_{13}	ϕ_{21}	ϕ_{22}	ϕ_{23}	θ_{11}	θ_{12}	θ_{13}	θ_{21}	θ_{22}	θ_{23}	c_1	c_2
Employment	-.104			.551***			-.007			.224***			.0001	-.00004
Industry	.187**			.274***			-.045			.196***			.0001	-.00003
Construction	.005			.172***			.106			.256***			-.0019	.00104
Trade	.691***	-.310***		.810***	-.655***		.009	.025		.120*	.113		.0003	-.00005
Services	-.078			.812***			-.040			.278***			.0003	-.00014
Agriculture	.221***	.027	.293***	.015	.008	-.017	.242	1.340***	.344	.348***	.108	.077	.0001	.005***

Source: Prepared by the author based on data from RAIS/CAGED and Central Bank of Brazil (2004 to 2019). ***p<0.01,**p<0.05,*p<0.1.

Table 6 presents the results of the Granger Causality test for various sectors related to employment stock and credit balance. In general, there is no empirical evidence that the credit balance Granger causes employment stock, except in the agriculture sector. Credit does not appear to be a significant predictor of short-term employment stock variations, as indicated by the results in Table 5. On the other hand, employment stock has a causal effect on the credit balance, meaning that changes in employment stock help predict credit variations, which may reflect the sensitivity of credit to labor market conditions. This inference suggests that, in the state of Santa Catarina, employment stock affects credit balance in the long run, aligning with the findings of Friedman and Schwartz (1963). Employment variations can influence consumption, investment, and credit. The results indicate an asymmetric relationship between employment stock and credit balance across various economic sectors. Employment stocks in sectors such as industry, construction, trade, and services are a significant predictor of credit, suggesting that policies affecting employment may have important consequences for the credit market. However, this relationship is not observed significantly in the agricultural sector, suggesting that other factors may be more relevant in this context.

It is worth noting that the study by Duran and Karahasan (2022) was based on error correction models (ECM) in analyzing policy responses and the long-term relationship between economic variables. In the present study, using data from Santa Catarina, a stable long-term relationship between credit and employment was found, aligning the model with results from other contexts. Cordeiro et al. (2023) evaluated how credit cooperatives promote economic development and job creation. In their findings, they highlighted the positive long-term impact of credit on employment, with a direct effect on the trade and service sectors, signaling convergence with the results found in the present study. The availability and access to credit significantly improve employment levels and production (Asaleye et al., 2018). However, the data indicated, through the Granger Causality Test, that employment stock significantly predicts the credit balance in the long run.

Table 6. Granger causality test

Null Hypothesis	Chi2	p value
Credit does not Granger-cause Employment Stock	0.2926	0.864
Employment Stock does not Granger-cause Credit	39.203***	0.000
Credit does not Granger-cause Industrial Employment Stock	2.0051	0.367
Industrial Employment Stock does not Granger-cause Credit	40.288***	0.000
Credit does not Granger-cause Construction Employment Stock	1.0386	0.595
Construction Employment Stock does not Granger-cause Credit	21.241***	0.000
Credit does not Granger-cause Trade Employment Stock	1.7609	0.623
Trade Employment Stock does not Granger-cause Credit	40.351***	0.000
Credit does not Granger-cause Service Employment Stock	7.8576**	0.020
Service Employment Stock does not Granger-cause Credit	22.37***	0.000
Credit does not Granger-cause Agricultural Employment Stock	45.029***	0.000
Service Employment Stock does not Granger-cause Agricultural Employment	6.6071	0.158

Source**:** Prepared by the author based on data from RAIS/CAGED and Central Bank of Brazil (2004 to 2019). ***p<0.01,**p<0.05,*p<0.1.

5. Conclusion

In general, the cointegration equations demonstrate a stable and significant relationship between employment stock and credit balance in the economy of Santa Catarina. The elasticity of 0.25% suggests that policies or factors affecting the credit balance have a positive long-term effect on employment. It is worth noting that, for the series that exhibit a long-term relationship, the magnitude of the coefficients varies, suggesting that the long-term effect of credit on employment differs by sector. Regarding the speed of adjustment, employment stock adjusts more slowly to a long-term equilibrium compared to the total credit balance in each period. This may indicate that credit is more sensitive to shocks and tends to return to equilibrium more quickly, with the magnitude and direction of adjustments differing depending on the sector under analysis.

Short-term dynamics show how past differences affect the current difference of the variables of interest. The past difference in employment stock suggests a significant negative effect on its own current difference, indicating possible inertia in employment. Similarly, the past difference in credit balance shows a very small negative effect on employment stock, indicating a very weak short-term interaction. On the other hand, the past difference in total employment stock has a significant positive effect on the total credit balance, indicating that an increase in employment in the previous period is associated with an increase in credit in the current period. In the same vein, the past difference in credit balance has a significant positive effect on its own current difference, showing some persistence in credit.

The short-term coefficients suggest that the response of employment variables to changes in credit is complex and varies across sectors. Sectors such as trade and services are particularly sensitive to short-term credit variations. The VECM results indicate robust cointegration between employment and credit in the sectors analyzed, with short- and long-term responses varying significantly between sectors. The analysis suggests that credit policies should consider the different sectoral adjustment dynamics to optimize the impact on employment. These findings provide a comprehensive view of the interactions between employment and credit, both in the short and long term. These relationships can be crucial for policymakers and economic analysts when making informed decisions and forecasting economic trends. Additionally, future studies could contribute by analyzing the behavior of the model during periods of crisis or relevant shocks, especially by testing how the pandemic context from 2020 to 2022 affected the influence of employment stock on credit and how the sectors of economic activity responded.

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