Vol. 49, No. 2 | pp. 185-337
June 2025 | Zagreb

ISSN: 2459-8860
https://doi.org/10.3326/pse.49.2

Institute of Public Finance

Public Sector Economics

2/2025

Public Sector Economics

2/2025

Vol. 49, No. 2 | pp. 185-337 | June 2025 | Zagreb

TABLE OF CONTENTS

Guiding through uncertainty: nowcasting the GDP of Croatia

MATEO LJUBIŠIĆ, univ. spec. oec.*

Article**
JEL: C32, C38, C53, E37, E60
https://doi.org/10.3326/pse.49.2.1

* The author would like to thank two anonymous reviewers for their valuable comments. The views and opinions expressed in this article are those of the author and do not necessarily reflect the policy or position of the Croatian National Bank.

** Received: June 1, 2024
Accepted: November 11, 2024

MATEO LJUBIŠIĆ
Croatian National Bank, Trg hrvatskih velikana 3, 10000 Zagreb, Croatia
e-mail: ljubisic.mateo@gmail.com
ORCiD: 0009-0003-2942-6646

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

Abstract

This paper addresses the creation of a nowcasting model for economic activity in Croatia. While considering the characteristics of a small, open economy incorporated in a larger economic unit, it emphasises, alongside domestic hard and soft indicators, the importance of using foreign indicators of short-term movements. By comparing factor models, including both the static method of principal components and dynamic methods of quasi-maximum likelihood and two-step estimation approaches, the paper aims to identify a model that accurately describes short-term GDP movements. The results indicate that structural factor extraction from two or three clusters of indicators combined with the simple method of principal components yields the best results. Such timely insights are crucial for decision-making at all levels, especially for fiscal policymakers in a recent entrant to the monetary union.

Keywords: nowcasting, GDP, factor extraction, timely information, decision-making, Croatia

1 INTRODUCTION

Gross domestic product (GDP) serves as the predominant metric utilised for quantifying economic activity within a country and is therefore considered a crucial element in both economic policy formulation and private sector decision-making processes. Thus, given the critical role of timely information for economic agents, it is important to recognise the limitations of GDP. The aforementioned indicator is released only quarterly and undergoes a time-intensive computational process, resulting in significant publication lags. Eurostat releases the first "flash" estimates of the GDP for the EU and euro area four weeks after the end of a quarter, whereas it takes the Croatian Bureau of Statistics eight weeks to release its first flash estimates for Croatia after the quarter. Furthermore, these releases are subject to revisions due to measurement errors and short-term volatility (Visco, 2007). The resultant information deficiency could be significantly mitigated by utilizing higher-frequency data from various sources, available much earlier, to formulate sufficiently accurate information on current economic conditions. This procedure is known as nowcasting, and as a term has a longstanding history in meteorology and has recently been adopted in economics (Giannone, Reichlin and Small, 2008).

Even subsequent to accession to the Eurozone and the adoption of the common monetary policy, national central banks possess evident advantages in monitoring current economic activity. The production of robust quick estimates at the national level can improve monitoring of activities at the Eurozone level overall. Moreover, the exchange of expertise among national central banks, coupled with the development of innovative ideas, information and practices, can contribute to the interpretation of underlying growth momentum, particularly in the series of shocks beginning with COVID-19 and the consequent data-dependent monetary policy approach. Such assessments could offer valuable insights to macroprudential policy frameworks for financial cycles evaluation, thereby preventing the accumulation of credit gaps and potential systemic risks (Škrinjarić, 2023).

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

Despite Croatia's substantial integration into the business cycle of the euro area countries (Arčabić, 2018) and the implementation of a countercyclical monetary policy at the eurozone level, the mitigation of potential asymmetric shocks is the task of fiscal policy as well. Consequently, it is particularly important for the fiscal authorities in a country that is a member of the monetary union to possess timely information on economic trends and their own independent nowcasting models in order to react promptly with discretionary measures. In this manner, fiscal authorities can contribute to the attainment of macroeconomic stability. They can effectively reduce social losses by preventing negative output gaps during periods of weak demand and alleviating inflationary pressures during periods of strong demand through the implementation of a targeted set of measures. In advocating for the development of proprietary fiscal policy nowcasting models, it is crucial to note the existence of an implementation lag following adverse macroeconomic events, especially in fiscal policy decisions, which are particularly vulnerable due to inherent administrative delays (Tsuruga and Wake, 2019). By generating analogous estimations at lower aggregate levels and the microeconomic level, fiscal policy is able to stimulate economic growth by adjusting work and investment incentives, augmenting total factor productivity and improving labour market efficiency.

Given the importance of incorporating dynamics in forecasting, the results obtained through nowcasting techniques can often serve as inputs for economic policymakers' forecasts. Timely information about ongoing economic activity is significant not only for economic policymakers but also for private economic agents. Both financial and non-financial enterprises, especially large ones, tend to base their business decisions on the evaluation of current and expected economic activity. Informed by these assessments, they engage in business planning and future investments, with GDP fluctuations serving as a vital input in their forecasts. Similarly, timely information is essential for consumers as it helps shape their expectations, facilitates their decision-making on significant expenses or household investments, and reduces irrational behaviour.

Nowadays, particularly in advanced countries, technological progress and improved efficiency in data collection and compilation have led to new information, such as short-term business statistics, labour market data, and sentiment indicators, being available much earlier than hitherto. Furthermore, various computational techniques have been developed to handle datasets containing highly correlated variables of different frequencies, thereby enabling the comprehensive utilization of all available information during the forecast generation process. Given the recent dominance of dynamic factor methodology in nowcasting, this paper aims to compare principal component analysis with several dynamic factor models and assess their performance in monitoring economic activity in Croatia.

The paper is structured as follows. The second section provides a literature overview, focusing on various techniques used in nowcasting with special emphasis on dynamic factor models, which are considered one of the mainstream methods

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

(Dauphin et al., 2022). The third section outlines the methodology of this paper employed in nowcasting, ranging from quite simple principal component analysis to dynamic factor models. The fourth section presents the number, characteristics, and scope of domestic and foreign variables used in the model. The fifth section discusses the results of different models and their relative performance on Croatian GDP data starting with the third quarter of 2008. The sixth section opens a discussion on further improvements in both modelling and fiscal response framework. The seventh section concludes this paper.

2 LITERATURE OVERVIEW

While the term "nowcasting" for flash estimates of current economic activity has gained popularity only recently, economists in academia and policy making having historically utilised high-frequency monthly data to evaluate the current state of GDP. Sargent and Sims (1977) pioneered the development of nowcasting models, which extracted common variation from an extensive dataset into a small set of factors (Dauphin et al., 2022). This section will offer an overview of various models utilised in nowcasting, starting with more straightforward ones, with a specific focus on principal component analysis and dynamic factor models.

A fundamental characteristic of nowcasting models is the disparity in frequency: whereas GDP is reported on a quarterly basis, an explanation of it often relies on economic indicators that are reported monthly. A relatively straightforward approach to nowcasting is represented by bridge models. The concept behind this approach is to aggregate available monthly indicators to a quarterly level, and then, through the application of a certain multiple linear regression method, establish a connection with GDP to obtain a quick estimate (Angelini et al., 2008). Nonetheless, a significant limitation of such an approach arises from the use of a large number of monthly indicators, resulting in a reduction of degrees of freedom. This could lead to overfit models, diminished parameter precision, and multicollinearity.

Consequently, as aforementioned, various factor models have become predominant in the development of nowcasting models. The essence of factor analysis in nowcasting involves grouping a diverse set of macroeconomic and financial variables on a monthly basis into factors, based on their common variation. Subsequently, a certain number of factors are aggregated at the quarterly level, followed by the estimation of a regression equation with GDP as the dependent variable. Principal component analysis is one of the most commonly employed methods in factor analysis, based on the extraction of latent factors through linear combinations of the original variables. These resultant constructs, known as principal components, provide a hierarchical explanation of variance, where the first component accounts for the largest proportion of variance within the dataset, followed by subsequent orthogonal components capturing successive proportions of variance (Abdi and Williams, 2010). Arnoštova et al. (2011) demonstrate that principal component models outperform others in nowcasting the Czech GDP.

Dynamic factor models help reduce the dimensionality of extensive datasets as well, but additionally model complex interdependencies between variables over time periods. These models consider dynamic changes in relationships between variables over time, enabling a better understanding of the dynamics of economic processes. Giannone, Reichlin and Small (2008) incorporate factors obtained through principal component analysis, then introduce dynamics using the ordinary least squares (OLS) method, and in the case of an unbalanced panel, re-estimate the factors using the Kalman filter. Furthermore, Doz, Giannone and Reichlin (2012), by utilizing quasi-maximum likelihood method in dynamic factor models, demonstrate the potential for efficiency improvements compared to PCA and handling missing data. The method has been shown to be suitable for structural analysis since it enables the imposition of restrictions on factor loadings. When applying factor analysis, it is essential to consider different criteria for specifying the number of factors, along with expert judgment. In the context of dynamic factor models, determining the number of lags is necessary, with the Akaike, Hannan-Quinn and Schwarz information criteria being the most commonly utilised.

Alongside traditional methods in nowcasting, mixed data sampling regressions (MIDAS) have been utilised as a direct multi-step tool for nowcasting quarterly GDP growth based on monthly indicators (Foroni and Marcellino, 2014; Schumacher, 2014). Various machine learning methods have been developed recently as well, and in the case of EU countries, it has been shown that they often perform well in the identification of turning points in the economic cycle (Dauphin et al., 2022). Besides, nowcasting models differ by some focusing on analysing the impact of the flow of information within the month on the estimation of current quarter GDP growth, thereby confirming that both the timeliness of the release and the quality are important for reducing uncertainty (Giannone, Reichlin and Small, 2008), while others conduct nowcasts at a particular time point. Giovanelli et al. (2020) employ an indirect approach to nowcasting individual components of GDP, thereby emphasizing the significance of business and consumer surveys, and concluding that the indirect approach yields more accurate nowcasts and forecasts than the direct approach.

The selection of an appropriate dataset is a critical stage in the development of nowcasting models. Bai and Ng (2008) find that increasing the number of monthly variables used to construct factors does not necessarily lead to better results. Moreover, the quality of their forecasts improves when factors are estimated using fewer but more informative predictors. Additionally, in the case of small, open economies, especially those integrated into an economic and monetary union and therefore dependent on external demand, the use of foreign variables is essential for improving forecasting performance (Rusnák, 2016).

In Croatia, the study conducted by Kunovac and Špalat (2014) is the only research on nowcasting GDP and is among the few on nowcasting overall. The authors employ principal component analysis along with structural factor extraction to

cluster domestic, foreign, and credit indicators, thereby creating a model that they subsequently compare with a dynamic factor model (Giannone, Reichlin and Small, 2008) and a PCA model combined with the EM algorithm (Schumacher and Breitung, 2008). They conclude that the dynamic factor model (Giannone, Reichlin and Small, 2008) provides a marginally better flash estimate than the other two models during recessionary periods, while their model offers the best estimates in the pre-recession period. Furthermore, they find that clustering factors into subgroups of indicators does not enhance the accuracy of flash estimates. In addition, Kunovac and Špalat (2014) employ the EM algorithm for imputing missing values in their nowcasting models and arrive at the conclusion that there is a potential for additional performance gain from averaging nowcasts derived through different factor models.

The objective of this paper is to highlight the exceptional importance of nowcasting GDP for policymakers at the national fiscal level within a monetary union. To this end, the paper presents potential estimators useful for nowcasting GDP, starting with principal component analysis, followed by the successful dynamic factor model using the Kalman filter (Giannone, Reichlin and Small, 2008), as well as a completely new estimator in the Croatian nowcasting literature – the quasi-maximum likelihood method, which is an enhancement of the previous dynamic factor model. Furthermore, in the context of reducing variables to factors, the new approach involves the classification of indicators into domestic, foreign, and confidence indicators. The key is to identify the best model that policymakers in fiscal policy can utilize in the upcoming period.

3 DATA

This section will elaborate on the data selection process for the nowcasting model of the GDP of the Republic of Croatia. Given the objective of this type of nowcast, which is to estimate current economic activity prior to the release of the first flash estimates of GDP, the selection of an appropriate dataset presents a critical phase in the process. A total of 21 domestic and foreign indicators of economic activity were utilised at a monthly frequency, covering the period from May 2008 to March 2024. Alongside the commonly used data on domestic industrial production, retail trade, employment, and unemployment, an additional country-specific indicator has been included: tourist overnights. This reflects the significant role of tourism activity in explaining the dynamics of GDP in Croatia. Additionally, the volume indicator of construction activity is taken into account due to its significant share in gross value added, with a one-period lag. Although the lag period can be explained by the impact on orders in other sectors of the economy, this lag was primarily considered for technical reasons. Given that the mentioned indicator is released with a delay of seven weeks, it was thought to be more beneficial to utilise its lagged dynamics for factor creation rather than excluding it from the analysis at all.

As previously mentioned, considering the exposure of a small, open economy to foreign movements, relatively early available indicators of retail trade or industrial production for major trading partners have also been considered. Soft indicators have proven helpful in identifying certain patterns in GDP data for timely assessment, and consequently, the economic sentiment indicator (ESI) has been chosen as it represents a weighted average of multiple sectors. Additionally, this indicator also captures signals from the services sector overall, whose dynamics are not encompassed in the model due to delays in release. Thus, in addition to the domestic economic sentiment indicator, an ESI for trading partners within the European Union and an ESI for the EU as a whole were selected. It is worth noting that only trading partners who are EU member states were selected for the ESI, as this indicator is not measured for non-members. It is important to emphasise that for this nowcast, the estimate of the Banca d'Italia €-coin – coincident indicator of the euro area economy (Visco, 2007) was used as an input. The main issue with this indicator as an input is that it provides quarterly growth rate estimates at a monthly frequency. Therefore, a moving average of the quarterly growth rate was computed and subsequently converted into a monthly rate to estimate the level (in indices) at a monthly frequency over the observed period.

Table 1

Description of monthly indicators and transformations

Indicator		Database	Description	Transformation
Production in industry – Croatia		Croatian Bureau of Statistics	Volume index of production, 2021 = 100, seasonally and calendar adjusted	Logarithmization, differencing
Retail trade turnover – Croatia			Volume index of turnover, 2021 = 100, deflated, seasonally and calendar adjusted	
Tourist overnights – Croatia		Croatian National Tourist Board	Number of tourist overnights	Seasonal adjustment, logarithmization, differencing
Employment in Legal Entities – Croatia		Croatian Bureau of Statistics	Number of persons	
Unemployment – Croatia				
Eurocoin		Banca d'Italia	Quarterly growth	Level estimation, logarithmization, differencing
Economic sentiment indicator	Germany	Eurostat	Balance, seasonally adjusted	Logarithmization, differencing
	Italy			
	Hungary			
	Austria			
	Slovenia			
	EU			
	Croatia			

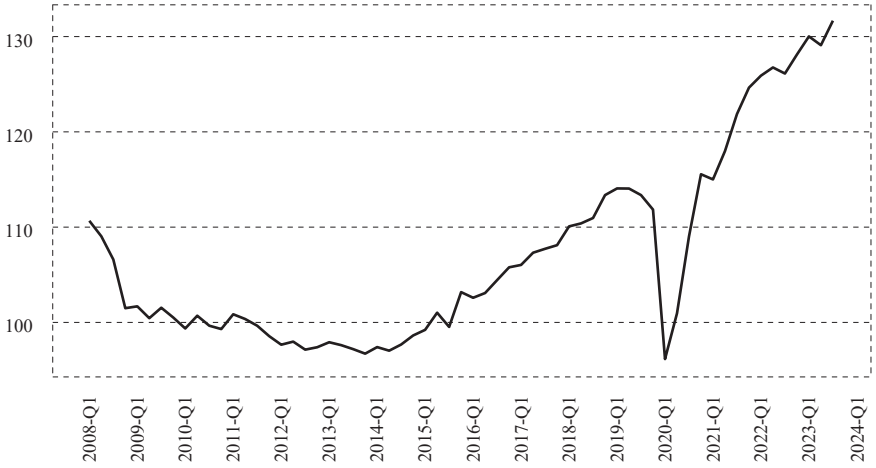
Indicator		Database	Description	Transformation
Retail trade turnover	Germany	Federal Statistical Office of Germany	Volume index of turnover, 2015 = 100, deflated, seasonally and calendar adjusted	
	Slovenia	Republic of Slovenia Statistical Office		
Employment	Italy	Italian National Institute of Statistics	Number of persons	Seasonal adjustment, logarithmization, differencing
	Hungary	Hungarian Central Statistical Office		
Production in industry	Austria	Statistics Austria	Turnover index of production, 2021 = 100, deflated, seasonally and calendar adjusted	Logarithmization, differencing
	Serbia	Statistical Office of Republic of Serbia	Volume index of production, 2021 = 100, seasonally adjusted	
	Bosnia and Herzegovina	Agency for Statistics of Bosnia and Herzegovina	Volume index of production, 2021 = 100, seasonally adjusted	

Source: Author's calculation based on the data mentioned in the Database row.

The primary objective of these models is to estimate the quarterly growth of the seasonally and calendar-adjusted gross domestic product, from which the annual growth rate estimate is derived. Consequently, before applying the data for model construction, it is necessary to deseasonalise indicators that have not been seasonally adjusted by statistical offices. Given the non-stationarity in these time series, logarithmic and differencing transformations were conducted. The data selection relies on their availability within a 4-week period following the conclusion of a specified month. Under these circumstances, a conclusive estimation derived from the selected model could be provided 30 days after the end of a particular quarter. Additionally, should the final observation be imputed by employment of the Kalman filter, and in the absence of significant shocks, it is possible to obtain a reasonably reliable GDP estimate on the very last day of the quarter.

Figure 1

Quarterly seasonally and calendar adjusted GDP of Croatia, index 2015 = 100



Source: Eurostat.

4 METHODOLOGY

This section addresses the methodological framework. As mentioned in the previous section, once the data are selected and collected, indicators need to be transformed: deseasonalizing those that require it and applying logarithmic and differencing transformations to all. The deseasonalization method used here is X-13ARIMA-SEATS. Below there is an overview of three factor models used in the paper to extract information from a broad set of high-frequency indicators as effectively as possible. A fundamental characteristic of factor analysis is parsimony, achieved by decomposing each indicator into two parts: the first part represents the common variation of the entire dataset in the form of factors, while the second part is the specific idiosyncratic component that each indicator possesses. Subsequently, for the purpose of nowcasting, these factors, which capture the co-movement of these indicators, are associated with the target variable – Gross Domestic Product. Three variants of factor models will be outlined: firstly, one of the most commonly employed approaches, principal component analysis, which is a static form method. Subsequently, two dynamic factor methodologies will be introduced: one estimated via the two-stage method (Doz, Giannone and Reichlin 2011), and the other via the quasi-maximum likelihood approach. Methods will be presented in the specified order with each subsequent method presenting a level of enhancement to the previous one, as will be explained below.

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

4.1 FACTOR METHODS

4.1.1 Principal component analysis

The starting point is a static method – principal component analysis (PCA), as presented in Stock and Watson (2011). The method is characterised by the following equation:

$$X_t = \Lambda F_t + \xi_t \tag{1}$$

where $X_t = (x_{1t}, ..., x_{nt})'$ are n monthly indicators transformed to be a stationary process. With r denoting the number of common factors, the matrix $\Lambda = (\lambda_{ij})$ is an $n \times r$ matrix of factor loadings, while $F_t = (f_{1t}, ..., f_{rt})'$ represents estimated principal components (common factors). $\xi_t = (\xi_{1t}, ..., \xi_{nt})'$ is an idiosyncratic component. (F_t) and (ξ_t) are two independent stationary processes. PCA directly estimates static factors as linear combinations of indicators, without the need for specifying a model or assuming specific distributions for the disturbances. In this manner, the indicators are decomposed into two orthogonal unobserved processes – the principal component that explains the common variation in the data and the idiosyncratic component, which is driven by variable-specific shocks. Within common variation, the first principal component explains the largest proportion of variance and each subsequent component needs to be orthogonal to the first component, additionally explaining incremental proportions of variance (Abdi and Williams, 2010).

The PCA method solves the next optimization problem:

$$\min_{F_1,...,F_T,\Lambda} V_r(\Lambda, F) \tag{2}$$

$$V_r(\Lambda, F) = \frac{1}{NT} \sum_{t=1}^{T} (X_t - \Lambda F_t)' (X_t - \Lambda F_t) \tag{3}$$

Here V_r denotes the objective function with respect to factors and factor loadings which are treated as unknown parameters to be estimated. The objective function is to be minimised using the least-squares method: the differences between actual observations and estimated observations derived from factors and factor loadings are computed. These differences measure the extent to which the factors adequately explain the variation in the data, thus determining the error variance which is to be minimised. The number of factors could either be constrained to a specific value or set by a certain extraction method.

4.1.2 Dynamic factor model: a two step estimation procedure

The next method employed in the study is the two-step estimation procedure, as presented in Giannone, Reichlin and Small (2008), and Doz, Giannone and Reichlin (2011). The first step of the procedure involves obtaining preliminary estimators of the factors and estimators of the model parameters using the PCA method, which has been shown to provide consistent estimates (Bai and Ng, 2002). This is illustrated in the preceding section by equations (1), (2), and (3). In the second step, dynamics are introduced into the model by estimating the parameters through

a vector autoregression using the ordinary least squares method, thereby enhancing the principal component method:

$$F_t = AF_{t-1} + Bu_t, u_t \sim WN(0, I_q) \tag{4}$$

where A is a $r \times r$ matrix with all roots of $det\ (Ir - Az)$ outside the unit circle and B is a $r \times q$ matrix of full rank q. As r represents the number of dynamic factors, u_t is a q dimensional process of the shocks to the common factors. Aligning with the assumptions of VAR models, u_t is a multivariate white noise process with a zero mean and a variance covariance matrix I_q. The idiosyncratic components ξ_t are cross-sectionally orthogonal white noise:

$$E\left(\xi_t, \xi'_t\right) = \Psi_t \tag{5}$$

$$E\left(\xi_t, \xi'_{t-s}\right) = 0, s > 0 \tag{6}$$

where Ψ_t is a covariance matrix that is therefore assumed to be diagonal. These idiosyncratic components ξ_t are as well orthogonal to the common shocks u_t:

$$E\left(\xi_t, u'_{t-s}\right) = 0, \text{ for all } s. \tag{7}$$

Finally, the Kalman filter is utilised to recursively re-estimate the expected values of the common factors since the model is expressed in a state space form. This could potentially lead to efficiency improvements and it also permits the use of unbalanced panels if necessary.

4.1.3 Quasi-maximum likelihood approach

The third and the final method for factor construction in this paper utilises the quasi-maximum likelihood approach, outlined in Banbura and Modugno (2014). As previously mentioned, each subsequent method represents an enhancement of the previous one, making this method the most sophisticated. Specifically, the previously outlined procedure is repeated: following the estimation of factors via the principal component method as presented in equations (1), (2), and (3), the introduction of dynamics in the form of a VAR model from equation (4) and subsequent recursive re-estimation using the Kalman filter, quasi-maximum likelihood estimation is employed to refine the preceding factor estimates. Specifically, the expectation-maximization (EM) approach is employed to estimate equations (1) and (4) through quasi-maximum likelihood estimation (QMLE).

The joint log-likelihood of the observed indicators (Y), latent factors (F) and parameters (θ) of the model is given by:

$$\begin{aligned} L(Y, F; \theta) = &-\frac{1}{2}\log|\Sigma| - \frac{1}{2} f_0' \Sigma^{-1} f_0 - \frac{T}{2}\log|Q| - \frac{1}{2}\sum_{t=1}^{T} (f_t - Af_{t-1})' Q^{-1} \\ &(f_t - Af_{t-1}) - \frac{T}{2}\log|R| - \frac{1}{2}\sum_{t=1}^{T} (y_t - \Lambda f_t)' R^{-1} (y_t - \Lambda f_t) \end{aligned} \tag{8}$$

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

where Σ represents the covariance matrix of observed variables Y, f_0 denotes the initial values of factors, Q denotes the covariance matrix of factors, and R denotes the covariance matrix of innovations in observed variables Y.

Typically, the EM algorithm consists of two steps. In the first step, known as the E-step, missing values are imputed, therefore serving a useful tool in the case of unbalanced panels, as follows:

$$L\left(\theta,\theta\left(j\right)\right)=\mathbb{E}_{\theta(j)}[L(Y,F;\theta)\,|\Omega_T] \tag{9}$$

where j represents a specific step or iteration, and $\mathbb{E}_{\theta(j)}$ denotes the expectation with respect to the probability distribution dependent on parameters $\theta\left(j\right)$ given the available data Ω_T.

In the second step, known as the M-step, the parameters are re-estimated by maximizing the expected log-likelihood with respect to θ:

$$\theta\left(j+1\right)=arg\max_{\theta} L\left(\theta,\theta\left(j\right)\right) \tag{10}$$

Ultimately, dynamic factors derived from these re-estimated parameters are the quasi-maximum likelihood approach factors.

4.2 FACTOR SELECTION CRITERIA

Factor selection criteria pertain to the methods or criteria used to determine the number of factors to retain in a factor analysis. These criteria aim to strike a balance between capturing enough variance in the data while avoiding overfitting or including redundant factors. Some common factor selection criteria include the Kaiser criterion (retaining factors with eigenvalues greater than 1), the Catelli scree plot method, cross-validation techniques, information criteria and parallel analysis. In this paper, the information criteria approach of Bai and Ng (2002) is considered and described as follows:

$$IC_1\left(r\right)=log\left(V_r\left(\hat{\mathrm{F}},\hat{\Lambda}\right)\right)+r\left(\frac{n+p}{np}\right)log\left(\frac{np}{n+p}\right) \tag{11}$$

$$IC_2\left(r\right)=log\left(V_r\left(\hat{\mathrm{F}},\hat{\Lambda}\right)\right)+r\left(\frac{n+p}{np}\right)log\left(min\left\{n,p\right\}\right) \tag{12}$$

$$IC_3\left(r\right)=log\left(V_r\left(\hat{\mathrm{F}},\hat{\Lambda}\right)\right)+r\frac{log(min\left\{n,p\right\})}{min\left\{n,p\right\}} \tag{13}$$

with the estimated factors $\hat{F}$ corresponding to principal components, the estimated loadings $\hat{\Lambda}$ corresponding to eigenvectors, n denoting the number of indicators used and p denoting the number of lags in the dynamic factor model. In this paper, factors will be derived utilizing the previously presented information criteria, as well as the proportion of explained variance from the corresponding Cattell scree

PUBLIC SECTOR ECONOMICS 49 (2) 185-211 (2025)

plot, analysed at a monthly frequency, together with expert judgment to contribute to the shaping of different models in the subsequent section. Furthermore, in the process of selecting the number of lags in dynamic factor models, the Akaike Information Criterion (AIC), Hannan-Quinn Criterion (HQ), and Schwarz Criterion (SC) will play a pivotal role.

4.3 FROM ESTIMATED FACTORS TO GDP

The next step involves the transformation of r stationary estimates of factors into a nowcast of GDP growth rates. Given that the aim is to assess the quarterly growth rate of seasonally and calendar-adjusted GDP, alongside the prior construction of factors at a monthly frequency, the initial task is to convert these factors to a quarterly frequency. Since the factors are expressed as log differences, i.e., percentage changes, the aggregation can be carried out using the methodology proposed by Mariano and Murasawa (2003), which is specifically designed to handle the transition from monthly to quarterly frequency:

$$\Delta F_t^q = \frac{1}{3}\Delta F_t^m + \frac{2}{3}\Delta F_{t-1}^m + \Delta F_{t-2}^m + \frac{2}{3}\Delta F_{t-3}^m + \frac{1}{3}\Delta F_{t-4}^m \tag{14}$$

Therefore, the aforementioned factors are used as the independent variable in estimating the following regression equation via the OLS method:

$$Y_t = \hat{\alpha} + \hat{\beta}\hat{F}_{it} + \hat{\gamma}D_t + \varepsilon_t \tag{15}$$

In addition to the quarterly factors, the equation also includes a dummy variable D_t, which takes the following form:

$$D_t = \begin{cases} 1 \text{ for COVID quarters} \\ 0 \text{ for other quarters} \end{cases} \tag{16}$$

Here, the COVID quarters are marked within the period Q1 2020 – Q2 2020, given that it was a period in which rigorous epidemiological measures were enjoined, the service sector, not adequately captured by the previously selected indicators that constitute the factors, experiencing significant disruption in economic activity.

Furthermore, following the estimation of the aforementioned regression equation, it is possible to generate nowcasts of both the annual and the quarterly growth rate of seasonally and calendar-adjusted GDP. As previously mentioned, all monthly indicators utilised in constructing quarterly factors are available 30 days after the end of each quarter, or 30 days prior to the initial estimation of quarterly GDP by the Croatian Bureau of Statistics, enabling a highly accurate forecast of the aforementioned GDP growth rates for the period $t + 1$. Moreover, by utilizing the Kalman filter or the EM algorithm to handle missing data, it is possible to perform this estimation with considerable accuracy even earlier, using only two out of three months of available monthly indicators for the construction of the quarterly factor. This approach may be available on the last day of a given quarter to assess GDP in that quarter, or 60 days prior to the first estimate provided by the Croatian Bureau of Statistics.

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

4.4 PREDICTIVE PERFORMANCE EVALUATION

In the following section, different models for nowcasting will be formulated based on the factor estimation method employed and the structure of *r* specific factors. Assessing the predictive performance of each model is pivotal in determining the optimal framework for promptly evaluating the state of economic activity in Croatia. These models may demonstrate varying performances depending on a range of elements, including country-specific dynamics, levels of aggregation, different time periods, and the impacts of specific economic shocks. Consequently, it is crucial to identify an appropriate loss function to assess the deviations between projected and actual GDP data for a given quarter. In this paper, the predictive performance of the models will be evaluated out-of-sample using the root mean squared error (RMSE) measure. This choice is motivated by its robust penalization of relatively large forecasting errors compared to smaller deviations:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{N} (y_t - \hat{y}_t)^2}{N}} \tag{17}$$

Dauphin et al. (2022) utilise the RMSE, taking its inverse for each model as a weight to generate an estimation that is the weighted average of multiple models. The sample period from Q4 2008 to Q4 2013 serves exclusively as the training dataset. Subsequently, by incrementally incorporating new monthly data and re-estimating the model, nowcasts are generated for the period beginning in Q1 2014. As mentioned, models may exhibit different performance during stable periods compared to periods of rapid economic downturn or recovery. Therefore, when comparing models based on RMSE, it is taken into account how the models performed before the COVID-19 pandemic, up to Q4 2019, and after the recovery phase, from Q1 2023 onwards. The period from Q1 2020 to Q4 2022 is excluded from the comparison due to the significant exogenous shock and the quick recovery from it.

5 EMPIRICAL RESULTS

5.1 DEMONSTRATION OF MODELS

In this section, a comparative analysis of various models is undertaken, together with their efficiency in generating accurate nowcasts of GDP for the Republic of Croatia. The section is structured into three different parts: the first part illustrates nine different models, each constructed according to the factor extraction method employed and the arrangement of variables. The second part involves a comparative analysis of the performance of these models against each other and relative to a benchmark. The final part provides a detailed exposition on the construction of the finally selected model. As previously specified, the models are classified into three categories according to the factor extraction methods utilised. These categories are assigned as follows: Model A, which relates to static factors derived by using the principal component method; Model B, which relates to dynamic factors derived by using the two-stage method; and Model C, which refers to dynamic factors derived by using the quasi-maximum likelihood method. This classification is presented in a table where each row corresponds to a distinct method employed for factor estimation. Additionally, the final models differ in the manner in which *N* indicators are aggregated into *r* factors.

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

In the first case, represented by Model 1, a naive method is employed wherein all indicators are joined, and factors are extracted from the entire dataset utilised for nowcasting. Thus, the first column in the ensuing table represents these "naive" extracted factors. The second and third case incorporate an element of expert judgment, resulting in "structurally" extracted factors. This approach is employed in nowcasting models and typically results in improved model performance (Dauphin et al., 2022). Here, the comprehensive dataset is divided into multiple clusters, each producing its own factor(s) informed by the characteristics of a small, open economy. These clusters are divided into specific datasets of interest, from which structurally extracted factors are estimated, following the approach of Kunovac and Špalat (2014). In contrast to methods involving the simultaneous estimation of factors with constraints on factor loadings, this approach compromises factor orthogonality. In Model 2, represented by the second column of the table, factor extraction is based separately on domestic variables and foreign variables of interest. Models in group 3, represented by the third column of the table, further segment the dataset in such a way that, in addition to domestic and foreign variables, a cluster is created that encompasses "soft variables", i.e., combined domestic and foreign confidence indicators.

Table 2
Model demonstration and description

Variable selection criterion	**Naive extraction**	**Structured extraction: domestic and foreign**	**Structured extraction: domestic, foreign and soft**
Method employed		**Models**	
Principal component method	1A	2A	3A
DFM: two-stage method	1B	2B	3B
DFM: QML method	1C	2C	3C

Source: Author.

As previously outlined, indicators including the period from May 2008 to March 2024 were considered, encompassing 21 monthly indicators, both domestic and foreign, as well as both "hard" and "soft" indicators crucial for nowcasting quarterly GDP growth rates from the fourth quarter of 2008 to the first quarter of 2024. In assessing the predictive power of individual models, aside from reviewing RMSE measures over the entire period, the evaluation will also be partitioned into the pre-COVID period, up to Q4 2019, and the post-COVID period, from Q1 2023 onwards. As previously explained, the period of the COVID-19 pandemic is regarded as a period of significantly disrupted economic activity, particularly in the services sector. Accordingly, dummy variables for Q1 and Q2 of 2020 are incorporated in specific models, as needed.

A question that may arise is whether different rules should apply in nowcasting, i.e., whether separate models should be used for the first part of the subset

(Q4 2008 – Q4 2019) and the second part of the subset (Q1 2023 onwards). This matter emerges with the increasing significance of EU funds in the Croatian economy, which may not be adequately captured by indicators available for nowcasts, considering these funds may have an asymmetric impact on certain components of the economy. Nonetheless, here it is assumed that the contribution of EU funds to the Croatian economy is visible through the indicator of construction activity and final consumption, represented by the retail trade turnover indicator, and spills over to other indicators. However, further considerations regarding the sectoral neutrality of EU funds and the impact of this phenomenon on nowcasting for a small, open economy remain for future research.

On April 22, 2024, the Croatian Bureau of Statistics published a revision of the gross domestic product, incorporating revisions to product subsidies, tax revenue, and government expenditure, to align with national accounts data (Pejković et al., 2024). As a result, the analysis employs these revised data.

5.2 EVALUATING NOWCAST MODEL ACCURACY

In table 3, the results of the assessment of the models utilised were evaluated under the assumption that all monthly indicators for the quarter being forecasted are known for all three months. Additionally, the nowcast for the GDP growth rate for the first quarter of 2024 is presented. The RMSE indicator, which assesses the performance of each individual model, is compared to the RMSE of the benchmark model, which is based on a random walk. Additionally, the analysis includes an AR(1) model, an ARIMA (1,1,1) model, Domestic Only model based on a domestic principal component, and a bridge model based on a straightforward two-variable setup using industry and retail data for comparative purposes.

It is evident that all models outperform the benchmark model of random drift in all subsamples. Furthermore, models of group 1, defined by naive factor extraction, unsurprisingly yield the poorest results overall. Moreover, in the subsample Q1 2014 – Q4 2019 the performance of dynamic variants of group 1 models is equal to or worse than that of the simple ARIMA (1,1,1) model. Models in groups 2 and 3 are significantly more successful in explaining the dynamics of GDP, confirming the importance of clustering indicators into domestic and foreign categories in the case of a small, open economy like Croatia. When analysing the performance of models based on structural factor extraction, group 2 models generally show slightly better performance than models of the group 3, which are one step more structured. This confirms that at one point, there is a certain trade-off between the structure and simplicity of the model. The key result is that in the case of Croatia, within each of these three groups of models, principal component models, which are the simplest, outperform others. This precision of PC models may be a result of capturing signals from the dynamics of previous periods, which can be damaging in the case of more unstable dynamics of the indicators themselves.

Table 3

Evaluating Nowcast Model Accuracy: RMSE with Q1 2024 projection

GDP nowcast		RMSE			Number of lags
Model	**Q1 2024 (%)**	**Q1 2014 – Q4 2019**	**Q1 – Q4 2023**	**Q1 2014 – Q1 2024**	*p*
1A	1.04	0.76	0.62	0.61	–
1B	1.03	0.74	0.66	0.62	2
1C	0.87	0.76	0.64	0.67	2
2A	**1.00**	**0.61**	0.61	**0.55**	**–**
2B	1.16	0.62	0.62	0.65	2
2C	0.85	0.67	0.62	0.64	2
3A	1.43	0.68	**0.58**	0.57	–
3B	1.32	0.68	0.61	0.58	3
3C	0.60	0.70	0.68	0.60	3
AR	0.21	0.75	0.68	0.82	1
ARIMA	0.84	0.62	0.73	1.02	1
Domestic-Only	1.05	0.64	0.67	0.73	–
Industry & Retail	1.04	0.75	0.86	0.58	–
RW	1.99	1.00	1.00	1.00	–

Source: Author's calculation.

Therefore, in the subsample Q1 2014 – Q1 2019 and throughout the entire time horizon, Model 2A is the most precise, while Model 3A has a slightly better performance in the post-COVID period. While the "Industry & Retail" model exhibits relatively poor predictive performance in both the pre-COVID and post-COVID subsamples, it demonstrates significantly improved accuracy over the entire observed period, approaching the precision of the best-performing models. This might be attributed to its relatively superior performance during the COVID period. It is also noteworthy that the ARIMA (1,1,1) model performs exceptionally well in the pre-COVID period, outperforming most other models, likely due to the relatively stable economic growth observed between 2014 and 2019. However, its predictive accuracy deteriorates markedly over the entire time horizon and the post-COVID period.

The estimated nowcast given by model 2A for Q1 2024 was 1.00%, which is consistent with the annual growth rate of seasonally and calendar-adjusted GDP of 3.94%. The initial estimate of the quarterly GDP growth rate in the given quarter is 0.96%, or 3.89% annually. In this case, the nowcast based on Model 2A proved to be as precise as the initial estimate of the quarterly GDP growth rate in the fourth quarter of 2023.

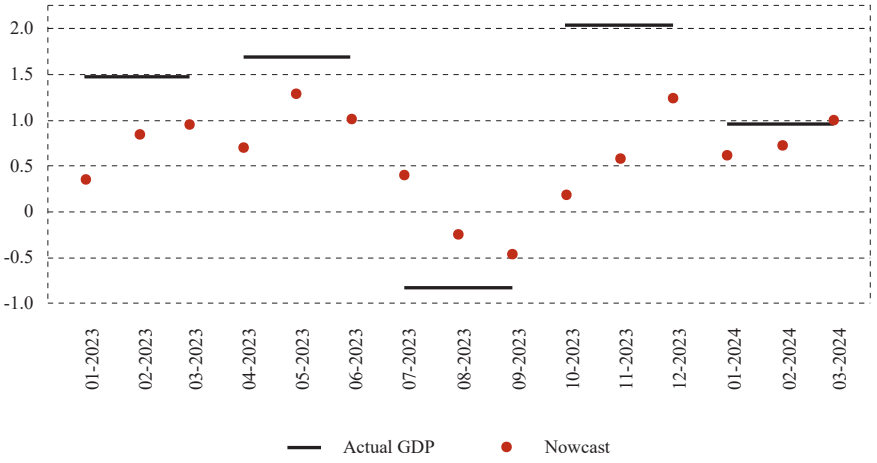
Although the Principal Component (PC) method embedded in models of group A yields the best results, dynamic models of groups B and C, utilizing the Kalman filter, facilitate the generation of nowcasts even in the presence of missing values

for the second or third month of a given quarter. Thus, considering Model 2B, it is possible to produce relatively accurate nowcasts even earlier, specifically on the last day of the second month of the quarter or on the last day of the quarter itself. In the case of complete data, Model 2A was employed. Figure 2 illustrates the nowcast of GDP with missing values from Q1 2023 to Q1 2024, alongside the actual data. The method demonstrates relative accuracy in cases of missing values for the third month of the quarter, with the exception of Q4 2023, where significant deviations occur.

Given that Model 3A has demonstrated a precision improvement of 4.9% over Model 2A in the period following Q1 2023, a relevant question arises as to whether structural changes have indeed occurred, as discussed in the preceding chapter. These changes may be linked to the aforementioned EU funds, the entry into the Eurozone and the Schengen Area, or certain structural changes of the economy relative to the pre-COVID period. Altogether, another key finding is that structuring in this manner is important, whether it involves clustering into domestic and foreign indicators, or into domestic, foreign, and soft indicators. However, given that only four quarters have been observed so far, additional observations are necessary to provide a more precise assessment of which model is superior and whether model averaging would lead to superior results. Consequently, a more detailed description of the structure and results of Model 2A will follow.

FIGURE 2

Nowcasting GDP with missing values in the post-pandemic period, quarterly growth rates (%)



Source: Croatian Bureau of Statistics, author.

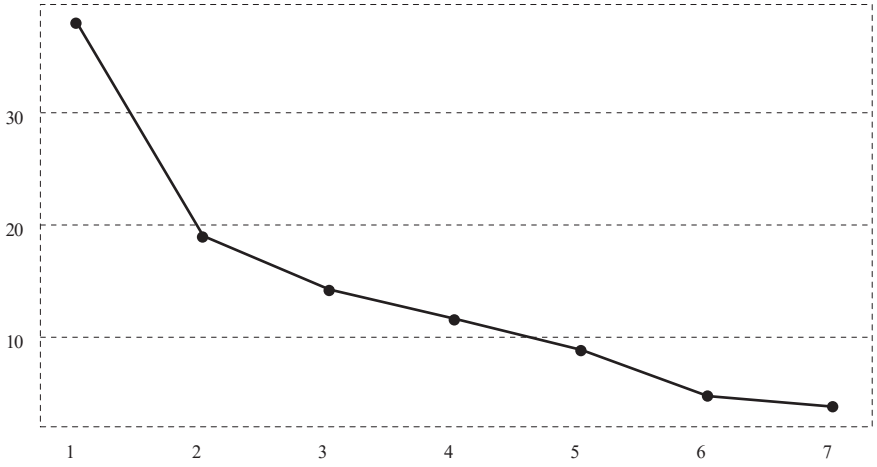
PUBLIC SECTOR ECONOMICS 49 (2) 185-211 (2025)

5.3 THE MODEL 2A

As previously mentioned, in Model 2A, structural factor extraction was employed by clustering indicators into domestic and foreign categories. It is noteworthy that one of the specifications in Kunovac and Špalat (2014) considers a similarly structured model, albeit with significantly different external indicators. From Cattell's diagram represented in figure 2, the information criteria approach of Bai and Ng (2002), as well as previous testing of the model with different numbers of factors, two common components were ultimately accepted, one from the foreign and one from the domestic cluster. In figure 2, it can be observed that the first principal component explains 37.9% of the total variance from the cluster of domestic indicators, while each subsequent one explains less than 20%.

FIGURE 3

Scree plot visualization for domestic indicators, variance explained (%)



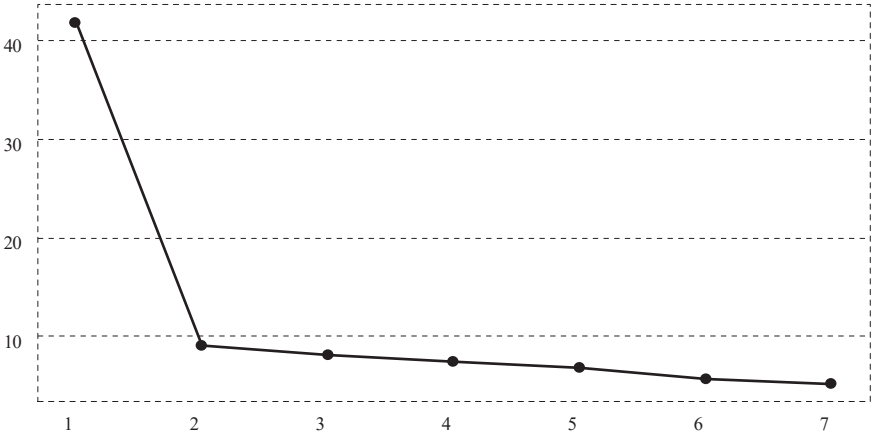
Source: Author's calculation.

Similarly, from the foreign cluster, the first principal component extracted explains 41.9% of the total variance among indicators, as evident in figure 3. Each subsequent principal component, orthogonal to the first, carries even less than 10% of the explained total variance. Despite this, other model specifications with more than one factor from each cluster were tested, but proved to yield results inferior to those of the selected model. However, it should be noted that the indicators were primarily selected to describe the dynamics of GDP as well as possible. Thus, these results should have been expected and may be a consequence of subsequent orthogonal principal components being orthogonal to GDP itself, thereby introducing some noise into the model.

PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

FIGURE 4

Scree plot visualization for foreign indicators, variance explained (%)

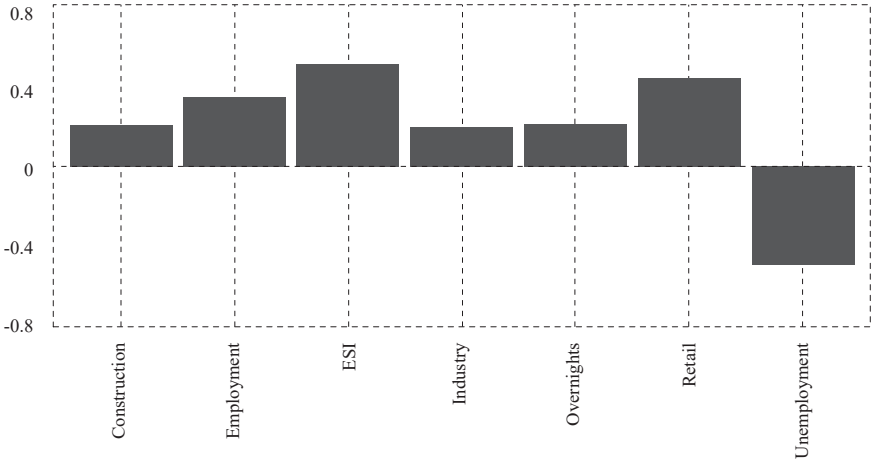


Source: Author's calculation.

In figure 4, the factor loadings extracted from the factor structure matrix for the cluster of domestic indicators are displayed. These factor loadings illustrate the importance of each indicator, or its contribution to the common principal component, as they can be interpreted as correlation coefficients. The highest factor loading on the latent factor is attributed to the economic sentiment indicator – Croatia, precisely 0.52, confirming the usefulness of soft indicators in nowcasting economic activity. Following closely is the retail trade turnover – Croatia, with a loading of 0.45, which makes sense considering its strong explanatory power for personal consumption, a significant component of GDP. As expected, the unemployment rate is the only indicator negatively correlated with the latent factor, with a loading of -0.51.

FIGURE 5

Factor loadings on the domestic principal component, correlation coefficients



Source: Author's calculation.

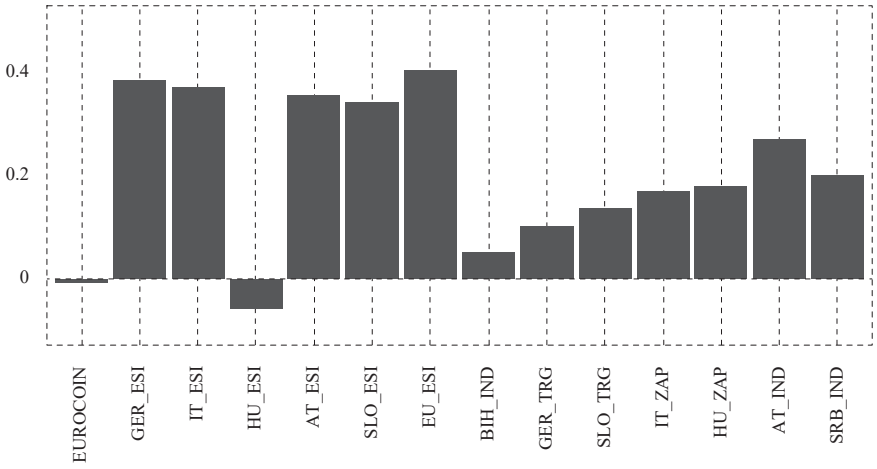
PUBLIC SECTOR ECONOMICS
49 (2) 185-211 (2025)

On the other hand, for the foreign latent factor, factor loadings visible in figure 5 are generally smaller, which makes sense given the larger number of economies and various indicators involved. Indicators such as Eurocoin, economic sentiment – Hungary, and industrial production – Bosnia and Herzegovina have proven to be practically unnecessary, as they exhibit very low factor loadings on the latent factor, with economic sentiment – Hungary surprisingly showing a negative factor loading. This confirms that the EUROCOIN indicator largely disregards short-term fluctuations in GDP. Furthermore, soft indicators for other countries used in the analysis show a strong contribution to the principal component, remaining just below 0.4. Among them, the economic sentiment indicator at the EU level stands out with a loading of 0.41. On the other hand, among the hard indicators, Austrian industrial production is the closest to the common component.

Ultimately, as previously mentioned, both the domestic and foreign principal components are directly linked to GDP, and based on this relationship, a nowcast is projected for the upcoming quarter. In the case of model 2A, the COVID dummy variable did not prove to be significant in creating the nowcast.

Figure 6

Factor loadings on the foreign principal component, correlation coefficients



Source: Author's calculation.

Furthermore, table 4 displays the autocorrelation function of the residuals of model 2A along with the corresponding p-value of the Ljung-Box test. The results indicate that autocorrelation is not significant at the first 6 lags, suggesting that the residuals, except for the COVID quarters, cannot be statistically distinguished from white noise. This suggests that these two principal components, each extracted from its own cluster of monthly indicators, capture the majority of the GDP dynamics.

TABLE 4

Autocorrelation function of the residuals – Model 2A

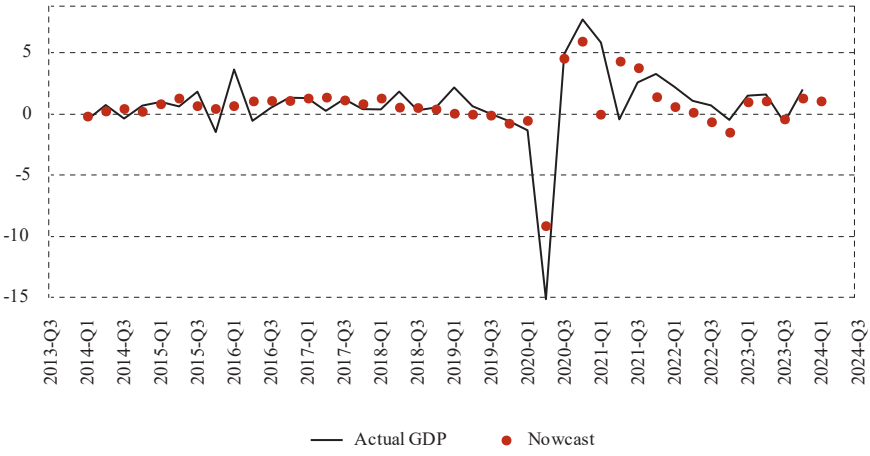
Lag	1	2	3	4	5	6
ACF	-0.15	0.03	-0.30	0.03	0.12	0.12
p-value	0.22	0.46	0.06	0.12	0.14	0.15

Source: Author's calculation.

Figure 7 represents a comparison between the growth rate values of GDP nowcast and actual GDP growth rates during the evaluated period, from the third quarter of 2008 to the fourth quarter of 2023, along with the corresponding nowcast for the first quarter of 2024. Additionally, this graphical representation based on increased residual deviations clearly illustrates distortions in monitoring economic activity during the shocks caused by the COVID-19 virus and the subsequent recovery from the pandemic.

FIGURE 7

Evaluating GDP nowcasts: a quarterly comparison with actuals, quarterly growth rates (%)



Source: Croatian Bureau of Statistics, author.

From these data, it is possible to detect a satisfactory 77.5% correct direction of change throughout the observed period, as well as 80% accuracy in the direction of change after the pandemic. Supporting this model is the out-of-sample forecast for Q1 2024 as well, considering that the difference between the model-estimated 1.00% quarterly growth and the real GDP growth estimate of 0.96% is low. Thus, the GDP nowcast for the first quarter of 2024 is somewhat accurate on an annual basis, with the estimated 3.94% annual growth deviating by only 0.05 percentage points from the initial GDP estimate of 3.89% by the Croatian Bureau of Statistics.

6 DISCUSSION

The main focus of this section is to discuss the variables used, empirical results, and further research possibilities in this field, with particular reference to fiscal policy makers. Given that one of the primary purposes of nowcasting is to provide timely information on economic activity, and considering that Eurostat and the Croatian Bureau of Statistics already have flash estimates of inflation on the last day of the month for the reference month based on 80 to 90% of the received and processed data, any future step that shortens the time required to obtain information on economic activity indicators such as retail trade, industry, or construction will be of value in the context of nowcasting, and thus in the context of better economic policy manoeuvring to minimise losses within its objective function. Furthermore, statistical offices might focus on real turnover, as is the case with retail trade, in the context of an indicator that takes precedence in release, i.e., first provides information on the industrial sector's performance. Real industry turnover should be a better measure of value-added in industry than the volume or quantity of production, and at the moment lags by a month. The primary advantage of this indicator is that the same production volume in physical units, utilizing advanced technologies and skill-rich human capital, can yield significantly higher value-added.

In the context of selecting models for nowcasting economic activity, in certain cases, a weighted average of multiple models may produce better results than individual models, as noted by Kunovac and Špalat (2014). In the case of the models presented in this study, it would probably be advisable to exclude naive models of group 1 from the weighted average, as they create significant noise in the absence of any clear distinction of foreign indicators. The mentioned study constructs a model-based monthly GDP using nowcasting models, which can be useful in various kinds of research as well as for discretionary economic policy. This can also be achieved with this model using the Chow-Lin method for temporal disaggregation of data, utilizing latent principal components as independent variables. Additionally, as mentioned earlier in the study, it is possible to further investigate the impact of the dynamics of EU fund inflows on real economic activity in the context of nowcasting, particularly during the 2021-2027 period, in which they play a crucial role for dynamics of movement of GDP in Croatia. When testing the validity of the model during periods when incomplete assessment is conducted using an unbalanced panel, such as the first or second month of the quarter, model 2B has been proven to be a good substitute for model 2A, given its slightly higher RMSE but the use of the Kalman filter for handling missing values.

As previously noted, understanding the process of creating a reliable nowcast of economic activity is crucial for decision-making or revising decisions at all levels, starting from economic policy makers at all levels of government, financial and non-financial enterprises, especially larger ones. However, the greatest added value to Croatia of having its own nowcast model would be for fiscal policy at the state level, particularly in the context of smoothing business cycles for a new

member of the monetary union adapting to new channels of monetary policy transmission. Furthermore, for this country, it would be very important to have a completely independent nowcast from the central banker while accompanying the pooling of knowledge and experience with certain methods. In this case, any positive or negative impulse from the nowcast estimate in relation to expectations would facilitate budget planning and make it more precise, ultimately aiming to increase general welfare in the economy. At the same time, the nowcast identifies the extent of fiscal space available to avoid the excessive deficit procedure and consequently minimise the creation of its own minor asymmetric shocks through increased risk premiums in government bond yields or generally.

7 CONCLUSION

In recent years, various computational techniques have evolved to exploit to the full all the information available when a nowcast is being produced. According to the comprehensive analysis presented, the development and application of models forecasting the current state of GDP in Croatia carry significant implications, particularly for the implementation of fiscal policy.

While conducting a nowcast in a small, open economy, particularly one intricately linked within a large economic unit, it is crucial to acknowledge the significance of incorporating foreign variables, such as high-frequency hard data and confidence indicators, to improve the predictive power of models. In this context, the research results highlight the effectiveness of applying structural factor extraction methods in capturing the fundamental dynamics of Croatia's GDP movement. Importantly, simpler models, such as those utilizing principal components, often outperform more complex dynamic factor models when building nowcasting models as it is presented in this paper, thus underscoring the importance of parsimony in model selection.

In the spotlight is the discussion on the potential repercussions of timely knowledge about the movement of economic activity for decision-making, implementation, and planning within the evolving time horizon of various economic subjects. Furthermore, of particular significance is the ability to forecast GDP movements with precision, enabling fiscal policymakers to make timely and informed decisions, thereby optimizing resource allocation and reducing the adverse effects of economic fluctuations. Given Croatia's status as a new member of the Eurozone, the importance of accurate forecasting becomes even more pronounced as it facilitates the adjustment of the business cycle by fiscal policy while the domestic economy adapts to the common monetary policy through new channels of monetary transmission. Moreover, given that the behaviour of the financial system within that framework is still being established during this period, there is a possibility of an asymmetric impact of the ECB's monetary policy emerging relative to the eurozone in general.

Additionally, the research identifies opportunities for further investigation and refinement of models forecasting the current state, including exploring the impact of EU fund inflows on real economic activity and suggesting advanced techniques for handling missing data. By continuously enhancing the sophistication and accuracy of the forecasting methodology of two independent nowcast models alongside ongoing communication, policymakers could improve their ability to predict economic trends and proactively respond to emerging challenges.

In conclusion, the development and application of models forecasting the current state of gross domestic product in Croatia represent a critical initiative with wide-ranging results for fiscal policy and overall economic stability. Through thorough empirical analysis and methodological refinement, these models will/can serve as fundamental tools for decision-making in all sectors, ultimately contributing to the overall prosperity and welfare of the Croatian economy.

Disclosure statement

The author has no conflict of interest to declare.

REFERENCES

1. Abdi, H. and Williams, L. J., 2010. Principal component analysis. *WIREs Computational Statistics*, 2(4), pp. 433-459. https://doi.org/10.1002/wics.101
2. Agency for Statistics of Bosnia and Herzegovina, 2024. Available at: https://bhas.gov.ba/?lang=en
3. Angelini, E. [et al.], 2008. Short-term forecasts of euro area GDP growth. *ECB Working Paper,* No. 949. https://doi.org/10.2139/ssrn.1275821
4. Arčabić, V., 2018. Usklađenost poslovnih ciklusa Republike Hrvatske sa zemljama Europske unije. *Zbornik radova znanstvenog skupa: Modeli razvoja hrvatskog gospodarstva*, pp. 157-176.
5. Arnoštová, K. [et al.], 2011. Short-Term Forecasting of Czech Quarterly GDP Using Monthly Indicators. *Czech Journal of Economics and Finance*, 61(6), pp. 566-583.
6. Bańbura, M. and Modugno, M., 2014. Maximum likelihood estimation of factor models on datasets with arbitrary pattern of missing data. *Journal of Applied Econometrics*, 29*(*1), pp. 133-160. https://doi.org/10.1002/jae.2306
7. Bai, J. and Ng, S., 2002. Determining the number of factors in approximate factor models. *Econometrica,* 70(1), pp. 191-221. https://doi.org/10.1111/1468-0262.00273
8. Bai, J. and Ng, S., 2008. Forecasting economic time series using targeted predictors. *Journal of Econometrics,* 146(2), pp. 304-317. https://doi.org/10.1016/j.jeconom.2008.08.010
9. Banca d'Italia, 2024. Available at: https://www.bancaditalia.it/
10. CBS, 2024. Available at: https://dzs.gov.hr/
11. Croatian National Tourist Board, 2024. Available at: https://croatia.hr/en-gb
12. Dauphin, J. F. [et al.], 2022. Nowcasting GDP – A Scalable Approach Using DFM, Machine Learning and Novel Data, Applied to European Economies. *IMF Working Paper*, No. 22/52. https://doi.org/10.5089/9798400204425.001
13. Doz, C., Giannone, D. and Reichlin, L., 2011. A two-step estimator for large approximate dynamic factor models based on Kalman filtering. *Journal of Econometrics*, 164(1), pp. 188-205. https://doi.org/10.1016/j.jeconom.2011.02.012
14. Doz, C., Giannone, D. and Reichlin, L., 2012. A Quasi-Maximum Likelihood Approach for Large, Approximate Dynamic Factor Models. *The Review of Economics and Statistics*, 94(4), pp. 1014-1024. https://doi.org/10.1162/REST_a_00225
15. Eurostat, 2024. Available at: https://ec.europa.eu/eurostat/en/
16. Federal Statistical Office of Germany, 2024. Available at: https://www.destatis.de/EN/Home/_node.html
17. Foroni, C. and Marcellino, M., 2014. A comparison of mixed frequency approaches for nowcasting euro area macroeconomic aggregates. *International Journal of Forecasting,* 30(3), pp. 554-568. https://doi.org/10.1016/j.ijforecast.2013.01.010
18. Giannone, D., Reichlin, L. and Small, D., 2008. Nowcasting: The real-time informational content of macroeconomic data. *Journal of Monetary Economics*, 55(4), pp. 665-676. https://doi.org/10.1016/j.jmoneco.2008.05.010

19. Giovanelli, A. [et al.], 2020. Nowcasting GDP and Its Components in a Data-rich Environment: the Merits of the Indirect Approach. *CEIS Research Paper*, No. 489. https://doi.org/10.2139/ssrn.3614110
20. Hungarian Central Statistical Office, 2024. Available at: https://www.ksh.hu/?lang=en
21. Italian National Institute of Statistics, 2024. Available at: https://www.istat.it/en/
22. Kunovac, D. and Špalat, B., 2014. Brza procjena BDP-a upotrebom dostupnih mjesečnih indikatora. *Istraživanja Hrvatske narodne banke,* I-42.
23. Mariano, R. S. and Murasawa, Y., 2003. A new coincident index of business cycles based on monthly and quarterly series. *Journal of Applied Econometrics*, 18(4), 427-443.
24. Pejković, I. [et al.], 2024. Quarterly gross domestic product, revised data by quarters. *Croatian Beurau of Statistics,* NR 2023-1-2.
25. Republic of Slovenia Statistical Office, 2024. Available at: https://www.stat.si/statweb/en
26. Rusnák, M., 2016. Nowcasting Czech GDP in real time. *Economic Modelling,* 54(C), pp. 26-39. https://doi.org/10.1016/j.econmod.2015.12.010
27. Sargent, T. J. and Sims, C. A., 1977. Business cycle modeling without pretending to have too much a priori economic theory. *New methods in business cycle research*, 1, pp. 145-168.
28. Schumacher, C. and Breitung, J., 2008. Real-time forecasting of German GDP based on a large factor model with monthly and quarterly data. *International Journal of Forecasting*, 24(3), pp. 386-398. https://doi.org/10.1016/j.ijforecast.2008.03.008
29. Schumacher, C., 2014. Midas and Bridge Equations. *Bundesbank Discussion Paper,* No. 26/2014. https://doi.org/10.2139/ssrn.2797010
30. Statistical Office of Republic of Serbia, 2024. Available at: https://www.stat.gov.rs/en-us/
31. Statistics Austria, 2024. Available at: https://www.statistik.at/
32. Stock, J. H. and Watson, M. W., 2011. Dynamic Factor Models, Factor-Augmented Vector Autoregressions, and Structural Vector Autoregressions in Macroeconomics. *Oxford Handbook on Economic Forecasting*, pp. 418-443. https://doi.org/10.1093/oxfordhb/9780195398649.013.0003
33. Škrinjarić, T., 2023. Introducing a composite indicator of cyclical systemic risk in Croatia: possibilities and limitations. *Pubic Sector Economics*, 47(1), pp. 1-39. https://doi.org/10.3326/pse.47.1.1
34. Tsuruga, T. and Wake, S., 2019. Money-Financed Fiscal Stimulus: The Effects of Implementation Lag. *CAMA Working Paper,* No. 12/2019. https://doi.org/10.2139/ssrn.3328295
35. Visco, I., 2007. *€-coin and the growth outlook for the euro area*. Presentation at the CEPR meeting on "After a volatile summer, where do we stand?" London, 20 September.

Analysis of internal communication in public companies in Croatia

JOSIP POLJAK, Ph.D.*

Article**
JEL: J28, M14
https://doi.org/10.3326/pse.49.2.2

* The author would like to thank two anonymous reviewers for their valuable comments.

** Received: May 15, 2024
Accepted: July 18, 2024

Josip POLJAK
Assistant Professor, Catholic University of Croatia, Ilica 242, 10000 Zagreb, Croatia
e-mail: josip.poljak@unicath.hr
ORCiD: 0009-0008-1732-6820

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

Abstract

The paper analyses the effectiveness of internal communication in public companies in Croatia and its impact on employee satisfaction after market changes. Research on internal communication and its effects on employee satisfaction was conducted with a sample of 1,342 respondents from three large public companies (these companies employ more than 23% of the total workforce belonging to large public companies in Croatia). The results obtained from a hierarchical regression analysis indicate that satisfaction with internal communication (44.3%) is more significantly related to overall job satisfaction than sociodemographic characteristics (total length of service in the company, employment type, managerial position in the company, sex, age group and highest level of education) (5.2%). In conclusion, when employees in public companies in Croatia receive clear information about their organization's goals, expectations, results, and progress, they feel informed and engaged, which positively influences their job satisfaction.

Keywords: internal communication, employee satisfaction, public companies, feedback

1 INTRODUCTION

Ensuring basic labour rights in public companies does not guarantee employee satisfaction and motivation (Kimeli Cheruiyot and Chemngetich Maru, 2014). There is an increasing need for employees in public companies to be involved in communication through a two-way exchange of information. In addition, a lack of efficient and timely communication often results in missed business opportunities, which causes public companies to lag behind private competitors, leading to an increase in employee dissatisfaction. Problems in internal communication and lack of transparency directly affect employees' trust in management, reducing their motivation to work, which is reflected in user satisfaction and overall business performance. Internal communication plays a key role in improving organizational efficiency and is reflected in external communication. Specifically, the quality of public companies is continuously under scrutiny from the public, and the best ambassadors for public companies should be their satisfied employees. It is therefore necessary to build quality relationships within an organization in order to influence a positive working atmosphere. For the above reasons, determining the current state of public companies is necessary to define guidelines for adapting organizational culture so that employees, through internal communication, develop beliefs that support the planned activities and strategies of public companies.

To determine the connection between internal communication and employee satisfaction in public companies, a survey of employee satisfaction in three large public companies, Croatian Post, Croatian Lottery, and the HŽ Passenger Transport Company, was conducted. The selected public companies were included in this study because they have more than 1,000 employees territorially dispersed throughout Croatia, allowing for a representative sample and ensuring that the research results are not predominantly tied to a particular region. Additionally, the

PUBLIC SECTOR ECONOMICS 49 (2) 213-238 (2025)

selection factors were the diversity of the primary activities or basic functions of the researched public companies, in addition to a need to restructure and adapt from a monopolistic position to classic market competition. Croatian Post operates entirely in an open market in all major areas, including postal and financial services, as there are alternative services from competitors even for universal postal services. Croatian Lottery operates partially in an open market, particularly with respect to betting, casino and slot machine games. However, even in the protected area of lottery games, there is illegal competition, which mainly operates using online portals. Unlike the two previously mentioned public companies, HŽ Passenger Transport Company still holds a monopoly, but only in its core business of passenger transportation via domestic rail transport.

In terms of large public companies with more than 1,000 employees, there are in all 53,648 employees, 23.16% of whom work in the three participating public companies (Lider, 2023). This research used a sample of 1,342 respondents, representing more than 10% of the employees of the observed public companies. This research was conducted in the last quarter of 2022 using a questionnaire designed to assess satisfaction with internal communication in the workplace. The responses were analysed collectively for all respondents across all three public companies that participated in the study.

1.1 INTERNAL COMMUNICATION

Effective internal communication is especially valuable in public companies because it fosters quality relationships within the organization, leading to a better work environment for conducting business processes. This, in turn, results in more successful operations and enhanced positive perception of the public company. Communication with employees influences the implementation of changes, efficiency, and employee satisfaction and trust, ultimately being reflected in task execution and the quality of services provided by the public company.

Internal public relations and internal communication are becoming increasingly important components of public relations systems within companies in which the employees of a specific company represent its internal public (Skoko, 2006: 259). Internal communication is the deliberate use of various communication activities to consciously influence the knowledge, attitudes, and behaviour of current employees (Yeomans, 2006: 334), with two-way communication considered a key tool for successful organizational management and achieving objectives (Ćorić, 2019: 119). Therefore, in all definitions of internal communication, there is joint emphasis on the role of management and leadership, indicating that "internal communication is related to the management function in all contexts" (Tomić, 2016: 794). In other words, internal communication is considered a valuable tool for the management of a company and its employees (Skoko, 2006: 260).

Therefore, we can conclude that internal communication is a communication process within a company which occurs among its employees on various levels. It can

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

encompass the delivery of news and information from management to the employees and vice versa. Furthermore, it also includes communication between teams and employees, i.e., all forms of formal and informal communication in the company.

Unfortunately, many public companies only focus on the benefits and advantages of working at a company. Even though these factors are important, they are not crucial to employee satisfaction. Specifically, "when an organization faces a crisis, the most important currency is no longer financial, but informational" (Kanajet and Jakopović, 2019: 58). In order to achieve a positive workplace experience, it is necessary to ensure honest, open, two-way communication between management and employees, as well as genuine care and understanding of employees' problems from the side of management.

Effective internal communication affects employee satisfaction, which is then reflected in their productivity and, ultimately, in the company's success. It is correlated with employees' motivation and job satisfaction, resulting in greater work efficiency and better performance of entire organizations (Bolfek, Milković and Lukavac, 2017; Brnad, Stilin and Tomljenović, 2016).

However, internal communication must be reciprocal. This means that the organization needs to listen to its employees and offer them an opportunity to express their opinions and concerns. When employees feel that their voices are heard, trust and loyalty are built, which also contributes to their job satisfaction (Ruck, Welch and Menara, 2017). Managers must be familiar with the events at the organization, while the employees need to have a thorough understanding of their responsibilities and manners of working. In addition, managers looking for feedback should be ready to accept criticism in order to foster a productive communication climate (Rouse and Rouse, 2005: 65).

1.2 PUBLIC COMPANIES

Public companies are companies or organizations where the state owns a majority share or controls the management. Depending on the political and economic environment, the state may have different levels of participation in the ownership and management of enterprises (Kimeli Cheruiyot and Chemngetich Maru, 2014). In some cases, the state may have full control, while in others, it may have a minority stake or control only over key decisions, such as product and service price restrictions on the market. The reasons for state ownership can vary, including the desire to preserve strategic resources, provide key services to citizens, or control certain markets. The negative aspects of state ownership are potential problems such as political influence, bureaucracy, and lack of innovation or efficiency.

For EU member states, there is no unified overall approach to public companies, i.e., regarding state ownership. This diversity is a result of the different strategies and priorities adopted by each individual member state toward maintaining a balance between market competition and state intervention in the economy. Thus, in

the economies of EU member states characterized by open access to the market and minimal state intervention, such as the Netherlands, state ownership is focused on only a few key economic sectors. On the other hand, countries with high levels of social sensitivity, such as the Nordic countries of Finland and Sweden, and most post-transition countries, have a larger share of state ownership in a diverse range of economic sectors. In other EU member states, the state plays a significant role, but this role is limited to selected economic sectors (Bajo and Zuber, 2017: 17). In Europe and around the world, the term public service encompasses not only social activities but also economic or commercial activities, including utilities, telecommunications, the energy sector, postal services, railways, and roads, which are referred to as "public enterprises" in Croatia (Klarić and Nikolić, 2011: 91). At the same time, Klarić and Nikolić (2011: 91) divide public services, depending on the realization of commercial profit – "into commercial or economic and non-commercial or non-economic." The former were commonly set up and operated as state-owned enterprises, providing commercial services under defined terms as state monopolies, whereas the latter were established and operated as public institutions, offering services devoid of commercial attributes in their functioning. Bajo and Zuber (2017) classified public companies into financial and non-financial, which can be organized as joint-stock companies or limited liability companies, while Kesner-Škreb (2005) states that the public sector includes general government entities, non-financial public companies, and public financial institutions. A joint-stock company is usually larger, has publicly available shares and greater access to capital, while a limited liability company is often smaller, with more flexible management and more limited access to capital. Both types of legal entities are used to organize business and allow for the limited liability of owners (Jakšić and Petrović, 2016).

In some cases, state-owned enterprises may be established to support economic development or achieve certain social goals. "State-owned enterprises, emerging from a combination of political objectives and economic necessities, have historically held significant sway in the political and economic landscapes of diverse nations. Advocates of state ownership in contemporary economic theory present various arguments to justify their existence, encompassing not only political and ideological rationales but also compelling economic justifications" (Crnković, Požega and Karačić, 2011: 280). However, the problem arises when non-financial public companies provide services on a non-commercial basis, often offering lower prices that are insufficient to cover the real costs. The financing of business conducted in such a way can be realized via two strategies: by redistributing subsidies among different groups of consumers or by covering the losses of public companies from the budget (Kesner-Škreb, 2005: 93). Precisely to limit and, in a certain way, regulate such interventions by member states, Article 86 of the EU Agreement stipulates that public companies and those with special or exclusive rights in member states are exempt from measures limiting market competition, with a specified exception for companies providing services of general economic interest, particularly monopolies (Klarić and Nikolić, 2011: 94).

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

Two trends have been observed in US public companies: a decrease in the number of public companies and an increase in the average age of public companies compared to private companies. There are fewer public companies because of the consolidation of existing public companies and a decrease in public interest for establishing new public companies. This suggests that the average age of public companies tends to increase over time. The above leads to changes in the dynamics of the market, which makes it more challenging to achieve success in the business of public companies (Kahle and Stulz, 2017: 70). These trends alter market dynamics, creating challenges such as reduced innovation, increased competition among established players, and higher barriers to entry, making it more difficult for public companies to achieve business success.

Reasons for state ownership can include a desire to preserve strategic resources, provide essential services to citizens, or control certain markets. In some cases, state enterprises are established to support economic development or achieve social goals. However, a problem arises when public enterprises lose, partially or entirely, their monopolistic status and must compete in the market with private competition. Adapting public enterprises involves changes not only in business processes but also in external communication with the outside environment and internal communication with the internal environment, which primarily comprises employees. These changes certainly affect the satisfaction of employees working in public enterprises.

2 METHODOLOGY

2.1 THE PURPOSE AND OBJECTIVES OF THE RESEARCH

The main purpose and objectives of this research were to investigate the influence of internal communication on the general satisfaction of employees in public companies in Croatia and to determine the significance of the role of the individual dimensions analysed in this research. The results were then used to establish an optimal model for adequate internal communication in public companies. Beginning with the research objectives, one main and three auxiliary hypotheses were formulated:

H1: Internal communication has a more significant impact on job satisfaction in public companies' employees than sociodemographic characteristics.

H2: There is a positive correlation between the satisfaction with corporate communication and the communication climate.

H3: There is a positive correlation between satisfaction with feedback and communication with superiors.

H4: There is a difference in satisfaction with horizontal communication according to employee age and length of service in a public company.

PUBLIC SECTOR ECONOMICS 49 (2) 213-238 (2025)

2.2 SAMPLE DESCRIPTION

This empirical research was conducted using a questionnaire on a sample of three representative public companies with more than 1,000 employees, in which the general satisfaction of employees was examined with an emphasis on internal communication, and the research results were also analysed using a comparative method (see appendix).

Although all three of the public companies included in this research are 100% owned by the Republic of Croatia and operate across the entire country, employing over 1,000 employees, they are specific in their market position and primary business activities. The volunteer sample for this study consisted of 1,342 employees (10.8% of the total employees in all three representative public companies). The data were collected using an online questionnaire over a two-month period, from October 27, 2022. to December 29, 2022. Closed-ended questions were used due to their greater clarity, ease of processing, and reduced risk of errors. In the sample, slightly more individuals were female (58.2%), with respondents between the ages of 45 and 54 comprising the dominant group (40.9%). Around half of the respondents (50.1%) had secondary education. The largest number of respondents who participated in the research were employed with indefinite contracts (95.4%). Regarding their length of service in the company, around two-thirds of the respondents had more than 10 years of work experience (70.4%), and almost one-third (29.9%) held some form of managerial position within the company where they are currently employed (manager, team leader, supervisor, director). The sample was evaluated to determine whether the distribution of respondents across the mentioned sociodemographic characteristics differed from that of employees in public companies. For this purpose, additional data on the sociodemographic characteristics of all employees (N=12,421) employed in the surveyed public companies, as of 31 December 2022, were collected. Chi-squared tests revealed the existence of differences in distribution between the respondents in the sample and the employees in these public companies concerning all the sociodemographic characteristics considered in the study.

The obtained differences between individual categories were statistically significant; however, they were expected considering the response rate to the survey and given that this research used a convenient sample of respondents. Around 10.80% (N=1,342) of the total of 12,421 people employed in these public companies participated in this study. The required sample size was determined (*a priori*) using the statistical tool G*Power 3 (Faul et al., 2007). Based on this analysis, it was determined that a minimum sample size of N=788 was required for an expected small effect size (d=0.2) and a minimum statistical power of 0.8. The abovementioned minimum sample size was exceeded in this research.

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

2.3 INSTRUMENT AND PROCEDURES

The research was conducted using a questionnaire designed to assess satisfaction with internal communication in the workplace. This questionnaire was created for the purpose of scientific research and was authored by Tkalac Verčič, Pološki Vokić and Sinčić Ćorić in 2007. It measures eight dimensions of satisfaction with internal communication.

Besides the internal communication satisfaction, the value the employees place on the aforementioned aspects of internal communication was also examined. Using a Likert scale ranging from 1 – not important at all to 5 – very important, the participants assessed how personally important they considered each aspect of internal communication.

Overall job satisfaction was considered a one-dimensional construct and was measured using the question, "Please rate how satisfied you are with your job in general", on a Likert scale, where possible response options range from 1 – extremely dissatisfied to 5 – extremely satisfied.

Furthermore, for the purposes of this study, data were collected on the participants' total length of employment in their current company, employment type (temporary/permanent), whether the participants held a managerial position in the company (manager, team leader, supervisor, director), and their basic sociodemographic characteristics, including sex, age, and highest level of education.

The first step of the regression analysis used the following employee features as analysis predictors: the length of service at the company, the employment type, work in a managerial position, sex, age, and the highest education level acquired. The second step of the regression analysis included aspects of internal communication satisfaction as predictors.

General job satisfaction was used as a criterion. To produce a highly accurate satisfaction forecast based on the used predictors, it is necessary for the predictors to have as little correlation with each other as possible and for each predictor to have a strong correlation with the criterion variable. The correlation between specific variables was determined based on the Pearson correlation coefficient (r).

Statistical analyses were conducted using the SPSS v20 statistics tool along with the IBM AMOS v20.0 tool. Descriptive statistics were used for description of the variables used in the research. The reliability of a multidimensional questionnaire of internal communication was determined on the basis of the coefficient of internal consistency, Cronbach's alpha[1]. T-tests[2] were used to evaluate the arithmetic mean between two groups of employees, while analysis of variance (ANOVA)[3] was used

[1] Cronbach's alpha is a measure of internal consistency, assessing how closely related a set of items are as a group in a survey or test.
[2] T-tests are statistical tests used to compare the means of two groups to determine if they are significantly different from each other.
[3] ANOVA (Analysis of Variance) is a statistical method used to compare the means of three or more groups to see if at least one group mean is significantly different from the others.

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

to measure the differences between more than two groups of employees. The factor structure of the internal communication satisfaction questionnaire was verified through confirmatory factor analysis[4]. The correlation between different measures was determined according to the Pearson correlation coefficient[5], and hierarchical multiple regression analysis[6] was used to examine the relationship between a set of predictor variables and the criterion. Data collection was conducted using a survey questionnaire, which was delivered to the participants via email or digital communication applications, depending on the possibility of reaching the maximum number of employees. In this case, the form and content of the questionnaire were the same regardless of the delivery channel, and the questionnaire was created using the Google Forms tool. Online survey completion ensures improved legibility and faster data processing, while the applied survey measurement instrument allows for the simultaneous examination of multiple anonymous respondents.

The factor structure of the questionnaire was examined using confirmatory factor analysis (CFA), which represents a robust instrument for assessing *construct validity* (Hair et al., 2006). Confirmatory analysis was conducted using the software tool IBM AMOS v20.0. A measurement model was specified using eight aspects of internal communication as exogenous variables and 32 questionnaire items as endogenous variables, with four items assigned to each latent variable (an aspect of internal communication). For the estimation of parameters, the Maximum Likelihood (ML) method was used. To assess how well the statistical model fit the observed data during structural equation modelling (SEM), the following four fit indices were used: χ^2/df, CFI, the TLI, and the RMSEA. Based on data collected from the sample of 1,342 respondents, it was shown that the specified measurement model with eight latent factors (eight aspects of internal communication) fit the data acceptably (χ^2 (434) = 2540.3; $p < 0.05$; χ^2/df[7] = 5.85; CFI[8] = 0.95; TLI[9] = 0.941; RMSEA[10] = 0.06). According to the recommendations of Hu and Bentler (1999), CFI and ILI values equal to or higher than 0.95 and RMSEA index values equal to or lower than 0.06 were considered an acceptable fit. The average saturations of individual items with the latent variable were 0.85, and all were statistically significant at the level of $p < 0.01$ which, according to the recommendations of Hair et al. (2006), is considered satisfactory.

[4] Confirmatory Factor Analysis (CFA) is a statistical technique used to test whether a set of observed variables represents the number of underlying latent constructs as expected.
[5] The Pearson correlation coefficient is a measure of the linear relationship between two continuous variables, ranging from -1 to 1.
[6] Hierarchical multiple regression analysis is a statistical method in which variables are entered into the regression equation in steps to understand the contribution of each set of variables after accounting for the others.
[7] χ^2/df (Chi-square/degrees of freedom): this index is the ratio of the chi-square statistic to its degrees of freedom, providing a measure of model fit in which values close to 1 indicate a good fit; this index can be sensitive to sample size.
[8] CFI (Comparative Fit Index): the CFI compares the fit of a target model to an independent model (one with no relationships between variables) and ranges from 0 to 1, with values closer to 1 indicating a better fit.
[9] TLI (Tucker–Lewis Index): the TLI, also known as the Non-Normed Fit Index (NNFI), compares the fit of a specified model to a baseline model, taking model complexity into account, with values closer to 1 indicating a good fit.
[10] RMSEA (Root Mean Square Error of Approximation): the RMSEA measures the discrepancy between the model and the data per degree of freedom, with values less than 0.06 indicating a close fit and values of up to 0.08 representing a reasonable fit.

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

3 RESULTS

In order to initially assess the average employee satisfaction with various aspects of internal communication, three indicators of mean results were calculated: the arithmetic mean (M), the central value/median (C), and the dominant mode (D). The average employee satisfaction with different aspects of internal communication, as well as overall job satisfaction, expressed as the arithmetic mean (M), was above the theoretical average for all aspects, except for the aspect of satisfaction with feedback, which was below the theoretical average of 3 for a Likert scale with a range of results from 1 to 5.

The employees were most satisfied with horizontal communication (M=3.79), followed by communication with superiors (M=3.60), the quality of communication medium (M=3.57), communication in meetings (M=3.25), corporate information (M=3.08), communication climate (M=3.08), informal communication (M=3.01), and feedback (M=2.98). A similar ranking would have been produced if the results had been categorized according to the calculated central value (C). The standard deviation of the results was approximately SD=1, with the maximum possible range of results ranging from 1 to 5 (table 6). The employees rated their overall job satisfaction as M=3.46 with SD=1.04, which also indicated an above-average result (table 1).

Table 1

Descriptive data for eight dimensions of satisfaction with internal communication and general (total) satisfaction with the job

	M	C	D	SD	Symmetry	Kurtosis
Satisfaction with horizontal communication (with colleagues)	3.79	3.75	4.0	0.82	-0.80	0.99
Satisfaction with communication with superiors	3.60	3.75	5.0	1.08	-0.57	-0.48
Communication medium quality satisfaction	3.57	3.75	4.0	0.92	-0.69	0.47
Meeting communication satisfaction	3.25	3.25	4.0	0.99	-0.38	-0.27
Corporate information satisfaction	3.08	3.00	3.0	1.01	-0.05	-0.54
Communication climate satisfaction	3.08	3.00	3.0	1.06	-0.17	-0.57
Informal communication satisfaction	3.01	3.00	3.0	0.77	-0.05	0.24
Feedback satisfaction	2.98	3.00	3.0	1.06	-0.04	-0.71
General job satisfaction	3.46	4.00	4.0	1.04	-0.69	-0.01

Note: M – arithmetic mean, C – the central value/median, D – dominant mode, SD – standard deviation.

Source: Author.

The distributions of the obtained results were slightly negatively skewed (tilted to the right) and slightly leptokurtic (flattened) for most dimensions of satisfaction with internal communication. However, based on the calculated measures of skewness and kurtosis, along with the corresponding standard errors of the results, it can be concluded that the obtained distributions of results approximately corresponded to a normal distribution.

According to a correlation analysis conducted as part of the regression analysis, the highest correlations were obtained between satisfaction with feedback and satisfaction with the communication climate (r=0.73), between satisfaction with feedback and satisfaction with communication with superiors (r=0.70), and between satisfaction with feedback and satisfaction with communication at meetings (r=0 ,70) (table 2).

Table 2

Correlation matrix of 8 dimensions of internal communication

	1	2	3	4	5	6	7	8
1 Feedback satisfaction	–							
2 Satisfaction with communication with superiors	**.70***	–						
3 Satisfaction with horizontal communication (with colleagues)	.49*	.48*	–					
4 Informal communication satisfaction	.57*	.50*	.53*	–				
5 Corporate information satisfaction	.68*	.58*	.43*	.48*	–			
6 Communication climate satisfaction	**.73***	.63*	.47*	.59*	.66*	–		
7 Communication medium quality satisfaction	.58*	.54*	.48*	.50*	.63*	.61*	–	
8 Meeting communication satisfaction	**.70***	.66*	.48*	.56*	.68*	.69*	.67*	–

*Note: *p<0.05; **p<0.01.*

Source: Author.

Below are detailed explanations of the research results for the main hypothesis and each of the three auxiliary hypotheses.

H1: Internal communication has a more significant impact on job satisfaction in public companies employees than sociodemographic characteristics

The focus of the comparative analysis of internal communication in public companies, conducted using a survey questionnaire, was to examine the possibility of predicting job satisfaction based on the characteristics of the respondents and various aspects of internal communication. A two-step hierarchical multiple regression analysis examined the possibility of explaining overall employee job satisfaction.

It was found that the sociodemographic characteristics of employees (total length of service in the company, employment type, managerial position in the company, sex, age group and highest level of education) were weakly correlated with each other, as well as with overall job satisfaction. Different aspects of internal communication, however, were, to a moderate degree, positively and statistically significantly correlated with each other and with overall job satisfaction.

The results of the regression analysis showed that sociodemographic characteristics explained only 5.2% of the variance in overall job satisfaction. The individual aspects of satisfaction with internal communication explained 44.3% of the variance in overall job satisfaction. This finding is in line with other research studies (Borovec and Balgač, 2017). The most important predictor of overall job satisfaction was found to be satisfaction with the communication climate (β=0.35, $p<0.01$), as well as satisfaction with communication with superiors. The results obtained from the regression analysis indicate that satisfaction with internal communication is, to a high degree, more strongly associated with overall job satisfaction than sociodemographic characteristics (table 3). Considering the aforementioned data, it can be concluded that the main hypothesis, which states that internal communication has a more significant impact on the job satisfaction of public company employees than sociodemographic characteristics, is accepted.

TABLE 3

Results of the hierarchical regression analysis of general job satisfaction

Model		B	β	R	R^2	ΔR^2
1	(Constant)	3.661				
	Total length of service in the company	-0.111	-0.141**			
	Employment type	-0.178	-0.036			
	Managerial position in the company (manager, team leader, supervisor, director)	-0.374	-0.165**	0.228	0.052	0.052
	Sex	0.140	0.067			
	Age group	0.169	0.152**			
	Highest level of education	0.051	0.048			
2	(Constant)	0.588				
	Total length of service in the company	-0.044	-0.056**			
	Employment type	-0.108	-0.022			
	Managerial position in the company (manager, team leader, supervisor, director)	-0.063	-0.028			
	Sex	0.039	0.018			
	Age group	0.107	0.097**			
	Highest acquired education level	0.055	0.051*			
	Feedback satisfaction	0.046	0.047	0.704	0.495	0.443
	Satisfaction with communication with superiors	0.186	0.195**			
	Satisfaction with horizontal communication (with colleagues)	0.047	0.037			
	Informal communication satisfaction	-0.001	0.000			
	Corporate information satisfaction	0.035	0.034			
	Communication climate satisfaction	0.342	0.351**			
	Communication medium quality satisfaction	0.045	0.040			
	Meeting communication satisfaction	0.099	0.095			

*Note: *p<0.05; **p<0.01.*

Source: Author.

H2: There is a positive correlation between the satisfaction with corporate information and the communication climate

Although it is not among the top three highest correlations, a positive and relatively high and statistically significant correlation was also obtained between satisfaction with corporate information and communication climate (r=0.66) (table 2). Namely, correlations above r=0.50 are considered statistically significant and high. The variables had a linear relationship, and the regression equation to predict satisfaction with the communication climate based on satisfaction with corporate information was y = 1.14 + 0.63*x.

For a more detailed insight into the relationship between the issues mentioned above, an analysis was conducted at the level of individual questions (items). The questions concerning satisfaction with corporate information were positively correlated with the questions related to satisfaction with the communication climate, ranging from r=0.50 for the relationship between satisfaction with the way communication in the organization encouraged individuals to achieve organizational goals (Z24) and satisfaction with the information about the work regulations (Z17) to r=0.60 for the relationship between satisfaction with the way communication helps employees identify with the organization (Z22) and satisfaction with information about legal regulations affecting the organization's operations (Z20) (table 4).

Table 4

Correlation between corporate information and the communication climate

	Z17	Z18	Z19	Z20	Z21	Z22	Z23	Z24
Z17 Satisfaction with information about the work regulations	1							
Z18 Satisfaction with information on the turnover, profit, and financial success of the organization	.68**	1						
Z19 Satisfaction with information on developments in the organization	.64**	.76**	1					
Z20 Satisfaction with information on legislative regulations that affect the operational activities of my company	.67**	.74**	.77**	1				
Z21 Satisfaction with the way communication helps me identify myself as a valuable part of the company	.51**	.52**	.60**	.59**	1			
Z21 Satisfaction with the way communication helps me identify with the company	.51**	.52**	.59**	.60**	.91**	1		
Z23 Satisfaction with the degree to which communication in the company promotes organizational values	.52**	.54**	.59**	.59**	.85**	.88**	1	
Z24 Satisfaction with the degree to which communication in the company encourages me to achieve organizational goals	.50**	.53**	.59**	.59**	.83**	.85**	.88**	1

*Note: Questions Z17 to Z20 comprise the satisfaction with corporate information, whereas questions Z21 to Z24 comprise the satisfaction with the communication climate. *p<0.05, **p<0.01; N=1,342.*

Source: Author.

The distribution of the participant responses to the question where they assessed satisfaction with corporate information was approximately normal, with an average rating of M=3.08 and a standard deviation of SD=1.01. A slightly more flattened but still approximately normal distribution of responses was obtained for the question related to satisfaction with the communication climate. The average grade equated to M=3.08 with SD=1.06. According to the information provided, it can be concluded that the hypothesis regarding the relationship between the satisfaction with corporate information and the communication climate is accepted.

H3: There is a positive correlation between satisfaction with feedback and communication with superiors

A positive, relatively high, and statistically significant correlation between satisfaction with feedback and satisfaction with communication with superiors was found ($r=0.70$, $p<0.01$) (table 2). These two variables were in a linear relationship, and the regression equation used to predict employee satisfaction with communication with superiors based on feedback satisfaction was $y = 0.54 + 0.68*x$.

To provide a more detailed depiction of the relationship between these two variables, correlation analysis was conducted at the level of individual items for these two aspects. The questions related to satisfaction with feedback were positively correlated with the questions related to satisfaction with communication with superiors. The correlation ranged from r=0.43 for the relationship between satisfaction with the availability of an immediate superior and satisfaction with information about the extent to which an employee contributes to the company's overall success to r=0.69 for the relationship between satisfaction with the recognition of employee potential by an immediate superior and satisfaction with feedback on how the employee performs their job (table 5).

TABLE 5

Correlation between feedback satisfaction and satisfaction with communication with superiors

	Z1	**Z2**	**Z3**	**Z4**	**Z5**	**Z6**	**Z7**	**Z8**
Z1 Satisfaction with information on the consequences of poor job performance	1							
Z2 Satisfaction with information on the extent to which I contribute to collective success	.65**	1						
Z3 Satisfaction with information on how much my job is valued within the organization	.60**	.77**	1					
Z4 Satisfaction with feedback on my job performance	.63**	.77**	.81**	1				
Z5 Satisfaction with the availability of an immediate superior	**.47****	**.43****	**.46****	**.52****	1			
Z6 Satisfaction with the extent to which my superior is familiar with the issues I encounter at work	.52**	.51**	**.55****	**.59****	.77**	1		

	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8
Z7 Satisfaction with the extent to which my superior understands my problems	**.53****	**.53****	**.59****	**.62****	.74**	.85**	1	
Z8 Satisfaction with my superior's recognition of my potential	**.54****	**.61****	**.68****	**.69****	.66**	.72**	.79**	1

*Note: Questions Z1 to Z4 comprise feedback satisfaction, whereas questions Z5 to Z8 comprise satisfaction with communication with superiors. *p<0.05; **p<0.01; N=1,342.*

Source: Author.

The distribution of the participant responses to the question regarding satisfaction with feedback was approximately normal, with an average rating of M=2.98 and a standard deviation of SD=1.06. The distribution of participant responses to the question regarding satisfaction with communication with superiors was slightly negatively skewed, indicating above-average satisfaction among participants regarding communication with their superiors. The average satisfaction was expressed as an arithmetic mean, which was M=3.6 with SD=1.08.

Therefore, employee satisfaction with feedback is most influenced by satisfaction with communication with superiors in the company. In other words, if an employee receives adequate and timely information about themselves and their work within the company, they are likely to be satisfied with communication with their superiors. From the information provided, it can be concluded that the third hypothesis, about the positive relationship between employee satisfaction with feedback and communication with superiors, has been accepted.

H4: There is a difference in the satisfaction with horizontal communication depending on employee age and length of service in the public company

By analysing all eight components of internal communication, it was established that satisfaction with horizontal communication was the aspect of internal communication with which employees were most satisfied. Specifically, the mean value was 3.79 with a standard deviation of 0.82 (Cronbach's α=0.896).

There was less variation in employee satisfaction with horizontal communication regarding the age and length of service in the company. In this context, employees in the age group of 45 to 54 years were slightly more satisfied with horizontal communication, while younger employees in public companies aged up to 25 years and those in the age group of 25 to 34 years were less satisfied. There was also a variation in satisfaction with horizontal communication according to the length of service in the company, where employees with the shortest length of service (less than 5 years) and those with 20 to 29 years of service were somewhat more satisfied.

However, it is important to emphasize that the mentioned variations were not sufficiently pronounced to establish significant differences among employees. The analysis of variance indicates that the differences in satisfaction with horizontal communication based on age and service length were not statistically significant (ANOVA) (table 6).

Table 6

Satisfaction with horizontal communication considering employee age groups and length of service

	M	SD	F (4, 1336)	η2
Age				
less than 25 years	3.70	0.82		
from 25 to 34 years	3.67	1.02		
from 35 to 44 years	3.78	0.87	0.15	0.005
from 45 to 54 years	3.85	0.77		
over 55 years	3.75	0.71		
Length of service				
less than 5 years	3.85	0.84		
from 5 to 9 years	3.73	0.91		
from 10 to 19 years	3.72	0.84	1.49	0.004
from 20 to 29 years	3.84	0.81		
over 30 years	3.77	0.71		

*Note: *p<0.05; **p<0.01.*

Source: Author.

From this information, it can be concluded that the hypothesis regarding the existence of differences in satisfaction with horizontal communication based on age and length of service among employees in a public company is rejected: employees are equally satisfied with horizontal communication regardless of their age group and/or length of service at a public company.

4 DISCUSSION

In recent years, there has been increasing focus on the topic of the impact of internal communication on employee satisfaction and its consequences for organizations. From the review of the available literature, it was observed that research on the topic of the relationship between employee satisfaction and internal communication in public companies is not very prevalent in Croatia compared to the international context, at least according to the number of publications. It is worth noting that previous research has primarily been conducted on private companies (Bolfek, Milković and Lukavac, 2017; Sušanj Šulentić, 2014), with fewer studies focusing on public companies (Ćorić and Musa, 2015).

This work presents the main hypothesis that internal communication has a significant impact on employee satisfaction in a public company. In the quantitative analysis of the questionnaire, various aspects of internal communication and general job satisfaction were considered. The research results for public companies highlight the significant importance of internal communication in explaining employee satisfaction. These findings are consistent with a study conducted in corporations (Tkalac Verčič, 2021), which indicates a positive relationship between employee involvement, organizational support, and satisfaction with internal communication. Furthermore, in a field study by Clampitt and Downs (1993), conducted in two representative service and manufacturing companies and using satisfaction questionnaires and conversations with all employees, it was found that high-quality internal communication is crucial for employee satisfaction.

The overall job satisfaction was explained to a lesser extent by the sociodemographic characteristics of employees (5.2% of the variance in overall job satisfaction), while it was significantly better explained by satisfaction with internal communication (44.3% of the variance in overall job satisfaction). This finding is in line with other research studies. Indeed, Borovec and Balgač (2017) also demonstrated that the impact of the sociodemographic characteristics of employees on overall job satisfaction was extremely small, accounting for only 3.1% of the variance in overall job satisfaction, in comparison to the overall explained variance in job satisfaction after introducing components related to satisfaction with internal communication, which accounted for 28.5% of the variance.

The most important predictor of overall job satisfaction was satisfaction with the communication climate (β=0.35). These results confirmed the findings of the research by Sušanj Šulentić (2014), where regression analysis revealed a positive relationship between a high-quality communication climate and job satisfaction. Employees value open and timely communication, even in situations of unpleasant changes in the organization, which contributes to their overall job satisfaction (Sušanj Šulentić, 2014).

The highest correlation was obtained between satisfaction with communication in meetings and satisfaction with feedback (r=0.73), while the lowest correlation was obtained between satisfaction with corporate communication and satisfaction with horizontal communication (r=0.43). Unlike employees in public companies, in a study of police officers' job satisfaction by Borovec and Balgač (2017), the highest correlation was found between satisfaction with communication informativeness and satisfaction with the communication climate (r=0.56), while the lowest correlation was found between satisfaction with communication with superiors and satisfaction with informal communication (r=0.29).

Furthermore, regarding the second hypothesis, a positive and moderately strong correlation between satisfaction with corporate communication and the communication climate (r=0.66) was confirmed, which is consistent with the study of police officers' job satisfaction by Borovec and Balgač (2017), where the highest correlation was also found between satisfaction with communication informativeness and satisfaction with the communication climate (r=0.56). When employees are well-informed and more satisfied with their jobs, they perceive their workplace as more stable, which can increase their loyalty to the company (Sušanj Šulentić, 2014). When the employees receive clear information about the organization's goals, expectations, results, and developments, they feel informed and involved, which ultimately positively affects their workplace satisfaction.

In addition, the results also confirmed the third hypothesis about the positive correlation between the satisfaction with feedback and employees' trust in their superiors (r=0.70), as one of the highest correlations. Hence, the findings obtained from the research showed that satisfaction with feedback was the lowest-rated component in the study of employee satisfaction with internal communication in public companies (M=2.98). This confirmed previous research findings (Ćorić and Musa, 2015)

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

that employees tend to express the lowest level of satisfaction with the feedback they receive regarding their personal performance. Transparency in communication between managers and employees contributes to the sense of connection and engagement of the employees (Robinson, Perryman and Hayday, 2004); thus, it is problematic for the company if that component is absent. The lack of feedback on job performance and incentives for success can lead to a mild devaluation of the job itself and its function (Bolfek, Milković and Lukavac, 2017).

The existence of differences in satisfaction with horizontal communication based on the age and length of service of employees in a public company was not confirmed, meaning that the fourth hypothesis was rejected. Indeed, the differences in satisfaction with horizontal communication based on the age and length of service of employees in a public company were statistically negligible ($\eta 2=0.004$, $\eta 2=0.005$). Horizontal communication represents a component of internal communication where all employees display the highest degree of satisfaction, with minimal mutual deviations regarding age groups and length of service at a public company. In line with the observation that satisfaction with horizontal communication helps employees feel connected with their colleagues, the findings also confirm those of an existing study emphasizing the significant impact of quality relationships with colleagues, a team environment, and peer support on employees' sense of inclusion (Lemon, 2020).

A limitation of the research was, that potential participants had to be reminded multiple times to complete the survey and needed motivation to participate. Additionally, since this research concerns public companies, there is a prevailing sense of mistrust among employees about any form of job satisfaction surveys. Due to the lack of empirical analyses in this field, uncovering the impact of internal communication on the satisfaction of employees in public companies is important for the improvement of organization and business operations in public companies, as well as for enhancing the quality of services for citizens in Croatia.

5 CONCLUSIONS

Internal communication should simultaneously and equally be focused on timely information exchange and employee satisfaction. Employees should be active participants in all changes and activities, rather than just passive observers. In creating a corporate culture of collaboration, the way management behaves and communicates with employees daily is especially important. Public companies can successfully communicate with all stakeholders only through the synergy of internal and external communication.

However, if such internal communication is lacking in a public company, if annual employee meetings, as defined by law, are the only contact between subordinates and superiors, and if there are many levels of management between the top executives and employees, then all internal communication is reduced to informal communication under the direction of unions, while employee meetings turn into expressions of employees' frustration with management due to lack of information. Situations in which employees do not have a full understanding of the public company's operations and tasks are conducive to the spread of gossip and dissatisfaction.

In cases where employees do not have a positive opinion about the public company's leadership or if they do not trust the formal communication, they are more likely to trust the informal communication network. Therefore, it is important to avoid employees being left in uncertainty and relying on speculation; instead, they should be provided with relevant information and facts to reduce this gap. The organized presence and management of internal communication are signs that employees are considered a crucial group within the public company.

In line with these insights, large Croatian public companies were analysed: Croatian Post, Croatian Lottery, and the HŽ Passenger Transport Company.

Upon examining the results of the regression analysis, the main hypothesis was confirmed that employee satisfaction with internal communication significantly influences overall employee satisfaction and much more strongly than the sociodemographic characteristics of the employees. The particularly important aspects of internal communication were satisfaction with the communication climate and satisfaction with the communication with superiors. In fact, the research has shown that satisfaction with corporate information accounts for almost half of the variations in satisfaction with the communication climate, while satisfaction with feedback explains half of the variations in satisfaction with communication with superiors. Therefore, if employees receive adequate and timely information about themselves and their performance in the public company, they will tend to be satisfied with their communication with superiors. Furthermore, it was found that the employees were equally satisfied with horizontal communication regardless of their age and length of service. In this context, horizontal communication, the dimension with which employees are most satisfied in public companies, plays a vital role in the sense of connection with colleagues.

As a result, it can be concluded that, when employees in public companies in Croatia receive clear information about their organization's goals, expectations, results, and developments, they feel informed and included, which positively impacts their job satisfaction. The research results suggest that public companies should continuously invest in the development and improvement of internal communication processes to enhance employee satisfaction with their workplaces. To implement this, public companies should organize internal communication that provides employees with access to current information about the company and supply feedback on processes and work results in order to gain the trust of their employees. This can be achieved by ensuring transparency, fostering two-way communication, providing regular updates to employees, and promoting teamwork through communication channels within the company.

It would be desirable to conduct further research involving a larger number of medium-sized and small public companies to verify whether the conclusions drawn from this study of large public companies are applicable to all public companies.

Disclosure statement
The author has no conflict of interest to declare.

REFERENCES

1. Bajo, A. and Zuber, L., 2017. Poslovanje javnih trgovačkih društava u državama članicama Europske unije. In: D. Koški, D. Karačić and D. Sajter, eds. *Financije: teorija i suvremena pitanja*, pp. 3-23.
2. Bolfek, B., Milković, V. and Lukavac, M., 2017. Utjecaj interne komunikacije na zadovoljstvo zaposlenika radnim mjestom. *Oeconomica Jadertina*, 7(1), pp. 16-27. https://doi.org/10.15291/oec.1348
3. Borovec, K. and Balgač, I., 2017. Doprinos interne komunikacije u predikciji zadovoljstva poslom policijskih službenika. *Kriminologija & socijalna integracija: časopis za kriminologiju, penologiju i poremećaje u ponašanju*, 25(1), pp. 1-16. https://doi.org/10.31299/ksi.25.1.1
4. Brnad, A., Stilin, A. and Tomljenović, Lj., 2016. Istraživanje motivacije i zadovoljstva zaposlenika u Republici Hrvatskoj. *Zbornik Veleučilišta u Rijeci*, 4(1), 109-122.
5. Clampitt, P. G. and Downs, C. W., 1993. Employee Perceptions of the Relationship Between Communication and Productivity: A Field Study. *Journal of Business Communication,* 30(1), pp. 5-28. https://doi.org/10.1177/002194369303000101
6. Crnković, B., Požega, Ž. and Karačić, D., 2011. Izazovi korporativnog upravljanja u državnim poduzećima – Hrvatske perspektive. *Ekonomski vjesnik: Review of Contemporary Entrepreneurship, Business, and Economic Issues,* 24(2), pp. 279-292.
7. Ćorić, N. and Musa, I., 2015. Istraživanje zadovoljstva internom komunikacijom. *Hum: časopis Filozofskog fakulteta Sveučilišta u Mostaru*, 10(14), pp. 148-159.
8. Ćorić, N., 2019. *Korporativna komunikacija*. Zagreb; Sarajevo; Mostar: Synopsis.
9. Faul, F. [et al.], 2007. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods,* 39, pp. 175-191. https://doi.org/10.3758/BF03193146
10. Hair, J. [et al.], 2006. *Multivariate Data Analysis.* Upper Saddle River: Pearson Prentice Hall.
11. Hu, L. T. and Bentler, P. M., 1999. Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria versus New Alternatives. *Structural Equation Modeling*, 6(1), pp. 1-55. https://doi.org/10.1080/10705519909540118
12. Jakšić, T. and Petrović, S., 2016. Mogući pravci izmjena i dopuna hrvatskoga prava društva. *Zbornik Pravnog fakulteta Sveučilišta u Rijeci*, 37(3), pp. 1101-1148. https://doi.org/10.30925/zpfsr.37.3.3
13. Kahle K. M. and Stulz, R. M., 2017. Is the US Public Corporation in Trouble? *Journal of Economic Perspectives*, 31(3), pp. 67-88. https://doi.org/10.1257/jep.31.3.67
14. Kanajet, K. and Jakopović, H., 2019. Izvještavanje o krizi i krizno komuniciranje Agrokora u 2017. godini putem internetskih platformi Večernji.hr i

Agrokor.hr. *Medijska istraživanja: znanstveno-stručni časopis za novinarstvo i medije,* 25(1), pp. 55-82. https://doi.org/10.22572/mi.25.1.3

15. Kesner-Škreb, M., 2005. Državni sektor. *Financijska teorija i praksa,* 30(1), pp. 93-94.
16. Kimeli Cheruiyot, T. and Chemngetich Maru, L., 2014. Corporate human rights social responsibility and employee job outcomes in Kenya. *International Journal of Law and Management,* 56(2), pp. 152-168. https://doi.org/10.1108/IJLMA-01-2013-0002
17. Klarić, M. and Nikolić, M., 2011. Ustrojstvo javnih službi u Europskom pravnom poretku. *Zbornik radova Pravnog fakulteta u Splitu*, 48(1), pp. 89-102.
18. Lemon, L. L., 2020. The employee experience: how employees make meaning of employee engagement. *Journal of Public Relations Research,* 31(5-6), pp. 176-199. https://doi.org/10.1080/1062726X.2019.1704288
19. Lider, 2023. *1000 najvećih hrvatskih tvrtki prema ukupnom prihodu u 2022.*
20. Robinson, D., Perryman, S. and Hayday, S., 2004. The Drivers of Employee Engagement. *IES Report,* No. 408.
21. Rouse, M. J. and Rouse, S., 2005. *Poslovne komunikacije*. Zagreb: Masmedia.
22. Ruck, K., Welch, M. and Menara, B., 2017. Employee voice: An antecedent to organisational engagement? *Public Relations Review*, 43(5), pp. 904-914. https://doi.org/10.1016/j.pubrev.2017.04.008.
23. Skoko, B., 2006. *Priručnik za razumijevanje odnosa s javnošću*. Zagreb: MPR.
24. Sušanj Šulentić, T., 2014. Istraživanje povezanosti interne komunikacijske klime sa zadovoljstvom poslom i lojalnošću zaposlenika. *Market-Tržište*, 26(1), pp. 59-76.
25. Tkalac Verčič, A., 2021. The impact of employee engagement, organisational support and employer branding on internal communication satisfaction. *Public Relations Review,* 47(1), 102009. https://doi.org/10.1016/j.pubrev.2021.102009
26. Tkalac Verčič, A., Pološki Vokić, N. and Sinčić Ćorić, D., 2007. Razvoj mjernog instrumenta za procjenu zadovoljstva internom komunikacijom. *Društvena istraživanja: časopis za opća društvena pitanja,* 18(1-2), pp. 175-202.
27. Tomić, Z., 2016. *Odnosi s javnošću: teorija i praksa*. Zagreb; Sarajevo: Synopsis.
28. Yeomans, L., 2006. *Internal Communication. Exploring Public Relations*. Harlow: FT-Printice Hall.

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

APPENDIX

INTERNAL COMMUNICATION SATISFACTION QUESTIONNAIRE

Dear participants,
This research is conducted with employees in public companies. The aim of the research is to collect data on employee satisfaction with different ways of internal communication. The data will be used for scientific purposes for the preparation of a doctoral dissertation at the postgraduate university study of Communication Studies. By answering the questions from the questionnaire, you will help us receive information about which ways of communication at work you are satisfied with, and which you would recommend for improvement.

It takes 5-10 minutes to answer all the questions from the questionnaire. Filling out the questionnaire is completely anonymous and the answers will not be analysed individually, but exclusively as a group as a common opinion of all respondents in all public companies participating in the research.

Your participation in this survey is voluntary and you have the right to withdraw at any time.

Thank you for participating!

1. Please rate how satisfied you are with feedback

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
Information on the consequences of poor job performance	1	2	3	4	5
Information on how much I contribute to the common success	1	2	3	4	5
Information about how much my work is valued within the organization	1	2	3	4	5
Feedback on how I do my job	1	2	3	4	5

2. Please assess how satisfied you are with communication with your superior?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
With the availability of the immediate superior	1	2	3	4	5
To what extent is my supervisor familiar with the problems I encounter at work?	1	2	3	4	5
How much does my supervisor understand my problems?	1	2	3	4	5
My potential being recognised by my immediate superior.	1	2	3	4	5

3. Please assess how satisfied you are with horizontal communication (with colleagues)?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
Availability of colleagues	1	2	3	4	5
How well I communicate with my team members?	1	2	3	4	5
Outcomes of communicating with colleagues	1	2	3	4	5
By the willingness of my colleagues to receive criticism	1	2	3	4	5

4. Please assess how satisfied you are with informal communication?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
The number of decisions taken on the basis of informal communication	1	2	3	4	5
The amount of gossip in the organization	1	2	3	4	5
The amount of time I spend in informal communication	1	2	3	4	5
The usefulness of information transmitted informally	1	2	3	4	5

5. Please assess how satisfied you are with corporate awareness?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
Information on the Work Regulations	1	2	3	4	5
Information about the turnover, profit and financial success of the organization	1	2	3	4	5
Information about the changes in the organization	1	2	3	4	5
Information about legal regulations that affect my organization's operations	1	2	3	4	5

6. Please assess how satisfied you are with the communication climate?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
How much communication in the organization helps me feel an important part of it	1	2	3	4	5
How much communication in the organization helps me identify with it	1	2	3	4	5
How much communication in the organization promotes organizational values	1	2	3	4	5
To what extent communication in the organization encourages me to achieve organizational goals	1	2	3	4	5

7. Please assess how satisfied you are with the quality of the communication medium?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
Communication medium (written notifications, intranet, oral communication, etc.)	1	2	3	4	5
The ability to communicate through modern medium (personal computers, mobile phones)	1	2	3	4	5
The quality of communication through modern medium (personal computers, mobile phones)	1	2	3	4	5
By choosing the medium to communicate with me	1	2	3	4	5

8. Please assess how satisfied you are with the communication at the meetings?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
How well organized are the meetings I attend?	1	2	3	4	5
The usefulness of the information obtained at the meetings	1	2	3	4	5
Do I receive information that is important for getting the job done in time?	1	2	3	4	5
Duration of meetings	1	2	3	4	5

9. Please assess how satisfied you are with your job overall?

	1 – Extremely dissatisfied	2 – Dissatisfied	3 – Neither satisfied nor dissatisfied	4 – Satisfied	5 – Extremely satisfied
Overall job satisfaction	1	2	3	4	5

10. Nine aspects of internal communication are listed. With a score of 1 to 5, please, rate how important each aspect of internal communication is to you personally?

	1 – Extremely unimportant	2 – Unimportant	3 – Neither important nor unimportant	4 – Important	5 – Extremely important
Get feedback	1	2	3	4	5
Communication with the supervisor	1	2	3	4	5
Horizontal communication (with colleagues)	1	2	3	4	5
Informal communication	1	2	3	4	5
Corporate awareness	1	2	3	4	5
Communication climate	1	2	3	4	5
Quality of the media of communication	1	2	3	4	5
Communication in meetings	1	2	3	4	5
General job satisfaction	1	2	3	4	5

PUBLIC SECTOR ECONOMICS
49 (2) 213-238 (2025)

11. Total length of service in the company where you are currently employed:

a) less than 5 years
b) from 5 to 9 years
c) from 10 to 19 years
d) from 20 to 29 years
e) more than 30 years

12. Type of employment:

a) Fixed-term contract
b) Indefinite contract

13. Managerial position in the company (manager, director):

a) No
b) Yes

14. What is your sex:

a) Female
b) Male

15. Which age group do you belong to:

a) less than 25 years
b) from 25 to 34 years
c) from 35 to 44 years
d) from 45 to 54 years
e) more than 55 years

16. Highest level of education achieved:

a) Primary school
b) Secondary school
c) Undergraduate studies
d) Graduate studies
e) Postgraduate study

An economic analysis of leisure-proportional benefits in a small open economy

WATARU KOBAYASHI, Ph.D.*
JUNICHIRO TAKAHATA, Ph.D.*

Article**
JEL: E21, H31, H55, J22
https://doi.org/10.3326/pse.49.2.3

* We are indebted to Mitsunari Ishida, Koichi Miyazaki, Atsushi Nakamoto, Taro Ohno, and the two anonymous referees for valuable comments and suggestions.

** Received: July 4, 2024
Accepted: April 5, 2025

Wataru KOBAYASHI
Faculty of Economics, Asia University, 5-8 Sakai, Musashino-city, Tokyo, Japan
e-mail: kobayashi_wataru@asia-u.ac.jp
ORCiD: 0000-0002-5613-779X

Junichiro TAKAHATA
Faculty of Economics, Dokkyo University, 1-1 Gakuen-cho, Soka-city, Saitama, Japan
e-mail: jtakahat@dokkyo.ac.jp
ORCiD: 0000-0002-8840-3722

PUBLIC SECTOR ECONOMICS
49 (2) 239-250 (2025)

Abstract

This paper analyses the impact of public pensions on resource allocation in a small open economy. In particular, we focus on the economic implications of leisure-proportional benefits. It is well known that a pay-as-you-go scheme can improve social welfare when the population growth rate exceeds the interest rate, which we call the "Aaron effect". We analyse the changes in labour supply, savings, and social welfare from an increase in the public pension taking into account the Aaron effect. We obtain the following results. First, we show that the effect of public pensions on labour supply includes the Aaron effect, but regardless of its sign, labour supply decreases as public pensions increase. Second, the effect of public pensions on savings does not include the Aaron effect, and savings decrease as public pensions increase. Third, the effect of the introduction of public pensions on social welfare consists only of the Aaron effect.

Keywords: social security, endogenous retirement, labour supply, savings, social welfare

1 INTRODUCTION

This paper analyses the impact of public pensions on resource allocation in a small open economy in which the labour supply of the older generations is endogenous. In particular, we focus on the economic implications of leisure-proportional benefits.

Leisure-proportional benefits have been discussed in Michel and Pestieau (2013), Miyazaki (2019), Liu and Thøgersen (2020), Kobayashi and Takahata (2022), and others. They consider retirement pensions, with which benefits begin on condition of retirement, considered in the model a la Diamond (1965) in the setting in which individuals have two periods of life. These studies examine the impact of public pensions on retirement decisions and resource allocation by assuming leisure to be post-retirement time.

Although the effects of leisure-proportional benefits have begun to emerge from these earlier studies, there are still some points that remain unclear. For example, Michel and Pestieau (2013) show that the pay-as-you-go scheme has both positive and negative effects on the steady-state capital-labour ratio, but the mechanism by which this occurs is not explained. In addition, Kobayashi and Takahata (2022) show that the introduction of funded schemes increases the steady-state capital-labour ratio, which is also the case.

Therefore, in this paper, we conduct an analysis that assumes a small open economy in order to deepen our understanding of the effects of leisure-proportional benefits. As van Groezen, Leers and Mejidam (2003) write "for analytical convenience", this assumption makes the analysis easier[1]. The above studies all assume a closed economy, so that the capital-labour ratio and factor prices are determined by market equilibrium. In a small open economy, however, where factors of production can move freely, factor prices are given. The capital-labour ratio is also a given condition under a first-order homogeneous

[1] See footnote 9 of van Groezen, Leers and Mejidam (2003: 239).

PUBLIC SECTOR ECONOMICS
49 (2) 239-250 (2025)

production function. This paper takes advantage of this property to analyse the effects of public pensions, including leisure-proportional benefits, on labour supply, savings, and social welfare. In Japan, public pension insurance premiums are collected through wage-proportional taxes, and benefits are paid in a form close to leisure-proportional benefits, and the model in this paper is based on this setting.

In particular, Michel and Pestieau (2013) show that an increase in the pay-as-you-go scheme reduces labour supply in the setting of a logarithmic utility function. The study examines the impact of the pay-as-you-go scheme on the capital-labour ratio. However, it does not determine whether it increases or not. Furthermore, the impact of the pay-as-you-go scheme on welfare is examined and it is shown that welfare is improved when the population growth rate is higher than the interest rate.

Liu and Thøgersen (2020) examine the impact of the pay-as-you-go scheme on the capital-labour ratio in the CES utility function setting. The study identifies a special case where the introduction of a pay-as-you-go scheme has no effect on the capital-labour ratio. This occurs when the elasticity of substitution between consumption and leisure is equal to 1. The study also shows that the impact of the pay-as-you-go scheme on the capital-labour ratio is positive when the elasticity is less than 1. Furthermore, they examine the conditions under which the introduction of a pay-as-you-go scheme improves welfare.

Kobayashi and Takahata (2022) point out that there is a possibility of improving welfare by introducing a funded scheme depending on the relationship between the population growth rate and the interest rate. To clarify the mechanism by which social welfare is improved by the introduction of public pensions, it would be important to know how the public pension system affects labour supply and savings in an economy where factor prices are fixed.

It is well known in the public pension literature that a pay-as-you-go scheme improves social welfare when the population growth rate exceeds the interest rate, because the rate of return on the pay-as-you-go scheme is the population growth rate. This result holds even if the economy does not account for capital accumulation, as shown in Aaron (1966). In this study, we will not take capital accumulation into account, but we will analyse the mechanism by which labour supply and savings are affected by the public pension by decomposing the change into several effects. One of these effects is related to the difference between the population growth rate and the interest rate. We will call this the "Aaron effect[2]".

The results of this study are as follows. First, the effect of public pensions on labour supply is always negative, although there are two effects. If the population growth rate were lower than the interest rate, the Aaron effect would reduce potential lifetime disposable income, so labour supply would increase with a concomitant

[2] Andersen and Bhattacharya (2013) call the property that a pay-as-you-go system improves welfare when the economy is in a dynamically inefficient state the Aaron-Samuelson result. This reflects the results in Samuelson's (1975) model with endogenous capital accumulation, but our study considers a small open economy with exogenous capital accumulation.

PUBLIC SECTOR ECONOMICS
49 (2) 239–250 (2025)

reduction of leisure. In addition, the relative price of leisure is reduced by both wage-proportional taxes and leisure-proportional benefits, so there is a negative effect on labour supply. The former effect (the Aaron effect) is dominated by the latter.

Second, the effect of public pensions on savings is always negative, although there are three effects: the Aaron effect, the "DIY effect", and other effects. In particular, it is shown that the Aaron effect does not exist at all in the case of leisure-proportional benefits, while it does exist in the case of fixed benefits. The effect that we call the DIY effect corresponds to the effect of reducing the source of savings, since Disposable Income in the Young Period is reduced by the collection of taxes. In addition, wage-proportional contributions and leisure-proportional benefits reduce the relative price of leisure, which has a negative impact on consumption in the young period, but this is equivalent to the effect of increasing savings.

Third, as is well known, the social welfare impact of public pensions can be positive if the population growth rate is higher than the interest rate.

The structure of this paper is as follows. In section 2, we present the basic settings of the model and conduct an analysis in the absence of public pensions. In section 3, we introduce public pensions and analyse resource allocation mainly for the case of wage-proportional taxes and leisure-proportional benefits. Section 4 is a summary.

2 MODEL

In this study, we assume a small open economy. Therefore, factor prices such as the wage rate w and the interest rate r are exogenously determined. We consider a two-generation overlapping generations model, and assume that two generations coexist simultaneously in a given period. Assume that there are N_t households in the country born in period t. Assume that the population growth rate for each period is exogenously given by n. This gives the relationship expressed by equation (1) below.

$$N_{t+1} = (1+n)N_t \tag{1}$$

Households born in period t that survive two periods consume c_t and save s_t with labour income w when they are young in period t. We assume that households exogenously supply one unit of labour when they are young. They also consume d_{t+1} with labour income wz_{t+1} and the savings with interest Rs_t when they are old in period $t+1$, where z_{t+1} is the endogenously determined labour supply when households are old in period $t+1$, and where $R \equiv 1+r$. The household budget constraints in such a case are shown in equations (2) and (3) below for young and old, respectively;

$$c_t = w - s_t \tag{2}$$

$$d_{t+1} = Rs_t + wz_{t+1} \tag{3}$$

Suppose that households receive utility from c_t, d_{t+1}, and $1-z_{t+1}$, which is leisure in period $t+1$. We assume that the utility function is logarithmic, as shown in equation (4).

PUBLIC SECTOR ECONOMICS
49 (2) 239-250 (2025)

$$U_t = U\left(c_t, d_{t+1}, 1-z_{t+1}\right) = \ln c_t + \beta\left\{\ln d_{t+1} + \gamma \ln\left(1-z_{t+1}\right)\right\} \tag{4}$$

The first-order conditions are derived for s_t and z_{t+1} as shown in equations (5) and (6).

$$-\frac{1}{w-s_t} + \frac{\beta R}{Rs_t + wz_{t+1}} = 0 \tag{5}$$

$$\frac{\beta w}{Rs_t + wz_{t+1}} - \frac{\beta\gamma}{1-z_{t+1}} = 0 \tag{6}$$

Solving equations (5) and (6) for s_t and z_{t+1} and substituting them into equations (2) and (3), we obtain equations (7)-(10) as follows.

$$z_{t+1} = \frac{1+\beta-\beta\gamma R}{1+\beta+\beta\gamma} \tag{7}$$

$$s_t = \frac{(1+\gamma)\beta R - 1}{(1+\beta+\beta\gamma)R} w \tag{8}$$

$$c_t = \frac{(1+R)}{(1+\beta+\beta\gamma)R} w \tag{9}$$

$$d_{t+1} = \frac{\beta(1+R)}{1+\beta+\beta\gamma} w \tag{10}$$

In this paper, we make the following assumptions so that labour supply and savings are positive in the absence of a public pension.

Assumption 1: $1+\beta-\beta\gamma R > 0$

Assumption 2: $(1+\gamma)\beta R - 1 > 0$.

3 INTRODUCTION OF PUBLIC PENSIONS

In this section, we consider the situation in which the government introduces a pay-as-you-go scheme for public pensions. We consider the case of wage-proportional taxes and leisure-proportional benefits[3]. This combination of taxes and benefits is familiar from the papers of Michel and Pestieau (2013), Miyazaki (2019), Liu and Thøgersen (2020), Kobayashi and Takahata (2022), and others.

In the following, we will analyse how savings, labour supply, and economic welfare will change with the introduction of public pensions. At this point, since we are considering the steady state welfare of a representative individual, we assume a social welfare function as shown in equation (11) below:

$$U = \ln c + \beta\left\{\ln d + \gamma \ln\left(1-z\right)\right\} \tag{11}$$

[3] We also consider the cases of a lump-sum tax and lump-sum benefits (ND, representing no distortion), a wage-proportional tax and lump-sum benefits (PT), and a lump-sum tax and leisure-proportional benefits (PB). The results are summarised in tables 1, 2 and 3.

PUBLIC SECTOR ECONOMICS
49 (2) 239-250 (2025)

We denote the contribution rates for the pay-as-you-go scheme as τ. Taxes are levied at these rates proportionally on wage income earned in both the young and old periods. In addition, the pension benefits are proportional to the length of leisure in the old period. Here, b_t is the pension benefit coefficient in period t. In this case, the household budget constraints in the young and old periods are shown in equations (12) and (13).

$$c_t = (1-\tau)w - s_t \tag{12}$$

$$d_{t+1} = Rs_t + (1-\tau)wz_{t+1} + b_{t+1}(1-z_{t+1}) \tag{13}$$

The government budget constraint for the pay-as-you-go scheme is represented in equation (14) as follows.

$$N_{t+1}\tau w + N_t \tau w z_{t+1} = N_t b_{t+1}(1-z_{t+1}) \tag{14}$$

From equation (14), per capita pension benefit for the scheme is derived as equation (15).

$$\tau w(1+n+z_{t+1}) = b_{t+1}(1-z_{t+1}) \tag{15}$$

The household's lifetime budget constraint in this case is given by equation (16).

$$c_t + \frac{d_{t+1}}{R} + \frac{w(1-z_{t+1})}{R} = w + \frac{w}{R} + \frac{(1+n-R)\tau w}{R} \tag{16}$$

The right-hand side of equation (16) is hereafter referred to as the potential lifetime disposable income. In considering the utility maximizing behaviour of households, government budget constraints are not taken into account.

When the household utility is maximised with respect to s_t and z_{t+1}, the first-order conditions will be as shown in (17) and (18) below.

$$-\frac{1}{(1-\tau)w - s_t} + \frac{\beta R}{Rs_t + (1-\tau)wz_{t+1} + b_{t+1}(1-z_{t+1})} = 0 \tag{17}$$

$$\frac{\beta\{(1-\tau)w - b_{t+1}\}}{Rs_t + (1-\tau)wz_{t+1} + b_{t+1}(1-z_{t+1})} - \frac{\beta\gamma}{1-z_{t+1}} = 0 \tag{18}$$

Given the government's budget constraints, s_t, z_{t+1}, c_t, and d_{t+1} are solved in equations (19)-(22) as follows.

$$s_t = \frac{(1-\tau)w\{(1+\gamma)\beta R - 1\}}{R(1+\beta+\beta\gamma)} \tag{19}$$

PUBLIC SECTOR ECONOMICS
49 (2) 239-250 (2025)

$$z_{t+1} = (1-\tau)\frac{1+\beta-\beta\gamma R}{1+\beta+\beta\gamma} - \tau(1+n) \tag{20}$$

$$c_t = \frac{(1-\tau)w(1+R)}{R(1+\beta+\beta\gamma)} \tag{21}$$

$$d_{t+1} = \frac{\beta(1-\tau)w(1+R)}{1+\beta+\beta\gamma} \tag{22}$$

In this case, the gross savings per capita are calculated as follows:

$$\frac{s_t}{1+n+z_{t+1}} = \frac{\dfrac{w\{(1+\gamma)\beta R-1\}}{R(1+\beta+\beta\gamma)}}{(1+n)+\dfrac{1+\beta-\beta\gamma R}{1+\beta+\beta\gamma}} \tag{23}$$

To see the effect of the public pensions on labour supply, we differentiate z with respect to τ, which is derived in equation (24) as follows:

$$\frac{\partial z}{\partial \tau} = -(1+n-R) - \frac{(1+\beta)(1+R)}{1+\beta+\beta\gamma} < 0 \tag{24}$$

Equation (24) shows that an increase in the pay-as-you-go scheme affects labour supply in two ways: the Aaron effect due to a change in the potential lifetime disposable income, and the other effects caused by a decrease in the after-tax wage rate. Under Assumption 1, the sum of the two terms is negative.

For the first term, if the population growth rate is higher than the interest rate, i.e. $1+n-R>0$, the potential lifetime disposable income, which is the right-hand side of the above equation (16), can be increased by introducing the pay-as-you-go scheme. This increase in the potential lifetime disposable income leads to an income effect that increases leisure and reduces labour supply, which we will call the Aaron effect.

In the second term, due to wage-proportional contributions and leisure-proportional benefits, the increase in the public pension reduces the after-tax wage rate, which discourages household labour supply. Comparing the labour supply derivatives between the leisure-proportional benefits and fixed benefits cases, it is shown that the leisure-proportional benefits have a greater effect in reducing the amount of labour supply that people are willing to provide[4].

This analysis shows that the sum of the two effects is always negative in total, as shown in Proposition 1.

[4] The details of PT case and PB case are omitted for reasons of space.

Proposition 1. The effect of public pensions on labour supply includes the Aaron effect, but regardless of its sign, labour supply decreases as public pensions increase.

Here we summarise the effects of public pensions on labour supply in table 1. The above case is considered as PT & PB in the right column, compared with the other cases of ND (No Distortion case; lump-sum tax and lump-sum benefits), PT (Wage-Proportional Tax case; wage-proportional tax and lump-sum benefits), and PB (Leisure-Proportional Benefits case; lump-sum tax and leisure-proportional benefits)[5].

Table 1

The effect of pay-as-you-go scheme on labour supply

Effect		ND	PT	PB	PT & PB
Aaron effect	If $1+n-R>0$	–	–	–	–
	If $1+n-R<0$	+	+	+	+
Other effects		0	–	–	–
Total	If $1+n-R>0$	–	–	–	–
	If $1+n-R<0$	+	–	–	–

Source: Authors.

Next, we will examine the impact of the introduction of public pensions on savings. Equation (25) shows the derivative of savings s with respect to τ, the contribution rate for the pay-as-you-go scheme, which shows the effect of the pay-as-you-go scheme on savings.

$$\frac{\partial s}{\partial \tau} = -w + \frac{w(1+R)}{R(1+\beta+\beta\gamma)} < 0 \tag{25}$$

It does not include the term for the Aaron effect, which results from changes in the potential lifetime disposable income. This is clear from the fact that there is no term associated with $1+n-R$. It is shown that there is no Aaron effect on savings in the case of leisure-proportional benefits, while it exists in the case of fixed benefits.

The first term is the DIY effect. Since the disposable income of young households is reduced by the tax levy, such a taxation has the effect of reducing the source of savings, and the DIY effect has a negative sign.

The second term consists of the other effects. The decrease in the relative price of leisure, caused by both wage-proportional taxes and leisure-proportional benefits, has a negative effect on consumption when individuals are young, but it is equivalent to the effect of increased savings.

Under Assumption 2, the sum of these two effects is negative.

[5] In the ND and PB cases, public pension contributions are collected as a lump-sum tax. In this case, whether the taxes are collected when households are young or not is only important for the DIY effect, since the tax is not distortionary. For reasons of space, the other three cases (ND, PB, and PT) are not discussed in detail.

PUBLIC SECTOR ECONOMICS
49 (2) 239-250 (2025)

Proposition 2. The effect of public pensions on savings does not include the Aaron effect, and savings decrease as public pensions increase.

We summarise the effects of the public pension on savings in table 2. The above case is considered as PT & PB in the right-hand column, compared with the other cases of ND, PT, and PB. It is clear that the Aaron effect disappears only when the leisure-proportional benefits are considered.

Table 2

The effect of pay-as-you-go scheme on savings

Effect		ND	PT	PB	PT & PB
Aaron effect	If $1+n-R>0$	–	–	0	0
	If $1+n-R<0$	+	+	0	0
DIY effect[6]		–	–	–	–
Other effects		0	+	+	+
Total		–	–	–	–

Source: Authors.

Finally, we will shift our focus to social welfare. From equations (20)-(22), social welfare is represented by the tax rates τ in equation (26).

$$U=(1+\beta)\ln\left\{\frac{(1-\tau)w(1+R)}{R(1+\beta+\beta\gamma)}\right\}+\beta\ln\beta R \\ +\beta\gamma\ln\left\{\frac{\beta\gamma(1+R)}{1+\beta+\beta\gamma}+\frac{(1+\beta)(2+n)+\beta\gamma(1+n-R)}{1+\beta+\beta\gamma}\tau\right\} \tag{26}$$

To see the impact of public pensions on social welfare, we calculate the derivatives of the social welfare function with respect to the contribution rates for each scheme in equation (27) as follows.

$$\frac{\partial U}{\partial\tau}=-\frac{1+\beta}{1-\tau}+\frac{\beta\gamma\left[(1+\beta)(2+n)+\beta\gamma(1+n-R)\right]}{\beta\gamma(1+R)+\left[(1+\beta)(2+n)+\beta\gamma(1+n-R)\right]\tau} \tag{27}$$

If we consider that there is no pension, we have the following;

$$\left.\frac{\partial U}{\partial\tau}\right|_{\tau=0}=\frac{(1+\beta+\beta\gamma)(1+n-R)}{1+R} \tag{28}$$

It is shown that if the contribution rate is sufficiently small, social welfare is improved by increasing the contribution rate as long as $1+n-R>0$. Even if the condition $1+n-R>0$ holds, when the public pension is large enough, expanding the public

[6] DIY denotes Disposable Income in Young Period.

pension worsens welfare. This is a well-known result that has been studied in the literature where capital accumulation is not explicitly considered, such as Aaron (1966)[7].

Proposition 3. The effect of the introduction of public pensions on social welfare consists only of the Aaron effect.

We summarise the effects of the introduction of public pensions on social welfare in table 3. It is verified that there is only the Aaron effect for these four cases.

Table 3

The effect of pay-as-you-go scheme introduction on social welfare

		ND	PT	PB	PT & PB
Aaron effect	If $1 + n - R > 0$	+	+	+	+
	If $1 + n - R < 0$	–	–	–	–

Source: Authors.

4 CONCLUSION

This paper analyses the economic impact of leisure-proportional benefits in a small open economy. In particular, it examines the effects of public pension contributions and benefits on labour supply, savings, and social welfare. The results of the study are presented below.

First, it is shown that the introduction of pensions discourages labour supply, except in the case of lump-sum contributions and lump-sum benefits (ND). It is shown that the wage-proportional contributions and leisure-proportional benefits have the effect of encouraging leisure and discouraging labour supply. Even in the cases where the Aaron effect is positive, the overall effect on labour supply is negative. Second, under the assumption of leisure-proportional benefits, there is no Aaron effect on savings. However, due to the effect of disposable income in the young period and the other effects, the pay-as-you-go scheme reduces total savings in all cases.

Third, this study has shown that the introduction of pay-as-you-go public pension schemes can improve social welfare, regardless of the combination of contributions and benefits. This is due to the Aaron effect, where an increase in public pensions can increase the potential lifetime disposable income if the population growth rate exceeds the interest rate.

The policy implication of this study is as follows. A small amount of public pension can improve welfare when population growth rates are higher than interest rates. If the public pension is too large, the welfare cannot be improved.

The paper leaves some questions open. First, even in the case of leisure-proportional benefits, it is clear that the pay-as-you-go schemes can change the potential lifetime

[7] There is another strand of literature that takes capital accumulation into account to consider dynamic efficiency, starting with Diamond (1965).

PUBLIC SECTOR ECONOMICS
49 (2) 239-250 (2025)

disposable income, which is the Aaron effect, but this paper does not provide any explanation as to why it has no effect on savings.

Second, the results in this study are obtained under a logarithmic utility function. Therefore, the robustness of the results obtained in this study is limited. To better understand the mechanism, the model should be considered in a general form using Slutsky decomposition. This issue should be investigated in future studies.

Third, how per capita capital changes when public pensions increase has not been analysed. This should be considered in a model in which capital accumulation is considered. Since this study is conducted on a model of a small open economy, this point should be investigated in another study.

Disclosure statement

The authors have no conflict of interest to declare.

REFERENCES

1. Aaron, H., 1966. The Social Insurance Paradox. *Canadian Journal of Economics and Political Science*, 32(3), pp. 371-374. https://doi.org/10.2307/139995
2. Andersen, T. and Bhattacharya, J., 2013. Unfunded Pensions and Endogenous Labor Supply. *Macroeconomic Dynamics*, 17(5), pp. 971-997. https://doi.org/10.1017/S1365100511000794
3. Diamond, P., 1965. National Debt in a Neoclassical Growth Model. *American Economic Review*, 55(5), pp. 1126-1150.
4. van Groezen, B., Leers, T. and Mejidam, L., 2003. Social Security and Endogenous Fertility: Pensions and Child Allowances as Siamese Twin. *Journal of Public Economics*, 87(2), pp. 233-251. https://doi.org/10.1016/S0047-2727(01)00134-7
5. Kobayashi, W. and Takahata, J., 2022. A Funded Pension System with Endogenous Retirement. *Asian Journal of Economic Modelling*, 10(3), pp. 207-215. https://doi.org/10.55493/5009.v10i3.4569
6. Liu, P. and Thøgersen, J., 2020. Pay-As-You-Go Pensions and Endogenous Retirement. *Macroeconomic Dynamics*, 24(7), pp. 1700-1719. https://doi.org/10.1017/S1365100518001013
7. Michel, P. and Pestieau, P., 2013. Social Security and Early Retirement in an Overlapping-Generations Growth Model. *Annals of Economics and Finance*, 14(2), pp. 705-719.
8. Miyazaki, K., 2019. Optimal Pay-as-You-Go Social Security with Endogenous Retirement. *Macroeconomic Dynamics*, 23(2), pp. 870-887. https://doi.org/10.1017/S1365100517000062
9. Samuelson, P., 1975. Optimum Social Security in a Life-Cycle Growth Model. *International Economic Review*, 16(3), pp. 539-544. https://doi.org/10.2307/2525994

Governance quality vs. stimulus size: fiscal policy effectiveness during the COVID-19 pandemic

MERT TOPCU, Professor of Economics*
MUSTAFA ALPIN GULSEN, Associate Professor of Public Finance*

Article**
JEL: H11, H30, O11
https://doi.org/10.3326/pse.49.2.4

* The authors would like to thank Co-Editor Katarina Ott and two anonymous reviewers for their valuable comments.

** Received: December 25, 2024
Accepted: March 23, 2025

Mert TOPCU
Alanya Alaaddin Keykubat University, Faculty of Economics, Administrative and Social Sciences, Department of Economics, 07425, Alanya, Antalya, Türkiye
e-mail: mert.topcu@alanya.edu.tr
ORCiD: 0000-0001-8236-9810

Mustafa Alpin GULSEN
Alanya Alaaddin Keykubat University, Faculty of Economics, Administrative and Social Sciences, Department of Public Finance, 07425, Alanya, Antalya, Türkiye
e-mail: alpin.gulsen@alanya.edu.tr
ORCiD: 0000-0002-2860-4469

PUBLIC SECTOR ECONOMICS
49 (2) 251–272 (2025)

Abstract

Given the importance of good governance for the efficiency of government spending, this study reveals the role of governance quality in fiscal policy effectiveness during the COVID-19 outbreak. Using cross-country threshold regressions for 144 countries, we find that a stringent lockdown policy (i) does not lead to economic downturn in countries with larger fiscal stimulus, (ii) leads countries with poor governance quality to head toward economic slowdown even with higher stimulus packages, (iii) does contribute to economic recovery even in countries with smaller fiscal packages if accompanied by higher governance quality. Overall, the results suggest that good governance helps achieve economic recovery, whereas an increase in the size of the fiscal stimulus can, at best, help protect against economic slowdown. The empirical findings have several implications for policymakers in countries where the blow hits the hardest, as well as for fiscal governance framework.

Keywords: fiscal stimulus, governance quality, COVID-19

1 INTRODUCTION

With the implementation of lockdown policies, pandemic-induced output losses have been of particular importance across the globe. Mobility levels collapsed in early March 2020 because of a mix of government-imposed restrictions and individual voluntary decisions. Production shrank dramatically in 2020 while recovery rose in 2021 with the vaccination rollout[1]. To mitigate the health and economic downturn caused by the outbreak, governments all over the world engaged in massive fiscal support programs (De Soyres, Santacreu and Young, 2022). As described by Blanchard (2020), the motto for fiscal policy was: "whatever it takes" and fiscal stimulus injections were probably the most effective tool adopted by the governments to slow down the impact of the lockdown during these unprecedented times of high uncertainty (Basri, Ing and Schulze, 2022; Tsatsaronis et al., 2022).

Makin and Layton (2021) argue that increased government spending as a fiscal stimulus that helps aggregate demand increase has countervailing effects elsewhere in the economy that eventually neutralize its influence[2]. The authors assert that fiscal relief measures focusing on stimulating aggregate demand are inferior to those targeting the supply side of the economy. Therefore, one might expect demand-stimulating policies to be well-calculated[3] or supported by a well-targeted supply-leading framework. Previous literature addresses good governance and/or

[1] Note that real per capita income (2015 U.S.$ in constant prices) growth was -3,85 in 2020 while it was 5,47 in 2021 (World Bank WDI Database, 2024).

[2] Notice that there is well-documented literature on the potential macroeconomic costs of fiscal packages provided in the pandemic era (see, i.e., Banerjee et al., 2022; Dean, 2022; De Soyres, Santacreu and Young, 2022; Horton and El-Ganainy, 2022; among others).

[3] According to Blanchard (2020), governments should be prepared to take action, but should not commit to a precise amount of fiscal expansion before they exactly estimate its impact on demand.

PUBLIC SECTOR ECONOMICS
49 (2) 251-272 (2025)

institutional quality[4] as a major determinant of government spending efficiency. However, the existing literature focusing on the pandemic era has, to the best of our knowledge, ignored the potential role of governance quality[5]. Ramey (2019) asserts that the effectiveness of fiscal stimulus may depend on the severity of the downturn and the initial economic conditions during an economic crisis. Given the severity of the pandemic, then the key question in the debate over fiscal policy effectiveness becomes whether stimulus size alone is sufficient to drive economic recovery or whether governance quality plays a moderating role. From this point of view, this study attempts to address the role of governance quality in fiscal policy effectiveness during the pandemic. The main research question raised in the study is: "does governance quality increase the effectiveness of fiscal stimulus?". Given this research question, this study addresses the aforementioned research gap by investigating the extent to which governance quality moderates the effectiveness of fiscal stimulus during the pandemic. Specifically, our main hypothesis is that "stringent lockdown policies do contribute to economic recovery in countries where governance quality is higher, regardless of the size of the fiscal stimulus".

Section 2 provides the background of the study. Section 3 describes the good governance concept. Section 4 presents the empirical framework and results. Section 5 discusses policy implications. Section 6 gives concluding remarks.

2 FISCAL POLICY, GOOD GOVERNANCE AND GROWTH

The role of government in an economy is crucial in the distribution and allocation of resources as well as social organization, law and order, and political stability (Cooray, 2009). A significant uneven growth pattern across rich and poor nations has been of great importance in the economics literature, and a large strand of the literature emphasizes the importance of institutional quality or good governance. Theoretically, governance quality can affect economic growth in two ways: (i) by enhancing the productivity of physical and human capital stock, and (ii) by improving social infrastructure which facilitates financial system soundness to attract capital investments (Azimi, 2022).

Following the early attempts that examined the size dimension (see, i.e., Barro, 1990; 1991; Barro and Sala-i-Martin, 1992; among others), recent studies have investigated the quality dimension indicating the efficiency of public services. In the late 1990s and early 2000s, some of the research focused on the effectiveness of public capital in the growth process. Pritchett (1996) shows that the slow growth rates in many developing countries are not due to the amount of government investment but rather to inefficiency in converting these investments into

[4] Because good governance stimulates the institutions expected to play a crucial role in facilitating economic growth (Knack and Keefer, 1995; 1997; Acemoglu, Johnson and Robinson, 2001; Acemoglu and Robinson, 2012; among others), there is a strong connection – even interchangeability – between governance quality and institutional quality.

[5] Gregory (2022), the only study that attempts to address this issue in the context of environmental and social governance with micro-level data, finds that non-financial firms that manage environmental and governance risk better were able to perform better over the pandemic.

productive capital, specifically with less than $0.50 of capital created for every $1 of public investment. Calculating an aggregate index based on a number of public services, Hulton (1996) shows that public infrastructure effectiveness is able to explain over one-quarter of the differential growth between Africa and East Asia. Using the indicators proposed by Hulton (1996), Aschauer (2000) constructs a different index to observe that a 1% increase in either the quantity or the efficiency of public capital leads to an increase in GDP per capita of 0.29%.

The literature provides strong support for a close relationship between fiscal policy and the quality of institutions. De Mello (2008) reveals that the quality of institutions is crucial for fiscal sustainability. Previous literature has indicated that excessive government spending and budget deficits commonly arise once the quality of institutions is poor and fiscal policy authority is fragmented (Alesina and Perotti, 1999; Kontopoulos and Perotti, 1999; Persson and Tabellini, 2004). In addition, there is also a parallel literature addressing the interaction between the weakness (strength) of political institutions and the procyclicality (countercyclicality) of fiscal policy. For instance, Alesina, Campante and Tabellini (2008) find that procyclicality of fiscal policy is more pronounced in more corrupt democracies, depending on the quality of political institutions. Calderón and Schmidt-Hebbel (2008) find that institutional factors are better able to explain the differences in the cyclicality of budget balances between advanced and developing countries. Frankel, Vegh and Vuletin (2013) discover a causality nexus running from high-quality institutions to a more countercyclical (or less procyclical) fiscal policy. Temsumrit (2022) shows that high-quality institutions play a crucial role in limiting cyclical policy, and these effects are more pronounced in democratic countries.

Wilhelms (1998) suggests that government policies executed within a sound institutional framework are of particular importance for any given country to achieve the desired improvements in economic growth. Given this argument, the contribution of government spending efficiency to economic growth through a good governance mechanism has received great attention in the empirical literature. Plumper and Martin (2003) find that the efficiency of public expenditure is lower in less democratic countries. Collier and Goderis (2007) find that increases in government expenditures decrease economic growth through a channel exacerbated by poor-quality institutions. Feeny and Rogers (2008) show that public spending efficiency increases with governance quality, which, in turn, helps achieve higher economic outcomes. Rajkumar and Swaroop (2008) find that government expenditures are more likely to be successful in countries with higher governance quality than in those with lower governance quality. Cooray (2009) shows that either higher government expenditure or higher governance quality could contribute to growth, though governance has a stronger impact. Afonso, Schuknecht and Tanzi (2010) report that institutional quality has a positive impact on the efficiency of social spending. Kaplanoglou and Rapanos (2011) reveal that even fiscal consolidation packages will fall short if the institutional quality does

PUBLIC SECTOR ECONOMICS 49 (2) 251-272 (2025)

not foster long-term growth. Chan and Karim (2012) report that political stability leads to higher public spending efficiency. El Anshasy and Katsaiti (2013) find that what matters to economic growth is the quality of fiscal policy, not the quantity. In particular, they point out that high governance quality and stronger democratic institutions improve fiscal performance, which, in turn, leads to higher economic growth. Chan, Ramly and Karim (2017) find that growth is accelerated by government expenditure efficiency and that the moderating impact of fiscal policy tools is improved by the democratic quality and legislative strength of the government. The authors argue that democracy and the ability of governments to implement their programs strengthen the quality of economic institutions, which, in turn, affects economic performance.

There is growing literature on the impact of fiscal policy in cushioning the blows to the economy of COVID-19. Aguirre and Hannan (2021) find that the detrimental medium-term impacts of the pandemic on output are relatively limited for countries with greater fiscal packages. Alberola et al. (2021) find that the size of the fiscal packages is determined by factors such as income, automatic stabilizers, and social safety levels. Chen et al. (2021) reveal that the pandemic severity is correlated with similarities in the types and aims of fiscal policy responses, variances in the quantity of fiscal stimulus, as well as the economic conditions of the countries. Chudik, Mohaddes and Raissi (2021) show that fiscal policy plays an important role in mitigating the effects of COVID-19 and countries with larger fiscal stimulus are expected to experience fewer output contractions. Deb et al. (2021) reveal that fiscal policy announcements are effective in boosting economic activity, but the impact is volatile across measures and country characteristics. In particular, emergency measures (such as unemployment insurance, wage subsidies, and cash transfers) are more effective when lockdown policies are stringent whereas demand-support measures (such as equity injections, government provision of loans, and other liquidity measures) are more effective when lockdown measures are loose. Haroutunian, Osterloh and Sławińska (2021) indicate that the immediate response of fiscal measures has been strong and has considerably helped countries mitigate the effects of the outbreak. Hudson et al. (2021) observe that the size of the fiscal packages is not uniform across countries, and the potential factors affecting the package sizes are the severity of the pandemic, automatic stabilizers, and pre-pandemic fiscal space. Auerbach et al. (2022) show that the effects of fiscal policies are stronger during the peak of the pandemic but only in places where stricter lockdown policies are not implemented. Without an empirical framework, Bascunan (2022) discusses the role of fiscal institutions and asserts that strengthening fiscal institutions should be an economic policy priority during the COVID-19 pandemic. Bui et al. (2022) show that the response to fiscal policy (represented by whether respondents and/or other households receive financial assistance from the government because of the pandemic) is expected to be stronger if there is an optimistic macroeconomic outlook and higher prosperity. Using a policy and a counterfactual scenario, Di Bartolomeo, D'Imperio and Felici (2022) show that prompt fiscal policy reactions to the pandemic have

PUBLIC SECTOR ECONOMICS
49 (2) 251–272 (2025)

dramatically slowed down the impact of the lockdown. Using total expenditure, public consumption, and public investment multipliers, Kinda, Lengyel and Chahande (2022) find that fiscal multipliers during the pandemic era (a year after) are about twice as large as they are during normal times. Tervala and Watson (2022) focus on output and welfare multipliers of transfer payments, public consumption, and public investment to observe that all components have high multipliers, though public investment has the highest. A report released by ESCAP (2020) argues that social protection must be a key element of recovery plans as a part of fiscal stimulus, which pushes up the aggregate demand and promotes the revival of the economy, by generating spillover and multiplier effects for the economy.

To summarize, one can make three essential inferences from the previous discussions that have motivated this study. First, government spending efficiency contributes to growth through governance and/or institutional qualities. Second, the effectiveness of fiscal stimulus in the COVID-19 era remains under examination in the current literature. Third, governance quality has not been addressed as a potential channel through which fiscal stimulus packages in the COVID-19 era may impact growth.

3 GOOD GOVERNANCE CONCEPT

The literature focusing on quality dimensions has measured the impact of governance using various aspects of governance such as democracy, property rights and so on (see, i.e., Barro, 1999; Acemoglu et al., 2008; Gradstein, 2004). However, Kaufmann, Kraay and Zoido-Lobatón (1999a; 1999b) show that compared to a single indicator, aggregate governance indicators are able to provide more information on the level of governance and offer multidimensional perspectives. Thus, they construct six indicators corresponding to six basic governance concepts. The latest version of these indicators is proposed by Kaufmann, Kraay and Mastruzzi (2010) and has been used by the World Bank (WB) as Worldwide Governance Indicators (WGI). Kaufmann, Kraay and Mastruzzi (2010: 4) define each indicator as follows:

> "(a) The process by which governments are selected, monitored, and replaced:
>
> 1. *Voice and accountability*, capturing perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.
>
> 2. *Political stability and the absence of violence/terrorism*, capturing perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.
>
> (b) The capacity of the government to effectively formulate and implement sound policies.
>
> 3. *Government effectiveness*, capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence

PUBLIC SECTOR ECONOMICS
49 (2) 251-272 (2025)

from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
4. *Regulatory quality*, capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. (c) The respect of citizens and the state for the institutions that govern economic and social interactions among them.
5. *Rule of law*, capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.
6. *Control of corruption*, capturing perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests."

With the proposal of multidimensional governance indicators, the most recent studies have incorporated these indicators to observe whether governance quality matters (see, i.e., Gani, 2011; Omri and Hadj, 2020; Abid et al., 2021; among others). Notice that these aggregate governance indicators are useful not only because of broad country groupings according to levels of governance; but their applicability even with a larger sample of countries (Kaufmann, Kraay and Zoido-Lobatón, 1999a).

4 EMPIRICAL FRAMEWORK

4.1 DATA AND VARIABLES

This study uses annual observations from 144 countries[6]. Considering Baumol's (1986) convergence equation, we use the following equation to estimate the impact of the lockdown on economic recovery:

$$lng_{i,2021} - lng_{i,2019} = \alpha_0 + \alpha_1 lnk_{i,2019} + \alpha_2 lne_{i,2019} + \alpha_3 lnld_{i,2020} + \varepsilon_i \qquad (1)$$

where economic growth (g) is the indicator of economic recovery and is measured by per capita real GDP in 2021 as a share of per capita real GDP in 2019 to observe the impact of the recovery. Note that the focus on the difference between a year after and a year before the pandemic is not only motivated by the measures and policies implemented in 2021 but also by the strong base effect in 2021. Note also that economic recovery is better captured at an annual level as quarterly GDP fluctuations may reflect short-term shocks or seasonal variations that do not accurately represent long-term recovery trends. Data on per capita real GDP originate from the International Monetary Fund World Economic Outlook (2022) database. Lockdown policies are measured using the stringency index proposed by Hale et al. (2021). The stringency index is an aggregate score composed of nine measures including

[6] Countries in the sample are available in appendix.

PUBLIC SECTOR ECONOMICS
49 (2) 251–272 (2025)

workplace closures, school closures, travel bans, etc., and rescaled to a value ranging from 0 to 100. Note that the higher stringency index[7] is associated with a stricter lockdown response. Note that there are a few other sources, including Google Community Mobility Reports to substitute for the stringency index. However, the stringency index is chosen specifically due to its explicit focus on government-imposed lockdown policies as well as providing consistent and comparable cross-country data on the severity and timing of restrictions. Capital stock (k) is represented by the per capita real gross fixed capital formation while the education (e) indicator is the mean years of schooling, both drawn from the United Nations Statistics Division (2021) database. Notice that we regress income growth over 2019-2021 on initial capital stock and initial education level. The fiscal policy package is represented by a stimulus index[8] proposed by Elgin, Basbug and Yalaman (2020). Governance quality is represented by Worldwide Governance Indicators obtained from the WB Worldwide Governance Indicators (2021) database. A single index has been constructed using principal components analysis (PCA) to measure the aggregate impact[9]. The PCA results, summarized in table 1, show that the first principal component (PC1) explains 85.18% of the total variance, while the second principal component (PC2) contributes an additional 6.78%. Since PC1 alone captures a substantial amount of the variance, this suggests that the six governance indicators have a common underlying structure. This justifies reducing multidimensionality by constructing a single composite governance index.

Table 1

PCA results (in %)

Principle component	Proportion of variance	Cumulative proportion
PC1	85.1	85.1
PC2	6.7	91.9
PC3	4.5	96.5
PC4	2.0	98.6
PC5	0.8	99.4
PC6	0.5	100.0

Source: Authors' calculation.

[7] While this index is widely used in the literature and provides a standardized measure for cross-country comparisons (Gros, Ounnas and Yeung, 2021; Ma et al., 2021), it has some limitations. Specifically, the index may not fully capture informal lockdowns, localized restrictions, or differences in enforcement levels across regions within a country. Moreover, reporting inconsistencies could exist among countries, particularly in cases where subnational governments implemented independent restrictions that were not reflected in national-level data. Despite these limitations, the index remains an effective proxy for lockdown stringency, given its broad coverage and methodological consistency across countries.

[8] We use the version of the dataset released on May 7, 2021.

[9] Governance quality is a multidimensional concept, and its impact on economic outcomes is often the result of the combined influence of various institutional factors. By using a single index derived from PCA, we focus on the aggregate effect of governance rather than the isolated impacts of each indicator. This approach allows us to analyse governance as a unified construct and prevents overemphasis on specific dimensions while maintaining methodological coherence.

PUBLIC SECTOR ECONOMICS
49 (2) 251–272 (2025)

Note that all variables have been converted to natural logarithms[10] to address skewness and heteroscedasticity. In addition, this transformation allows us to interpret the coefficients as elasticities in measuring the lockdown elasticity of growth.

Table 2
Summary statistics

Variables	Obs.	Mean	Std. dev.	Min.	Max.
Growth	144	-0.010	0.053	-0.179	0.165
Capital	144	7.116	1.541	2.978	10.561
Education	143	2.079	0.457	0.470	2.653
Lockdown policy	144	3.988	0.451	1.868	4.497
Fiscal stimulus	144	2.293	1.211	-1.647	8.202
Governance quality	144	-0.150	1.379	-2.304	2.222

Source: Authors' calculation.

Table 2 provides descriptive statistics. Notice that the highest standard deviation comes from the capital variable which is followed by the governance and stimulus variable, indicating the heterogeneous governance quality and package size across the countries in the sample. Notice also that the high variation in the capital stock variable indicates heterogeneity in financial resources and investment capacity across countries. Countries with higher capital levels likely exhibit greater economic resilience, enabling them to finance recovery efforts more effectively.

Table 3
Correlation matrix

	Growth	Capital	Education	Lockdown policy	Fiscal stimulus
Growth	1.000				
Capital	0.187	1.000			
Education	0.191	0.690	1.000		
Lockdown policy	-0.163	0.416	0.435	1.000	
Fiscal stimulus	0.048	0.436	0.376	0.227	1.000

Source: Authors' calculation.

Table 3 shows the correlation matrix among the variables. The weak correlation between fiscal stimulus and growth indicates that fiscal stimulus alone may not significantly impact economic recovery, addressing the main motivation of the existing paper. Notice that the weak correlation between growth and traditionally strong drivers like capital and education suggests that the pandemic disrupted usual growth patterns. Notice also that all correlations are positive with the exception of the lockdown policy variable, indicating that stricter lockdown measures were associated with weaker economic growth. The fact that the correlation of lockdown policy with growth is slightly similar in absolute terms to those of

[10] To avoid negative values, the inverse hyperbolic sine transformation is applied where required.

PUBLIC SECTOR ECONOMICS
49 (2) 251–272 (2025)

capital and education suggests that lockdown measures have a comparable impact on economic recovery as traditional growth drivers during the pandemic, which reflects the exceptional nature of the crisis.

4.2 MODEL SPECIFICATION AND RESULTS

The empirical model is based on a cross-country threshold regression. Unlike interaction models, which assume a continuous moderating effect, the threshold approach empirically determines cut-off points where the impact of the lockdown policy on growth shifts significantly depending on fiscal stimulus size and governance quality levels. To this end, we use a simple cross-section version of Hansen's (1999) threshold model as described below:

$$g_i = \alpha_0 + \alpha_i^{'} Z_i I\left(X_i \le \lambda\right) + \alpha_i^{'} Z_i I\left(X_i > \lambda\right) + \varepsilon_i \quad (2)$$

where $I(\cdot)$ is the indicator function. $Z_i = (k_i, e_i, ld_i)'$ is a (3×1) vector and $\alpha_i = \left(\alpha_{1i}, \alpha_{2i}, \alpha_{3i}\right)'$ is the parameter vector of slope coefficients. The observations are divided into two regimes in equation (2) depending on whether the threshold variable X_i is smaller or larger than the threshold λ.

Notice that equation (2) has a single threshold and can be extended with multiple thresholds. The double threshold model takes the form:

$$g_i = \alpha_0 + \alpha_1^{'} Z_i I\left(X_i \le \lambda_1\right) + \alpha_2^{'} Z_i I\left(\lambda_1 < X_i \le \lambda_2\right) + \alpha_3^{'} Z_i I\left(\lambda_2 < X_i\right) + \varepsilon_i \quad (3)$$

where the thresholds are ordered so that $\lambda_1 < \lambda_2$.

Empirical results reported in Panel A of table 4 indicate a single threshold effect with respect to the fiscal package whereas we find evidence of a double threshold effect that separates countries based on their governance quality. Note that the focus on single and double thresholds is motivated by the continuous structure of governance quality and fiscal stimulus size, indicating that their effects may exhibit multiple breakpoints where fiscal policy shifts from being effective to ineffective or vice versa.

In light of the findings presented in Panel A, we observe that a stringent lockdown policy does not lead to an economic slowdown in countries with larger fiscal stimulus. We also find that a stringent lockdown policy helps economic recovery in countries with stronger governance quality even if they announce a smaller fiscal package, whereas countries with weaker governance quality – even when announcing larger fiscal packages – are headed toward an economic slowdown. Overall, regression results across thresholds reveal that what really matters in the recovery process is good governance practices rather and not the size of the stimulus. As a consequence, these findings strongly support the hypothesis that stringent lockdown policies contribute to economic recovery in countries with higher governance quality, regardless of the size of the fiscal stimulus.

Table 4
Estimation results

	Panel A: Full Sample		Panel B: Robustness Check	
Regimes	**Coefficients**		**Coefficients**	
Regime 1	-0.045*** (0.009)	-0.027** (0.014)	-0.040*** (0.012)	-0.041*** (0.015)
Regime 2	0.017 (0.015)	0.001 (0.013)	0.038 (0.018)	0.002 (0.016)
Regime 3	–	0.039** (0.019)	–	0.039** (0.019)
Threshold variable	fiscal stimulus	δ	fiscal stimulus	δ
Threshold order	1: 1.395	1: -0.736 2: 0.145	1: 1.798	1: -0.761 2: 0.145

*Note: Regressions include a regime varying constant. The results of regime-varying control variables are not reported. δ is an interaction of governance quality with the reverse of the fiscal stimulus. White-corrected standard errors in parentheses. *** and ** indicate significance at 1% and 5% levels, respectively. The maximum number of thresholds has been set to 2.*

Source: Authors' calculation.

Note that an encompassing sample is likely to lead to biased and inefficient results due to the presence of outliers. Therefore, countries whose per capita income is less than 2,500 U.S. dollars are omitted from the robustness analysis[11] to see whether our result remains consistent. These countries include the following: Burkina Faso, Burundi, Central African Republic, Chad, Democratic Congo, Eritrea, Gambia, Guinea, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Togo, Uganda, Yemen, and Zimbabwe. Empirical results presented in Panel B show that our findings are robust to the sample size.

5 DISCUSSION

Public governance is more important than ever during crises such as the COVID-19 pandemic, in view of its economic and social effects. Government structures have been vital to the initial reactions of the countries and will remain so as economies recover and establish "a new normal" after the crisis. Therefore, the implications of this study are highly relevant to governments, not only in addressing the economic aftermath of the COVID-19 pandemic but also in preparing for large potential external shocks in the future.

The actual threshold values obtained from the regression analysis let us identify and compare the country-level interaction terms to see if any country's interaction term has passed the threshold value and if so, what this would mean in practice. Table 5 classifies the countries with respect to threshold values. Notice that countries characterized by strong governance quality and superior institutional

[11] As an additional methodological robustness check, it would be helpful to address potential endogeneity concerns related to governance quality and fiscal stimulus influenced by unobserved country characteristics. While panel data approaches could help mitigate such concerns, our analysis based on cross-sectional data limits is limited in its ability to control for unobserved heterogeneity.

performance (above the threshold value 2) are able to benefit from even smaller fiscal packages whereas less developed countries (below the threshold value 1) find it difficult to mitigate the effects of the pandemic, irrespective of the package size. One can simply infer from this classification that countries with the ability to allocate required resources promptly could respond more forcefully to external shocks due to their structural soundness, and, therefore, buffer the unforeseen impacts of COVID-19 effectively.

Table 5

Country list by threshold level

Below threshold value 1			Above threshold value 2			
Angola	Gabon	Myanmar	Algeria	Denmark	Israel	Saudi Arabia
Bangladesh	Haiti	Nicaragua	Australia	Estonia	Jamaica	Slovak R.
Belarus	Iraq	Nigeria	Austria	Finland	Malaysia	South Korea
Central African R.	Kenya	Republic of Congo	Belgium	France	Mauritius	Spain
Chad	Laos	Tajikistan	Botswana	Georgia	Namibia	Sweden
Democratic Congo	Liberia	Tanzania	Canada	Germany	Netherlands	Switzerland
Ecuador	Libya	Turkmenistan	Chile	Hong Kong	New Zealand	United Arab Emirates
Egypt	Malawi	Uzbekistan	Costa Rica	Hungary	Norway	United Kingdom
Eswatini	Mali	Zimbabwe	Czech R.	Ireland	Portugal	Uruguay

Source: Authors' calculation.

The empirical result that "good governance helps achieve economic recovery whereas increasing fiscal stimulus size can at best help protect against economic slowdown" is an indication of the requirement for structural reforms in which good governance practices are a must (Shifter, 2003; Horton and El-Ganainy, 2012). Thus, the main policy implication for the countries where the pandemic has been the most severe and the blow is hitting the hardest is that strengthening governance is a prerequisite to fully reaping the benefits of the fiscal stimulus and escaping fiscal instability. According to the IMF (2022), the management of public resources through institutional reforms in the public sector as well as a transparent and stable economic and regulatory environment conducive to private sector activities will assist policymakers in achieving long-term goals.

Another important implication of this study is related to a trade-off between short-term benefits and inevitable long-term costs of countercyclical stimulus policies in fighting conventional recessions. Most governments have issued new public debt to fund stimulus packages, particularly in the healthcare sector, social welfare programs, and small- and medium-sized enterprises (Basri, Ing and Schulze, 2022). Given the close association between increased government spending and budget deficits, the outbreak is likely to cause a significant deterioration in public finances in countries with low governance quality, which, in turn, raises debt rollover risks.

In line with the fiscal relief argument proposed by Makin and Layton (2021), the results obtained from this study emphasize that strengthening governance quality helps countries not to suffer much from possible medium- and long-term macroeconomic costs, indicating an implicit relief role. Therefore, an enhanced governance quality might ease the trade-off which is likely to bequeath a smaller economy to future generations. Notice also that automatic stabilizers are associated with the size of the governments and tend to be larger in developed economies. Therefore, one can infer that in countries where governance quality is higher, and, therefore, stabilizers are larger, there may be less need for fiscal stimulus since both approaches help soften the effects of a recession. As a result, governance practices can be considered an implicit automatic stabilizer since efficient resource allocation is directly linked to institutional structure during crises. This argument is in line with assumptions that such countries have better fiscal institutions with the inclusion of tighter spending restrictions and taxation abilities, and that they are less prone to experience binding credit constraints in bad economic conjunctures (Debrun and Kapoor, 2010). In addition, Horton and El-Ganainy (2012) assert that governments are expected to have a well-regulated fiscal strategy during a time of recession to help ensure solvency and address fiscal correction upon recovery and structural reforms as the key elements of this framework. The results obtained from this study bring good governance practices to the fore, both as a commitment to fiscal soundness and as a crucial step for structural reforms. From these perspectives, the lesson we have learned is quite similar to not only the mainstream literature in which economic growth is determined and sustained by governance quality (Williamson, 1984; 1996; Hall and Jones, 1999; Williamson, 2005), but to those addressing the fiscal governance framework drawn by the EU (Hallerberg, Strauch and Von Hagen, 2009; Hallett and Hougaard Jensen, 2012).

Fiscal governance is a crucial determinant of fiscal performance insofar as it can reduce the deficit bias of fiscal policy-making by increasing the effectiveness of public spending (EU Commission, n.d.). Public policies may result in fiscal risks including inefficient expenditures, particularly in emerging countries, given the gradually growing role of public policies to combat the COVID-19 outbreak. By enhancing transparency, efficiency, and accountability as well as maintaining fiscal space, sound fiscal governance can help reduce fiscal risks (Kim, Cho and Molineris, 2020). Moreover, Bascunan (2022) discusses the proposition that the institutional framework enables fiscal policy to be more long-term oriented, highlighting the existence of an intertemporal budget constraint that takes extremely long-time horizons into consideration. According to Bascunan (2022), this is important for handling a shock like the COVID-19 outbreak, both when resources need to be used and when fiscal consolidation is required to preserve the long-term sustainability of public finances. Therefore, governments in countries where good governance practices are not convincing should take necessary actions to improve fiscal governance by considering their own policy environment as well as the experiences of other nations and global best practices. This insight can help policymakers enhance fiscal policy effectiveness during future crises. Moving

PUBLIC SECTOR ECONOMICS
49 (2) 251–272 (2025)

forward, governments should integrate governance-focused reforms as part of their fiscal policy strategies to strengthen resilience against future economic shocks.

The implications of this paper are quite similar to those in the previous literature. For instance, the results of this study are in line with those of Kaplanoglou and Rapanos (2011) indicating that even fiscal consolidation packages would be inadequate without a strong institutional framework that supports commitment to sustainable and growth-oriented long-term plans. In addition, our results are also consistent with the arguments of Bascunan (2022) indicating that countries with higher governance quality are better able to deliver fiscal transfers, subsidies, and guarantees, which allow faster recovery from the COVID-19 shock. Chen et al. (2021) conclude that the adoption of large fiscal stimulus packages is not necessarily sufficient, and there is no one-size-fits-all fiscal policy. Their main policy implication is that countries should develop the most appropriate policies, considering their own economic condition and the severity of the pandemic. Our implication is somewhat consistent with Chen et al. (2021): high-quality governance matters more than the size of the fiscal stimulus. Finally, our results are similar to those of Horton and El-Ganainy (2012), which address the importance of structural reforms as a key element of fiscal soundness. Notice that our findings also challenge some existing assumptions. While previous studies emphasize the size of fiscal stimulus as a key determinant of economic recovery (Deb et al., 2021; Haroutunian, Osterloh and Sławińska, 2021), we find that stimulus size alone is not sufficient.

6 CONCLUSION

This study uses cross-country threshold regressions to examine the role of governance quality in the nexus between lockdown policies and economic recovery during the COVID-19 pandemic. Empirical results indicate that a stringent lockdown policy does not lead to an economic downturn in countries with larger stimulus. We also find that stringent policies do contribute to economic recovery even in countries with smaller fiscal packages if accompanied by governance quality, whereas the opposite leads to an economic slowdown. This study reveals that good governance practices are crucial in determining the effectiveness of fiscal stimulus, particularly in combating the economic aftermath of the lockdown period.

This study makes a distinct contribution to the literature by demonstrating that governance quality plays a crucial role in determining the effectiveness of fiscal stimulus during a crisis. While previous studies primarily focus on the size of fiscal stimulus as a driver of economic recovery, our findings reveal that institutional strength is a critical moderating factor. Using cross-country threshold regressions, we identify non-linear effects that highlight how governance quality shapes the impact of fiscal stimulus. Unlike standard linear approaches, our methodology captures heterogeneous policy responses, which, in turn, make our results more robust and generalizable across different institutional settings. Furthermore, by

introducing governance quality as a structural component of fiscal policy effectiveness, we provide policy-relevant insights that emphasize the need for institutional reforms alongside economic stimulus measures.

The limitations of this study can suggest future research directions. First, it uses an aggregate stimulus index that includes all the adopted fiscal measures. Future attempts may incorporate disaggregated fiscal tools to observe how volatile the results are across those tools. Second, this study discovers the economic recovery response and can easily be extended to other objectives of fiscal policy such as poverty, income inequality, and so on. Third, while we test whether our results remain consistent by excluding only low-income outliers, future studies could further examine how outliers in fiscal stimulus and/or governance quality affect the findings. Finally, future research could extend the framework by incorporating temporal dynamics to analyse how the effects of governance and fiscal stimulus evolve over time.

Disclosure statement

The authors have no conflicts of interest to declare.

REFERENCES

1. Abid, N. [et al.], 2021. Towards environmental sustainability: exploring the nexus among ISO 14001, governance indicators and green economy in Pakistan. *Sustainable Production and Consumption*, 27, pp. 653-666. https://doi.org/10.1016/j.spc.2021.01.024
2. Acemoglu, D. [et al.], 2008. Income and democracy. *American Economic Review*, 98(3), pp. 808-842. https://doi.org/10.1257/aer.98.3.808
3. Acemoglu, D. and Robinson, J. A., 2012. *Why nations fail: The origins of power, prosperity, and poverty*. New York: Crown.
4. Acemoglu, D., Johnson, S. and Robinson, J. A., 2001. The colonial origins of comparative development: An empirical investigation. *American Economic Review*, 91(5), pp. 1369-1401. https://doi.org/10.1257/aer.91.5.1369
5. Afonso, A., Schuknecht, L. and Tanzi, V., 2010. Public sector efficiency: evidence for new EU member states and emerging markets. *Applied Economics*, 42(17), pp. 2147-2164. https://doi.org/10.1080/00036840701765460
6. Aguirre, J. P. C. and Hannan, M. S. A., 2021. Recoveries after pandemics: the role of policies and structural features. *IMF Working Paper,* No. 21/181. https://doi.org/10.5089/9781513583792.001
7. Alberola, E. [et al.], 2021. Fiscal response to the COVID-19 crisis in advanced and emerging market economies. *Pacific Economic Review*, 26(4), pp. 459-468. https://doi.org/10.1111/1468-0106.12370
8. Alesina, A. F. and Perotti, R., 1999. Budget deficits and budget institutions. In: *Fiscal institutions and fiscal performance.* University of Chicago Press, pp. 13-36.
9. Alesina, A., Campante, F. R. and Tabellini, G., 2008. Why is fiscal policy often procyclical? *Journal of the European Economic Association*, 6(5), pp. 1006-1036. https://doi.org/10.1162/JEEA.2008.6.5.1006
10. Aschauer, D. A., 2000. Public capital and economic growth: Issues of quantity, finance, and efficiency. *Economic Development and Cultural Change*, 48(2), pp. 391-406. https://doi.org/10.1086/452464
11. Auerbach, A. [et al.], 2022. Fiscal multipliers in the COVID19 recession. *Journal of International Money and Finance*, 126, 102669. https://doi.org/10.1016/j.jimonfin.2022.102669
12. Azimi, M. N., 2022. Revisiting the governance-growth nexus: Evidence from the world's largest economies. *Cogent Economics and Finance*, 10(1), 2043589. https://doi.org/10.1080/23322039.2022.2043589
13. Banerjee, R. [et al.], 2022. Fiscal deficits and inflation risks: the role of fiscal and monetary regimes. *BIS Working Paper,* No. 1028.
14. Barro, R. J. and Sala-i-Martin, X., 1992. Public finance in models of economic growth. *The Review of Economic Studies,* 59(4), pp. 645-661. https://doi.org/10.2307/2297991
15. Barro, R. J., 1990. Government spending in a simple model of endogeneous growth. *Journal of Political Economy*, 98(5, Part 2), pp. 103-125. https://doi.org/10.1086/261726

16. Barro, R. J., 1991. Economic growth in a cross section of countries. *The Quarterly Journal of Economics*, 106(2), pp. 407-443. https://doi.org/10.2307/2937943
17. Barro, R. J., 1999. Determinants of democracy. *Journal of Political Economy*, 107(S6), pp. 158-183. https://doi.org/10.1086/250107
18. Bascunan, F. L., 2022. *Fiscal Institutions and the Pandemic. Finance and Development*. Washington: IMF.
19. Basri, M. C., Ing, L. Y. and Schulze, G. G., 2022. Economic Recovery Requires Global Efforts. In: L. Y. Ing. and D. Rodrik, eds. *New Normal, New Technology, New Financing*. Jakarta: ERIA and IEA, pp. 8-21.
20. Baumol, W. J., 1986. Productivity growth, convergence, and welfare: What the long-run data show. *The American Economic Review*, 76(5), pp. 1072-1085. https://www.jstor.org/stable/1816469
21. Blanchard, O., 2020. "Whatever It Takes." Getting into the Specifics of Fiscal Policy to Fight COVID-19. *Peterson Institute for International Economics Realtime Economics Issues Watch, Blog*, 30 March.
22. Bui, D. [et al.], 2022. The effects of fiscal policy on households during the COVID-19 pandemic: Evidence from Thailand and Vietnam. *World Development*, 153, 105828. https://doi.org/10.1016/j.worlddev.2022.105828
23. Calderón, C. and Schmidt-Hebbel, K., 2008. Business cycles and fiscal policies: The role of institutions and financial markets. *Working Papers Central Bank of Chile,* No. 481.
24. Chan, S. G. and Karim, M. A. Z., 2012. Public spending efficiency and political and economic factors: Evidence from selected East Asian countries. *Economic Annals*, 57(193), pp. 7-23. https://doi.org/10.2298/EKA1293007C
25. Chan, S. G., Ramly, Z. and Karim, M. Z. A., 2017. Government spending efficiency on economic growth: Roles of value-added tax. *Global Economic Review*, 46(2), pp. 162-188. https://doi.org/10.1080/1226508X.2017.1292857
26. Chen, C. [et al.], 2021. A cross-country comparison of fiscal policy responses to the COVID-19 global pandemic. *Journal of Comparative Policy Analysis: Research and Practice*, 23(2), pp. 262-273. https://doi.org/10.1080/13876988.2021.1878885
27. Chudik, A., Mohaddes, K. and Raissi, M., 2021. Covid-19 fiscal support and its effectiveness. *Economics Letters*, 205, 109939. https://doi.org/10.1016/j.econlet.2021.109939
28. Collier, P. and Goderis, B., 2007. Commodity Prices, Growth, and the Natural Resource Curse: Reconciling a Conundrum. *Centre for the Study of African Economies Working Paper Series*. https://doi.org/10.2139/ssrn.1473716
29. Cooray, A., 2009. *Government expenditure*, governance and economic growth. *Comparative Economic Studies*, 51(3), pp. 401-418. https://doi.org/10.1057/ces.2009.7
30. De Mello, L. 2008. Estimating a fiscal reaction function: the case of debt sustainability in Brazil. *Applied Economics*, 40(3), pp. 271-284. https://doi.org/10.1080/00036840500461873

31. De Soyres, F., Santacreu, A. M. and Young, H., 2022. Fiscal policy and excess inflation during Covid-19: a cross-country view. *Feds Notes*, July 15. https://doi.org/10.17016/2380-7172.3083
32. Dean, P., 2022. The Unprecedented Federal Fiscal Policy Response to the COVID-19 Pandemic and Its Impact on State Budgets. *California Journal of Politics and Policy*, 14(1), pp. 1-29. https://doi.org/10.5070/P2CJPP14157320
33. Deb, P. [et al.], 2021. The effects of fiscal measures during COVID-19. *IMF Working Paper,* WP/21/262. https://doi.org/10.5089/9781557754264.001
34. Debrun, M. X. and Kapoor, R., 2010. Fiscal policy and macroeconomic stability: automatic stabilizers work, always and everywhere. *IMF Working Paper*, No. 111. https://doi.org/10.5089/9781455200702.001
35. Di Bartolomeo, G., D'Imperio, P. and Felici, F., 2022. The fiscal response to the Italian COVID-19 crisis: A counterfactual analysis. *Journal of Macroeconomics*, 73, 103447. https://doi.org/10.1016/j.jmacro.2022.103447
36. El Anshasy, A. A. and Katsaiti, M. S., 2013. Natural resources and fiscal performance: Does good governance matter? *Journal of Macroeconomics*, 37, pp. 285-298. https://doi.org/10.1016/j.jmacro.2013.05.006
37. Elgin, C., Basbug, G. and Yalaman, A., 2020. Economic policy responses to a pandemic: Developing the COVID-19 economic stimulus index. *Covid Economics*, 1(3), pp. 40-53.
38. ESCAP, 2020. The Impact and Policy Responses for COVID-19 in Asia and the Pacific. *Policy Brief,* March 26.
39. European Commission, 2025. *What is fiscal governance?*
40. Feeny, S. and Rogers, M., 2008. Public sector efficiency, foreign aid and small island developing states. *Journal of International Development*, 20(4), pp. 526-546. https://doi.org/10.1002/jid.1475
41. Frankel, J. A., Vegh, C. A. and Vuletin, G., 2013. On graduation from fiscal procyclicality. *Journal of Development Economics*, 100(1), pp. 32-47. https://doi.org/10.1016/j.jdeveco.2012.07.001
42. Gani, A., 2011. Governance and growth in developing countries. *Journal of Economic Issues*, 45(1), pp. 19-40. https://doi.org/10.2753/JEI0021-3624450102
43. Gradstein, M., 2004. Governance and growth. *Journal of Development Economics*, 73(2), pp. 505-518. https://doi.org/10.1016/j.jdeveco.2003.05.002
44. Gregory, R. P., 2022. ESG scores and the response of the S&P 1500 to monetary and fiscal policy during the Covid-19 pandemic. *International Review of Economics and Finance*, 78, pp. 446-456. https://doi.org/10.1016/j.iref.2021.12.013
45. Gros, D., Ounnas, A. and Yeung, T. Y. C., 2021. A new Covid policy stringency index for Europe. *Covid Economics*, 66, pp. 115-136.
46. Hale, T. [et al.], 2021. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nature Human Behavior*, 5(4), pp. 529-538. https://doi.org/10.1038/s41562-021-01079-8
47. Hall, R. E. and Jones, C. I., 1999. Why do some countries produce so much more output per worker than others? *The Quarterly Journal of Economics*, 114(1), pp. 83-116. https://doi.org/10.1162/003355399555954

48. Hallerberg, M., Strauch, R. R. and Von Hagen, J., 2009. *Fiscal governance in Europe.* Cambridge University Press. https://doi.org/10.1017/CBO9780511759505
49. Hallett, A. H. and Hougaard Jensen, S. E., 2012. Fiscal governance in the euro area: Institutions vs. rules. *Journal of European Public Policy*, 19(5), pp. 646-664. https://doi.org/10.1080/13501763.2011.646773
50. Hansen, B. E., 1999. Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics*, 93(2), pp. 345-368. https://doi.org/10.1016/S0304-4076(99)00025-1
51. Haroutunian, S., Osterloh, S. and Sławińska, K., 2021. The Initial Fiscal Policy Responses of Euro Area Countries to the COVID Crisis. *European Central Bank Economic Bulletin*, No. 1.
52. Horton, M. and El-Ganainy, A., 2012. Fiscal policy: taking and giving away. *Finance and Development.*
53. Hudson, C. [et al.], 2021. The Global Fiscal Response to COVID-19. *RBA Bulletin*, June, pp. 100-109.
54. Hulton, C., 1996. Infrastructure capital and economic growth: How well you use it may be more important than how much you have. *NBER Working Paper,* No. 5847. https://doi.org/10.3386/w5847
55. IMF, 2022. *IMF and good governance*. Washington: IMF.
56. IMF, 2023. *IMF World Economic Outlook 2022*. *Database*. Washington: IMF.
57. Kaplanoglou, G. and Rapanos, V. T., 2011. The Greek fiscal crisis and the role of fiscal governance. *GreeSE*, 48. https://doi.org/10.2139/ssrn.2158590
58. Kaufmann, D., Kraay, A. and Mastruzzi, M., 2010. The worldwide governance indicators: Methodology and analytical issues. *Policy Research Working Paper*, No. WPS 5430.
59. Kaufmann, D., Kraay, A. and Zoido-Lobatón, P., 1999a. Aggregating Governance Indicators. *World Bank Policy Research Working Paper*, No. 2195. https://doi.org/10.2139/ssrn.188548
60. Kaufmann, D., Kraay, A. and Zoido-Lobatón, P., 1999b. Governance Matters. *World Bank Policy Research Working Paper,* No. 2196.
61. Kim, C. J., Cho, Y. B. and Molineris, M., 2020. Toward Better Fiscal Governance in Asia and the Pacific. *Asian Development Bank Institute Working Paper*, No. 2020-3.
62. Kinda, T., Lengyel, A. and Chahande, K., 2022. Fiscal Multipliers During Pandemics. *IMF Working Papers*, No. 149. https://doi.org/10.5089/9798400215698.001
63. Knack, S. and Keefer, P., 1995. Institutions and economic performance: Cross-country tests using alternative institutional measures. *Economics and Politics*, 7(3), pp. 207-227. https://doi.org/10.1111/j.1468-0343.1995.tb00111.x
64. Knack, S. and Keefer, P., 1997. Does social capital have an economic pay-off. A cross-country investigation. *The Quarterly Journal of Economics*, 112(4), pp. 1251-1288. https://doi.org/10.1162/003355300555475

65. Kontopoulos, Y. and Perotti, R., 1999. Government fragmentation and fiscal policy outcomes: Evidence from OECD countries. In: *Fiscal institutions and fiscal performance.* University of Chicago Press.
66. Ma, Y. [et al.], 2021. The relationship between time to a high COVID-19 response level and timing of peak daily incidence: an analysis of governments' Stringency Index from 148 countries. *Infectious Diseases of Poverty*, 10, pp. 1-10. https://doi.org/10.1186/s40249-021-00880-x
67. Makin, A. J. and Layton, A., 2021. The global fiscal response to COVID-19: Risks and repercussions. *Economic Analysis and Policy*, 69, pp. 340-349. https://doi.org/10.1016/j.eap.2020.12.016
68. Omri, A. and Hadj, T. B., 2020. Foreign investment and air pollution: do good governance and technological innovation matter? *Environmental Research*, 185, 109469. https://doi.org/10.1016/j.envres.2020.109469
69. Persson, T. and Tabellini, G., 2004. Constitutional rules and fiscal policy outcomes. *American Economic Review*, 94(1), pp. 25-45. https://doi.org/10.1257/000282804322970689
70. Plumper, T. and Martin, C. W., 2003. Democracy, government spending, and economic growth: A political-economic explanation of the Barro-effect. *Public Choice*, 117(1), pp. 27-50.
71. Pritchett, L., 1996. Mind you P's and Q's: The cost of public investment is not the value of public capital. *World Bank Policy Research Working Paper,* No. 1660.
72. Rajkumar, A. S. and Swaroop, V., 2008. Public spending and outcomes: Does governance matter? *Journal of Development Economics*, 86(1), pp. 96-111. https://doi.org/10.1016/j.jdeveco.2007.08.003
73. Ramey, V. A., 2019. Ten years after the financial crisis: What have we learned from the renaissance in fiscal research? *Journal of Economic Perspectives*, 33(2), pp. 89-114. https://doi.org/10.1257/jep.33.2.89
74. Shifter, M. (ed.), 2003. *Constructing democratic governance in Latin America.* JHU Press.
75. Temsumrit, N., 2022. Democracy, institutional quality and fiscal policy cycle: evidence from developing countries. *Applied Economics*, 54(1), pp. 75-98. https://doi.org/10.1080/00036846.2021.1959894
76. Tervala, J. and Watson, T., 2022. Hysteresis and fiscal stimulus in a recession. *Journal of International Money and Finance,* 124, 102614. https://doi.org/10.1016/j.jimonfin.2022.102614
77. Tsatsaronis, K. [et al.], 2022. The monetary-fiscal policy nexus in the wake of the pandemic. *Bank for International Settlements Papers*, No. 122.
78. United Nations Statistics Division 2021. *Database*.
79. *WB Worldwide Governance Indicators 2021 Database*.
80. Wilhelms, S. K. S., 1998. *Institutional FDI fitness: determinants of foreign direct investment to emerging economies.* Fletcher School of Law and Diplomacy (Tufts University).

81. Williamson, O. E., 1984. The economics of governance: Framework and implications. *Journal of Institutional and Theoretical Economics*, (H. 1), pp. 195-223.
82. Williamson, O. E., 1996. *The mechanisms of governance*. Oxford University Press. https://doi.org/10.1093/oso/9780195078244.001.0001
83. Williamson, O. E., 2005. The economics of governance. *American Economic Review*, 95(2), pp. 1-18. https://doi.org/10.1257/000282805774669880

APPENDIX

TABLE A1
Country coverage

Albania	Burundi	Egypt	Hong Kong	Latvia	Nepal	Romania	Tanzania
Algeria	Cambodia	El Salvador	Hungary	Lesotho	Netherlands	Russia	Thailand
Angola	Cameroon	Eritrea	India	Liberia	New Zealand	Rwanda	Togo
Argentina	Canada	Estonia	Indonesia	Libya	Nicaragua	Saudi Arabia	Trinidad Tobago
Australia	Central African Republic	Eswatini	Iran	Lithuania	Niger	Senegal	Tunisia
Austria	Chad	Ethiopia	Iraq	Madagascar	Nigeria	Serbia	Turkey
Azerbaijan	Chile	Finland	Ireland	Malawi	Norway	Sierra Leone	Turkmenistan
Bahrain	China	France	Israel	Malaysia	Oman	Singapore	UAE
Bangladesh	Colombia	Gabon	Italy	Mali	Pakistan	Slovak Republic	Uganda
Belarus	Costa Rica	Gambia	Jamaica	Mauritania	Panama	Slovenia	UK
Belgium	Cote Ivory	Georgia	Japan	Mauritius	Papua New Guinea	South Africa	Ukraine
Benin	Croatia	Germany	Jordan	Mexico	Paraguay	South Korea	United States
Bolivia	Cyprus	Ghana	Kazakhstan	Moldova	Peru	Spain	Uruguay
Bosnia and Herzegovina	Czech Republic	Greece	Kenya	Mongolia	Philippines	Sri Lanka	Uzbekistan
Botswana	Democratic Republic of Congo	Guatemala	Kosovo	Morocco	Poland	Sudan	Vietnam
Brazil	Denmark	Guinea	Kuwait	Mozambique	Portugal	Sweden	Yemen
Bulgaria	Dominican Republic	Haiti	Kyrgyz Republic	Myanmar	Qatar	Switzerland	Zambia
Burkina Faso	Ecuador	Honduras	Laos	Namibia	Republic of Congo	Tajikistan	Zimbabwe

The role of economic and political factors in budget forecasting errors: evidence from Turkey's metropolitan municipalities for the period 2011-2022

BERAT KARA, Ph.D.*

Article**
JEL: H61, H68, H72
https://doi.org/10.3326/pse.49.2.5

* The author would like to thank two anonymous reviewers for their valuable comments.

** Received: June 14, 2024
Accepted: September 25, 2024

Berat KARA
Istanbul Medeniyet University, Faculty of Political Sciences, Department of Public Finance, Ünalan Neighborhood, D-100 Highway, North Campus, P.O. Box 34700, Üsküdar/Istanbul, Turkey
e-mail: berat.kara@medeniyet.edu.tr
ORCiD: 0000-0002-6948-2197

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

Abstract

This study examines budget forecasting errors in 15 major metropolitan municipalities in Turkey for the period 2011-2022 using a random effects panel regression model. The dependent variables include budget surplus, inflation, population growth, unemployment, GDP per capita, export-to-import ratio, mayor's political party, mayor's re-candidacy status, and election periods. Findings show that in the revenue model, budget surplus and unemployment reduce errors, while inflation, population growth, and election years increase them. In the expenditure model, unemployment reduces errors, whereas inflation and election periods increase them. This research is the first of its kind in Turkey, aiming to fill a gap in the literature by identifying factors contributing to budget errors. It highlights the importance of local influences on budget accuracy and seeks to guide budget preparers in improving their forecasts, ultimately enhancing fiscal management and public service delivery.

Keywords: budget forecasting, Turkey, revenue, expenditure, panel regression, municipality

1 INTRODUCTION

The financial structures and budgets of local governments are fundamental components of public administration. Municipalities provide a significant portion of services that directly affect the daily lives of local residents, and the effective delivery of these services heavily relies on the proper and efficient management of financial resources. The budget serves as a crucial tool for planning and managing a municipality's financial resources. However, errors in budget forecasts can lead to significant problems in financial management. The magnitude and frequency of these errors can severely impact the fiscal discipline and service delivery capacity of local governments.

Understanding and addressing budget forecasting errors is essential for several reasons. These errors can result in resource misallocation, inefficiencies, and an inability to meet community needs effectively. The central question this study seeks to answer is: *What are the underlying economic and political factors contributing to budget forecasting errors in Turkey's metropolitan municipalities, and how can these factors be mitigated?* This question is crucial, because identifying and understanding these factors can help local governments improve their financial management practices and service delivery.

In recent years, there has been an increasing body of literature dedicated to analysing budget forecasting errors. These studies aim to understand the underlying causes of such errors and to develop methods to enhance forecasting accuracy. This trend reflects a growing recognition of the importance of accurate budget forecasts in maintaining fiscal health and delivering public services efficiently. By contributing to this body of knowledge, this study aims to provide valuable insights that can aid local governments in improving their budget forecasting practices.

The study focuses on the budget forecasting errors of 15 selected metropolitan municipalities in Turkey, analysed through panel regression using a random effects model. The investigation centres on the following research questions: (1) What are the specific economic and political determinants of budget forecasting errors in Turkish metropolitan municipalities? (2) How do these determinants impact the accuracy of budget forecasts? By addressing these questions, the study seeks to provide empirical evidence and insights that can guide local governments in refining their budget forecasting processes.

Inspired by existing literature, the dependent variables include budget surplus, inflation, population growth, unemployment, GDP per capita, the export-to-import ratio, the mayor's political party, the mayor's re-candidacy status, and election periods. The findings indicate that in the revenue model, budget surplus and unemployment reduce forecasting errors, while inflation, population growth, and election years increase them. Conversely, in the expenditure model, unemployment reduces forecasting errors, whereas inflation and election periods increase them.

Prior to these analyses, the mean absolute percentage error (MAPE) of forecasting errors for these metropolitan municipalities was examined for the period from 2011 to 2022, alongside the frequency of positive and negative errors. This comprehensive approach provides a detailed understanding of the nature and determinants of budget forecasting errors in Turkey's major cities.

One notable observation is that local governments in Turkey tend to produce significantly more erroneous forecasts than the central government. This discrepancy highlights the unique challenges faced by local governments in budgeting, which may stem from both national and local factors. While national economic conditions undoubtedly influence local budgets, local factors such as regional economic activity, local governance practices, and specific demographic trends may also play a crucial role. This study aims to uncover the extent to which these local factors contribute to budget forecasting errors, thereby providing a more nuanced understanding of the issue.

The importance of this study lies in its potential to fill a significant gap in the literature on budget forecasting errors in Turkey. By providing empirical evidence and insights, this research aims to guide budget preparers about the sources of their errors and prompt further studies to enhance forecasting accuracy. It is the first study of its kind in Turkey, addressing the critical need for reliable budget forecasts in local governments. Through this contribution, it seeks to improve fiscal management practices and support the sustainable delivery of public services at the local level.

Moreover, the findings of this study have broader implications for public administration and fiscal policy. By identifying the factors that lead to budget forecasting errors, policymakers can develop targeted interventions to mitigate these errors. For

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

instance, if inflation and population growth are found to significantly increase forecasting errors, local governments could implement more robust economic analysis and demographic modelling techniques in their budget preparation processes. Additionally, understanding the impact of political and electoral cycles on budget accuracy can help in the design of more stable and consistent fiscal policies.

In conclusion, this study not only addresses a critical issue in the field of public administration but also paves the way for future research. By highlighting the importance of both national and local factors in budget forecasting, it opens new avenues for exploring how different variables interact and thus influence fiscal outcomes. This, in turn, can lead to the development of more sophisticated models and tools for budget forecasting, ultimately enhancing the financial stability and service delivery capabilities of local governments.

2 THEORETICAL BASIS, PRACTICAL SIGNIFICANCE AND METHODOLOGY OF BUDGET FORECASTS

Public institutions, commercial enterprises, large or small organizations, and nearly all institutions and organizations, whether technically advanced or underdeveloped, utilize forecasts in their decision-making and policy-formulation processes (Jones, Bretschneider and Gorr, 1997: 241). Local governments also express their views and plans regarding the general outlook of fiscal policy through budget forecasts. These include revenue, expenditure, and balance forecasts. Revenue and expenditure forecasts, in particular, play a key role in detailing annual budgets and setting targets (Leal et al., 2008: 349). Budget forecasting is not merely a simple prediction affecting macroeconomic variables. It is based on the identification of various goals and instruments such as monetary policy, fiscal policy, tax administration, and trade volume (Lazar and Andrei, 2006: 43). In this respect, budget forecasts are significant in many aspects.

2.1 MACROECONOMIC PERSPECTIVE

The success of budget forecasts, which form the foundation of fiscal planning, is critically important from a macroeconomic perspective in six key areas. First, it concerns the efficient use of scarce resources. High-quality forecasts are needed to allocate scarce public resources efficiently and to enable successful public-private sector planning (Krause and Corder, 2007: 130). Second, it pertains to the relationship between the accuracy of budget forecasts and fiscal policy and their importance in ensuring fiscal discipline. Careful attention during both the planning and implementation stages of the budget process is necessary to achieve and maintain fiscal discipline. This is because the path of fiscal policy is seen as synonymous with the budget. According to Davis (1980: 187), the analysis of the accuracy of budget forecasts is related not only to the impact of fiscal policy on the economy but also to the impact of the economy on the budget. Third, it concerns the sectoral impacts of the success of forecasts. The local government budget, through its forecasts, regulates economic activities both collectively and sectorally, shaping monetary and fiscal policies (Bhattacharya and Kumari, 1988: 1327).

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

Considering the increasing share of the public sector in the economy, both directly and as a regulator, and the importance of resource allocation to the private sector for a country's development, it becomes clear that budget forecasts are highly significant in this regard.

Fourth, budget forecasts also serve as indicators. Forecasts are accepted as indicators by economic actors, influencing various financial indicators, particularly interest rates. Households and financial market agents make long-term decisions based on economic forecasts, and central banks targeting inflation use these forecasts for policy decisions. Fifth and finally, the preparation of budget forecasts entails its own costs. Bureaucratic processes, departmental approvals, and mid-fiscal year revisions require significant time, money, and effort (Zakaria and Ali, 2010: 113). This highlights the economic importance of the technical aspect of the budget. Therefore, to make efficient use of valuable public resources, budget forecasts must be prepared carefully and realistically.

2.2 ISSUE OF LONG-TERM PLANNING

Budget forecasting is important not only from a macroeconomic perspective but also for long-term planning. Without realistic budget forecasts and strong fiscal discipline, it is challenging to instil discipline in other areas critical for economic growth and development, thereby making it difficult to bridge the gap between the formulation and implementation of long-term plans (Asher, 1978: 431; Zakaria and Ali, 2010: 114). Long-term planning inherently relies on forecasts, the accuracy of which is critical, particularly for the efficient financing of significant future public expenditures (Auld, 1970: 507). Multi-year expenditure forecasts estimate the cost of providing a certain level of public service (Schroeder, 2007: 65). Hence, budget items should align with medium-term plans and relate to available resources. Adequate knowledge of current resources ensures more effective management of the budget process for long-term programs and projects. Accurate evaluation of this information guides project and program selection and helps determine feasible options in the medium term (Jena, 2006: 3975). In this context, a country's forecasts for key sectors provide an informed basis for strategic planning (Fedotov, 2017: 416).

The success of forecasts is vital also for long-term planning in the private economy. The stability objective of budget policy aims to maintain internal economic balance, preserve the equilibrium between aggregate supply and demand, ensure stable price levels, and achieve high employment in the long term. Assuming the local government's economic assessment and planning are reasonably acceptable, deficiencies in private sector plans and forecasts need to be corrected through budget policy. These corrections are crucial for maintaining internal economic balance (Auld, 1970: 507).

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

2.3 POLITICAL STANDPOINT

Budget forecasting is important not only from a macroeconomic and long-term planning perspective but also from a political standpoint. Forecasting fiscal variables is considered both an economic and a political issue (Botrić and Vizek, 2012: 35). For a local government to achieve its planned objectives, realistic budget forecasts are essential (Khan, Hussain and Malik, 2018: 21). As observed in modern economies, the ability of a local government to respond effectively to any crisis depends on the information, particularly of a financial nature, available to government officials, policymakers, and public managers (Willoughby and Guo, 2008: 28). Policymakers consider the financial information presented to them when making fiscal decisions (Botrić and Vizek, 2012: 35).

Budgeting, situated at the intersection of economics and politics, aligns the local government's political goals with its financial resources and its sources and targets are the subject of continued debate (Lazar and Andrei, 2006: 41). These debates occur during the preparation, implementation, and outcome phases of the budget. Initial and final stage debates focus on the accuracy of budget forecasts and on the outcomes, highlighting forecasting errors.

The state of public resources defines the boundaries of debates during the budget preparation stage. As financial pressures intensify, the realism, reliability, and informativeness of budget forecasts become more critical in the budget process (Agostini, 1991: 13). In democratic countries, budgets are discussed and approved in parliaments. Unreliable budget forecasts can obstruct budget approval, as has happened in many countries, including Turkey, leading to numerous economic and political issues.

Discussions on budget outcomes typically arise from forecasting errors, especially when expenditures exceed predictions or budget deficits are higher than expected. These discussions are crucial for identifying the causes of forecasting errors and implementing measures to reduce errors in future forecasts.

Moreover, budget forecasts have political implications for the public, including voters and pressure groups. Forecasts are assumed to reflect the local government's fiscal stance, and examining their accuracy is considered a criterion for evaluating the success of budget policy (Asher, 1978: 423). In other words, the success of forecasts shapes public opinion regarding the effectiveness of the local government's fiscal policy (Leal et al., 2008: 381).

2.4 FORECASTING METHODOLOGY

Predictive activities are a natural part of life. In this flow, individuals may make predictions using their instincts if necessary. However, organizations and professionals cannot make predictions using such simple methods. They require sufficient information and must resort to systematic and complex materials to make accurate forecasts (Bağdigen, 2002: 30). The budget is the primary tool for

implementing policies developed at the government level. Strategic budget planning is not a static or temporary event; it involves continuity in the production and management of programs. Therefore, it is to be expected that forecasting models, which consider national accounts and the current economic situation, will be used in budget forecasting. Naturally, the complexity of these models may vary from country to country (Lazar and Andrei, 2006: 45). Generally, there are four basic forecasting methods in use, and three new alternative methods are being discussed in the current literature.

The first fundamental forecasting method is the judgmental method. Sometimes referred to as the expert method or the naive method, the judgmental method involves preparing forecasts based on the evaluation of data collected from various personnel such as managers, experts, practitioners, and researchers (Stevenson, 2012: 80). In this method, no econometric analysis is conducted; the forecast is prepared directly by individuals. As such, the judgmental method is considered the oldest and most basic method. Indeed, this method is also applied in the budgets of both national and local public institutions in Turkey.

The second fundamental forecasting method, that of time series models, simply attempts to project the past into the future by using historical data to make predictions (Stevenson, 2012: 80). The third model, that of econometric methods, generally involves producing forecasts by relating a series of independent variables to a dependent variable through regression (Williams and Calabrese, 2016: 136-138).

The first of the alternative methods discussed in the literature is the use of independent forecasting institutions. Recently, it has been proposed that in many European Union (EU) countries, the task of budget forecasting be transferred to independent institutions or that these institutions at least actively participate in the forecasting process. The second method is a relatively easy and inexpensive way to estimate economic variables more realistically by systematically and linearly combining alternative forecasts of these variables into a new forecast (Fullerton, 1989: 373). The literature suggests preparing forecasts using multiple different methods and then combining them to obtain the final forecast, a process known as the "combination of forecasts" method. The third and final method is the consensus forecasting method. Initiated in Florida, USA, in 1970, the consensus forecasting method involves multiple institutions or groups jointly being responsible for creating the forecast. At first glance, this method resembles the practices of independent forecasting institutions and combining forecasts; however, it differs in that both institutions involved are public authorities and a single forecast is produced. The institutions in question are mostly the executive and legislative branches, and the method involves these entities jointly preparing and approving the budget forecast through consensus.

The literature includes various studies on the effects of forecasting methods, comparative cases, and recommendations on which method should be applied. These

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

are not covered within the scope of this study. However, for detailed information on this topic, see: Penner (2001), Beckett-Camarata (2006), Bretschneider et al. (1989), Grizzle and Klay (1994), Feenberg et al. (1989), Botrić and Vizek (2012), McCollough and Frank (1992), Geys, Goeminne and Smolders (2008), Khan (2019), Forrester (1991).

3 THE LEGISLATIVE FRAMEWORK FOR MUNICIPAL BUDGETS IN TURKEY

The preparation of municipal budgets in Turkey is governed by the Municipal Law No. 5393 and the Public Financial Management and Control Law No. 5018. According to Article 61 of Law No. 5393, a municipal budget is a council decision that authorizes the collection of revenues and expenditures in line with the strategic plan and performance program for the financial year and the subsequent two years. The strategic plan and performance program are fundamental to the municipal budgeting process, as stipulated in Article 41 of the same law. This mandates that the strategic plan and performance program must form the basis for budget preparation and must be approved by the municipal council before the budget itself.

The budget preparation process involves principles of frugality, efficiency, and effectiveness, ensuring cost-benefit considerations are met. Like central government institutions, municipalities follow a structured process comprising the preparation, implementation, and auditing phases of the budget. The mayor, acting as the chief executive, initiates the budget preparation process by calling upon departments to prepare their expenditure budgets aligned with the strategic plan and performance program by the end of June. Departments then prepare their budget proposals, including expenditure forecasts and detailed expenditure programs, and submit them to the financial services unit by the end of July. The financial services unit consolidates the departmental expenditure proposals and prepares the revenue budget and the draft budget of the institution. This draft, including detailed expenditure and financing programs, is submitted for review and correction to the chief executive by the end of August for municipalities and by early September for special provincial administrations.

The draft budget is sent to the council, where it is reviewed along with the forecast revenues and expenditures for the following two years. The draft is then sent to the Ministry of Interior for inclusion in the central government budget. The council's planning and budget committee, the membership of which is proportional to the council's political composition, reviews the draft budget. This committee's primary function is to examine the draft budget and prepare a report. The council discusses and votes on the budget in its meetings in October for district municipalities within metropolitan cities and in November for other municipalities. The budget must be approved within a maximum of twenty days, including the committee's review period.

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

The mayor is responsible for the execution of the budget. The authority to spend can be delegated to deputies and department heads, though the mayor retains ultimate responsibility. Expenditures must comply with budgetary principles and legal provisions, and any unused appropriations at the end of the year are cancelled unless they are to be carried over to the next fiscal year due to specific conditions. If the new year's budget is not finalized, the previous year's budget continues to be in effect until the new budget is approved. In summary, the municipal budgeting process in Turkey is a comprehensive and regulated procedure that ensures alignment with strategic planning, efficient allocation of resources, and compliance with legal and financial regulations.

4 LITERATURE REVIEW AND HYPOTHESES

Many studies in the literature have demonstrated that budgets in local governments are often significantly inaccurate and biased. Examples of such studies include Gentry (1989), Larkey and Smith (1989), Mayper, Granof and Giroux (1991), Reddick (2008), Voorhees (2006), Calabrese and Williams (2019), Lago-Peñas and Lago-Peñas (2008), Benito, Guillamon and Bastida (2015), Ríos et al. (2018), Geys, Goeminne and Smolders (20089, Sedmihradská and Čabla (2013), Boukari and Veiga (2018), Lee and Kwak (2020), Kara (2024a).

Considering the insufficient number and capacity of personnel preparing budget forecasts in metropolitan municipalities in Turkey, it is believed that the forecasts will be highly inaccurate and predominantly negative. Therefore, this study calculates PE, MPE, and MAPE values to test the following two hypotheses.

Hypothesis 1: The budgets of metropolitan municipalities in Turkey are significantly inaccurately forecasted.

Hypothesis 2: The forecasting errors of metropolitan municipalities in Turkey are predominantly negative.

No studies have been identified in the literature that test the impact of budget surpluses on revenue and expenditure forecasting errors. However, it is believed that in metropolitan municipalities in Turkey, there is a spilover effect from balance to revenue and expenditure errors, especially when the balance is positive. Therefore, a dummy variable, where 1 indicates periods with budget surplus and 0 indicates periods with budget deficit, has been included in the analyses.

Hypothesis 3: A budget surplus in metropolitan municipalities positively affects the revenue and expenditure forecasts.

Studies (Gentry, 1989; Allan, 1965; Islam, 1999; Afonso and Silva, 2012; Sedmihradská and Čabla, 2013; Kara, 2024b; and Aizenman & Hausmann, 2000) have identified that inflation affects forecasting errors. Krol (2013) also included inflation as a control variable in the analysis. It is believed that metropolitan municipalities in Turkey spend more and generate more revenue than forecasted

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

due to local inflation. Therefore, the inflation rates of cities have been included in the analyses in this study.

Hypothesis 4: An increase in city's inflation positively affects the forecasting error. Gentry (1989), Mayper, Granof and Giroux (1991), Boukari and Veiga (2018), and Brogan (2012) have found a correlation between unemployment and forecasting errors. On the other hand, Sedmihradská and Čabla (2013) and Afonso and Silva (2012) did not find a significant relationship. It is sometimes wondered, in Turkey particularly, whether local unemployment rates have an impact on revenue forecasting errors. The theoretical expectation is that as unemployment increases, revenue forecasting errors will trend negatively and expenditure forecasting errors positively. This is because metropolitan municipalities incur expenses to combat unemployment, while an increase in unemployment reduces household spending and thereby reduces the revenue of metropolitan municipalities. Therefore, unemployment rates of cities have been included in the analysis in this study.

Hypothesis 5: An increase in a city's unemployment rate affects revenue forecasting errors negatively and expenditure forecasting errors positively.
Boukari and Veiga (2018), Brogan (2012), Buettner and Kauder (2015), Sedmihradská and Čabla (2013), Merola and Pérez (2013) and Boukari and Veiga (2018) have found a significant relationship between GDP per capita and forecasting errors. Bağdigen (2002) has partly confirmed this relationship. However, Ríos et al. (2018) did not find such a relationship. It is deemed necessary to analyse this situation in Turkey as well. It is thought that as GDP per capita increases, expenditures will increase, leading metropolitan municipalities to generate more revenue than forecast and consequently spend more than forecast.

Hypothesis 6: An increase in a city's GDP per capita positively increases forecasting errors.
In examining the causes of budget forecasting errors in metropolitan municipalities in Turkey, I have introduced the export-to-import ratio as a variable. The literature does not show any study that includes foreign trade in the analysis of forecasting errors. Despite this absence, I chose to include it, considering Turkey's status as a developing country where both exports and imports significantly contribute to the industrialization and development of cities. The aim is to determine whether this effect exists in Turkey. Due to the observed autocorrelation in import and export data, they could not be included separately in the models. Attempts to build models using the difference between them, the balance of trade, also resulted in the same error. Therefore, the study includes the export-to-import ratio instead. By incorporating this variable, I aim to explore its potential impact on municipal budgetary performance, thereby offering a novel contribution to the literature. This approach seeks to fill a gap in existing research and provide a deeper understanding of the factors influencing budgetary accuracy in developing economies.

Hypothesis 7: As the export-to-import ratio of a city increases, forecasting errors increase.

Gentry (1989), Mayper, Granof and Giroux (1991), Lago-Peñas and Lago-Peñas (2008), Benito, Guillamon and Bastida (2015), Deus and de Mendonça (2017) have found a relationship between population and forecasting errors. The population growth rates of cities have been added to the analysis in this study.

Hypothesis 8: As the population growth rate of a city increases, forecasting errors increase.

Numerous studies have indicated that the political affiliation of political officials impacts forecast bias (Bischoff and Gohout, 2006; Bretschneider and Gorr, 1992; Brogan, 2012; Couture and Imbeau, 2009; Krol, 2013; Ríos et al., 2018; Brouthers, 1986; Bretschneider et al., 1989; Oliver and Villalonga, 2018). A dummy variable has been added to the analysis, with a value of 1 for mayors affiliated with right-wing parties and 0 for mayors affiliated with left-wing parties.

Hypothesis 9: The political ideology of the metropolitan mayor's party influences forecast bias.

Numerous studies have demonstrated that political manipulation of revenue forecasts occurs before elections, impacting forecasts. Incumbents seeking re-election tend to favour forecasts showing higher revenue to facilitate increased spending or reduced taxation, thereby enhancing their image during the election period (Alesina and Paradisi, 2017; Bee and Moulton, 2015; Bohn, 2010, 2011; Boukari and Veiga, 2018; Brogan, 2012; Haan and Mink, 2005; Sturm, Jong-A-Pin and de Haan, 2012; Krol, 2013; Lalvani, 1999; Mink and de Haan, 2006; Ríos et al., 2018). A dummy variable has been added to the analysis, with a value of 1 if the mayor is running for re-election and 0 for otherwise.

Hypothesis 10: The re-candidacy of the metropolitan mayor in the upcoming elections affects revenue forecasting errors negatively and expenditure forecasting errors positively.

Brouthers (1986), Boylan (2008), Couture and Imbeau (2009), Lago-Peñas and Lago-Peñas (2008), Benito, Guillamon and Bastida (2015), Ríos et al. (2018), Heinemann (2006), Bischoff and Gohout (2006), Sedmihradská and Čabla (2013), Deus and de Mendonça (2017), Strauch, Hallerberg and Hagen (2004), Brück and Stephan (2005), Pina and Venes (2011), Holm-Hadulla, Hauptmeier and Rother (2012), Merola and Pérez (2013) and Boukari and Veiga (2018) have found that election periods significantly impact budget forecasting errors. On the other hand, Deus and de Mendonça (2015) found them to be ineffective, while Kauder, Potrafke and Schinke (2017) found them to be partially effective. To assess the situation in Turkey, a dummy variable has been included in the analysis, with a value of 1 for election periods and 0 for otherwise.

Hypothesis 11: Local government election periods in Turkey positively impact forecasting errors in metropolitan municipalities.

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

5 DATASET AND METHODOLOGY

Provincial GDP levels, and the possibility of data availability were considered, and fifteen selected metropolitan municipalities (Istanbul, Ankara, Izmir, Kocaeli, Bursa, Antalya, Konya, Adana, Tekirdag, Gaziantep, Kayseri, Sanliurfa, Samsun, Ordu, Erzurum) were addressed[1]. The period from 2011 to 2022 has been considered. Initially, revenue and expenditure forecasting errors were calculated through the following equations[2].

$$PE_t = \frac{(A_t - F_t) * 100}{F_t} \tag{1}$$

$$MPE_t = \frac{1}{T} \sum_{T=1}^{T} \frac{(A_t - F_t) * 100}{F_t} \tag{2}$$

$$MAPE_t = \frac{1}{T} \sum_{T=1}^{T} \frac{|(A_t - F_t)| * 100}{|F_t|} \tag{3}$$

The percent error (PE) measures the difference between forecasted and actual values as a percentage of the actual value, providing a direct measure of error magnitude relative to the actual values. However, PE can be misleading when actual values are very small, as the percentage error may become disproportionately large. The mean percent error (MPE) calculates the average of all percent errors for each forecast, offering insights into the overall bias of the forecasts. Nonetheless, the MPE can be affected by the sign of the errors, potentially cancelling out positive and negative errors and providing a skewed perspective if errors are not evenly distributed. The mean absolute percent error (MAPE) calculates the average of the absolute values of percent errors, providing a measure of forecast accuracy that is not influenced by the direction of the errors. MAPE is widely used due to its interpretability and simplicity, but it is sensitive to cases where actual values are zero or near zero, which can result in disproportionately high errors. Since none of the data considered in the study showed this near-zero condition, it was decided to use the MAPE value.

[1] In Turkey, there are 30 metropolitan municipalities. Thirteen of these were established in 2012, and one was established in 2013. With the regulatory changes made to the Turkish financial system between 2003 and 2006, it was decided that metropolitan municipalities would publish their budget-related documents annually to the public. However, due to the time required to develop the necessary infrastructure and to train personnel on the relevant regulations, compliance with financial legislation by metropolitan municipalities took time. At this point, only a few metropolitan municipalities published information for a few years prior to 2011. The vast majority of the metropolitan municipalities covered in the study only began to publish information from 2011 onward. Indeed, the information for other metropolitan municipalities not included in the study for the years 2011 and later remains inaccessible to the public and researchers. It is believed that the reason the fifteen metropolitan municipalities covered in the study were able to achieve earlier compliance is that they are the fifteen largest metropolitan municipalities economically in Turkey. Finally, considering that the final accounts for the year 2023 have not yet been released, it was deemed appropriate to prepare the study for the period 2011-2023 for these fifteen metropolitan municipalities.

[2] Since metropolitan municipalities forecast a budget balance of 0 (equal revenue and expenditure) for certain periods, the balance error could not be calculated during these periods. Therefore, a model could not be established for the budget balance forecasting errors.

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

Subsequently, considering their presence, correlations with each other, literature on forecasting errors, and theoretical background, the following economic and political variables have been compiled.

Table 1
Explanation and acronyms of variables

Variable	Explanation	Acronym
Revenue forecasting error	Annual budget revenue forecasting absolute error rate	REV
Expenditure forecasting error	Annual budget expenditure forecasting absolute error rate	EXP
Inflation	Annual local inflation rate	INF
Unemployment	Annual local unemployment rate	UNP
Per capita GDP	Annual local per capita GDP	GDP
Export-to-import ratio	Local Export-to-import ratio: (Export/Import)	EIR
Population growth rate	Annual local population growth rate	PGR
Mayor's political party	"1" if mayor's political party is right-wing, "0" otherwise	RLP
Mayor's re-candidacy	"1" if mayor re-candidate for the next election, "0" otherwise	REL
Municipality election periods	"1" if municipality elections were held that year, "0" otherwise	ELC
Budget surplus	"1" if budget surplus, "0" otherwise	BDM

Source: TURKSTAT, Central Bank of the Republic of Turkey, Ministry of Treasury and Finance.

The variables outlined in table 1 were chosen because they represent key economic and political factors that can influence the accuracy of budget forecasts in metropolitan municipalities. Specifically, inflation, unemployment, and per capita GDP were selected as economic variables, reflecting the uncertainties municipalities encounter in their fiscal planning. Higher inflation rates, for example, tend to increase budget unpredictability, while unemployment rates and GDP per capita levels are proxies for regional economic stability, which may also affect revenue and expenditure forecasting accuracy. These variables are commonly utilized in the literature on budget forecasting errors, where economic instability is shown to correlate with greater deviations between forecast and actual budget outcomes (see hypotheses 3 to 8).

Political factors, such as the mayor's political affiliation, re-candidacy status, and election periods, were included to capture the potential influence of political incentives on fiscal decision-making. Mayors who intend to run for re-election, for instance, may be more inclined to present optimistic revenue forecasts or adjust expenditure plans to align with voter expectations. Similarly, election years may introduce biases into forecasts as political parties seek to maximize electoral support, potentially leading to either overestimation or underestimation of revenues and expenditures. Prior research highlights the impact of electoral cycles on fiscal behaviour, particularly in terms of optimistic revenue forecasting in election periods, making these variables relevant for understanding the political drivers of budget forecasting errors (see hypotheses 9 and 10).

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

In the study, the absolute values of the revenue and expenditure forecasting errors of metropolitan municipalities were used as dependent variables in the two different models established. These values were calculated by the author. As independent variables, the following were compiled from the Turkish Statistical Institute and used: regional inflation, regional unemployment, regional per capita GDP, regional export-to-import ratio, regional population growth rate, the size of the budget deficit for the relevant year of the metropolitan municipality budget, the stance of the current president's political party (according to the party's charter), whether the current president will run for the next election, and finally, the years of local administrative elections.

At this point, it has been deemed necessary to provide information about the dataset and models. There is no doubt that national macroeconomic variables such as national inflation, unemployment, and growth, as well as national elections, significantly affect the budget forecasting errors of metropolitan municipalities. However, this study focuses on answering the question, "Do local economic and political factors affect the budget forecasting errors of metropolitan municipalities?" Therefore, national data have been excluded from the scope of the study.

The descriptive statistics of the data used in this study are presented in table 2. The dataset comprises a total of 11 variables, with 180 observations for each variable. The table provides the mean, standard deviation, maximum, and minimum values for each variable. Overall, it can be observed that the deviations from the mean for all variables are relatively low, indicating a consistent distribution of the data. This suggests that the variables used in the analysis exhibit limited variability, which may enhance the reliability of the regression model results by minimizing potential distortions caused by extreme outliers.

Table 2
Descriptive statistics

Variable		Mean	Std. dev.	Min.	Max.	Obs.	
EXP	overall	0.1887	0.1870	0.0001	1.1190	N	180
	between		0.0693	0.0699	0.3068	n	15
	within		0.1745	-0.0971	1.0452	T	12
REV	overall	0.1707	0.1325	0.0021	0.7005	N	180
	between		0.0673	0.0729	0.3074	n	15
	within		0.1154	-0.0332	0.6644	T	12
BDM	overall	0.3555	0.4800	0	1.0000	N	180
	between		0.2076	0	0.7500	n	15
	within		0.4358	-0.3944	1.1888	T	12
INF	overall	18.4078	18.4690	5.4300	73.3000	N	180
	between		0.4282	17.6466	19.000	n	15
	within		18.4643	4.8787	73.1670	T	12
UNP	overall	10.3150	3.3335	3.6000	23.4000	N	180
	between		2.8017	6.575	15.6083	n	15
	within		1.9351	1.6066	18.1066	T	12

Variable		Mean	Std. dev.	Min.	Max.	Obs.	
GDP	overall	10,464.9800	4,376.7860	3,0430	20,8830	N	180
	between		4,301.0550	3,901.3330	17,653.0800	n	15
	within		1,339.4010	5,983.3940	13,952.6400	T	12
EIR	overall	1.4758	1.6461	0.3546	10.4561	N	180
	between		1.1814	0.6403	5.3017	n	15
	within		1.1831	-2.6785	8.0300	T	12
PGR	overall	14.7243	11.1765	-23.2400	39.0900	N	180
	between		8.6468	-2.1208	29.8908	n	15
	within		7.3986	-13.4640	48.8660	T	12
RLP	overall	0.7444	0.4373	0	1	N	180
	between		0.3542	0	1	n	15
	within		0.2712	-0.0055	1.3277	T	12
REL	overall	0.5888	0.4934	0	1	N	180
	between		0.3556	0	1	n	15
	within		0.3532	-0.3277	1.3388	T	12
ELC	overall	0.1666	0.3737	0	1	N	180
	between		0	0.1666	0.1666	n	15
	within		0.3738	0	1	T	12

Note: For all variables: N=180, n=15, T=12.

Source: Author's calculations.

The dependent and independent variables used to estimate municipal budget errors are presented in table 3. The correlation coefficient ranges between -1 and 1, indicating the linear relationship between the variables. As the absolute value of the correlation coefficient approaches 1, the relationship is considered strong, while values closer to 0 indicate a weak relationship.

Table 3

Correlation matrix

	REV	EXP	BDM	INF	UNP	GDP	EIR	PGR	RLP	REL	ELC
REV	1										
EXP	0.4953	1									
BDM	-0.1505	0.0248	1								
INF	0.1057	0.4426	0.0511	1							
UNP	-0.2229	-0.0935	0.2320	0.0323	1						
GDP	0.0362	0.3941	0.1327	0.8105	0.0975	1					
EIR	0.0329	0.0457	-0.1073	0.0038	-0.1091	-0.1018	1				
PGR	0.0476	-0.0175	0.2151	-0.1706	0.1340	-0.0091	-0.1330	1			
RLP	-0.0326	-0.1492	-0.0171	-0.1224	-0.1905	-0.3044	-0.1116	-0.1572	1		
REL	0.0497	-0.0384	-0.0398	-0.0607	-0.0893	0.0539	-0.1870	0.1035	-0.1789	1	
ELC	0.1203	0.1016	0.0415	-0.2056	0.1235	-0.1068	0.0026	0.0228	-0.0114	-0.0808	1

Source: Author's calculations.

In general, it has been observed that the variables used exhibit a moderate level of correlation. The strongest relationship was found between GDP and INF, with a correlation coefficient of 0.8105. Additionally, the correlation coefficient between REV and EXP was 0.4953, and between INF and EXP, it was 0.4426. The correlation coefficients between the other variables were determined to be moderate to low.

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

After calculating the errors and identifying the variables to be used, the appropriate panel regression model was determined using the Hausman test. The results indicated that random effect should be used for both revenue (p=0.4531) and expenditure (p=0.0957) models (see appendix). Furthermore, the results of the LM tests conducted also demonstrate that the random effect model should be used for both the revenue (p=0.0000) and expenditure (p=0.0352) models. In this regard, two different panel regression models for revenue and expenditure were established using the following equations.

$$REV_{it} = \beta_0 + \beta_1 INF_{it} + \beta_2 UNP_{it} + \beta_3 GDP_{it} + \beta_4 EIR_{it} + \beta_5 PGR_{it} + \beta_6 BDM_{it} + \beta_7 RLP_{it} + \beta_8 REL_{it} + \beta_9 ELC_{it} + u_{it} \quad (4)$$

$$EXP_{it} = \beta_0 + \beta_1 INF_{it} + \beta_2 UNP_{it} + \beta_3 GDP_{it} + \beta_4 EIR_{it} + \beta_5 PGR_{it} + \beta_6 BDM_{it} + \beta_7 RLP_{it} + \beta_8 REL_{it} + \beta_9 ELC_{it} + u_{it} \quad (5)$$

The term (i) in the equations (4 and 5) represents the observation unit, which is the metropolitan municipalities. (t) represents the time periods, that is, years. And (β_0, β_1, β_2,.....,β_9) represent the coefficients. These coefficients specify the impact of each independent variable on REV_{it} or EXP_{it}. Finally, (u_{it}) represents the error term of the model.

6 RESULTS

Before the regression analysis, the MPE and MAPE values of metropolitan municipalities in Turkey were calculated using the above equations (2 and 3) and are shown in the table 4. Additionally, the table includes information on the number of periods with negative and positive errors.

TABLE 4

MPE, MAPE, NoNEP and NoPEP

Municipality	Category	MPE	MAPE	NoNEP	NoPEP
Istanbul	Revenue	11.17	14.42	4	8
	Expenditure	5.78	13.21	6	6
Ankara	Revenue	-4.66	12.62	8	4
	Expenditure	-1.97	16.88	11	1
Izmir	Revenue	-1.62	7.29	8	4
	Expenditure	-7.92	11.92	11	1
Kocaeli	Revenue	-3.09	13.26	7	5
	Expenditure	-6.72	20.91	9	3
Bursa	Revenue	-4.10	10.82	9	3
	Expenditure	3.34	15.68	7	5
Antalya	Revenue	-12.89	30.74	9	3
	Expenditure	-20.06	24.61	10	2
Konya	Revenue	-24.40	26.35	11	1
	Expenditure	-12.54	29.20	11	1
Adana	Revenue	-21.00	23.72	11	1
	Expenditure	-18.51	18.51	12	0
Tekirdag	Revenue	-7.03	20.03	7	5
	Expenditure	-24.99	30.68	11	1

Municipality	Category	MPE	MAPE	NoNEP	NoPEP
Gaziantep	Revenue	-9.11	14.14	9	3
	Expenditure	-10.38	10.38	12	0
Kayseri	Revenue	2.30	20.68	8	4
	Expenditure	-4.95	26.25	10	2
Sanliurfa	Revenue	-7.79	11.99	9	3
	Expenditure	-15.87	15.87	12	0
Samsun	Revenue	-4.95	9.74	9	3
	Expenditure	1.17	6.99	7	5
Ordu	Revenue	-9.86	17.60	11	1
	Expenditure	3.23	18.91	7	5
Erzurum	Revenue	-20.52	22.64	10	2
	Expenditure	-0.75	23.11	10	2

Note: NoNEP: number of negative error periods; NoPEP: number of positive error periods.
Source: Author's calculations based on the Ministry of Treasury and Finance data.

The analysis of the table reveals intriguing insights into the revenue and expenditure forecasting performances of metropolitan municipalities in Turkey. Among these municipalities, Izmir emerges as the standout performer in revenue forecasting, showing a robust and accurate forecasting methodology. On the other hand, Samsun shines in expenditure forecasting, demonstrating a remarkable ability to forecast expenditures accurately. In contrast, Antalya experiences challenges in revenue forecasting, exhibiting the weakest performance in this aspect. Similarly, Tekirdag struggles in expenditure forecasting, displaying the least accurate forecasts among the metropolitan municipalities studied.

The overall picture indicates that, except for Izmir and Samsun, the forecasting errors of the other metropolitan municipalities are notably high, highlighting areas for improvement in their forecasting methodologies. Comparing these municipal errors to the central government's revenue MAPE of 5.65% and expenditure forecast MAPE of 4.41% provides context to the significance of these errors. It becomes evident that the forecasting errors of municipalities are substantial, underscoring the challenges they face in accurately forecasting revenue and expenditure.

Furthermore, a noteworthy observation is that most of these forecasting errors are negative, indicating a consistent tendency to overestimate revenues and expenditures. This pattern of overestimation is a crucial aspect to consider in refining forecasting techniques and ensuring fiscal prudence. During the same period, the central government's revenue forecasting error was negative for only one year, while the expenditure forecast was never negative. These findings shed light on the complexities of forecasting in the municipal context and emphasize the importance of continuous evaluation and refinement of forecasting methodologies.

Directly following the analysis presented above, we delve into the quantitative results of the revenue forecasting errors model, as depicted in the table 5.

Table 5

Panel regression results for revenue model

	Coef.	Std. err	z	P > z	[95% conf.	interval]
BDM	-0.0405	0.0198	-2.04	0.042**	-0.0794	-0.0015
INF	0.0021	0.0010	2.08	0.037**	0.0001	0.0040
UNP	-0.0100	0.0038	-2.62	0.009***	-0.0176	-0.0025
GDP	-0.0004	0.0004	-0.99	0.324	-0.0012	0.0004
EIR	0.0014	0.0068	0.21	0.831	-0.0119	0.0148
PGR	0.0018	0.0010	1.72	0.085*	-0.0002	0.0039
RLP	-0.0265	0.0294	-0.90	0.367	-0.0842	0.0311
REL	-0.0265	0.0228	-1.16	0.245	-0.0713	0.0182
ELC	0.0671	0.0241	2.78	0.006***	0.0197	0.1145
_cons	0.2659	0.0614	4.32	0.000	0.1453	0.3864
R-sq	within	0.1345			min	12
	between	0.0939		Obs. per group	avg	12
	overall	0.1179			max	12
Number of obs.		180		Number of groups		15
Wald chi2(9)						25.1400
Prob > chi2						0.0028
sigma_u						0.0594
sigma_e						0.1147
rho						0.2114

Source: Author's calculations.

The results from the revenue forecasting errors model, as shown in table 5, reveal key insights into the factors affecting revenue forecast accuracy in metropolitan municipalities. Specifically, budget surplus, inflation, unemployment, population growth, and election periods emerge as significant variables. Among these, election periods and unemployment exhibit high statistical significance at the 1% level, underscoring their critical roles in shaping forecast outcomes. Meanwhile, budget surplus and inflation are significant at the 5% level, and population growth reaches marginal significance at the 10% level.

The coefficients suggest that during election periods, municipalities tend to exhibit larger forecasting errors in their revenue estimates. This finding is consistent with the broader literature, which indicates that political pressures often lead to overly optimistic revenue forecasts in pre-election periods, as local governments attempt to gain favour with voters through increased public spending or fiscal promises. The positive effect of election periods on forecasting errors can be attributed to the complex dynamics of electoral cycles, where fiscal prudence may be compromised to accommodate short-term political objectives.

Conversely, unemployment has a negative and significant effect on revenue forecasting errors. This indicates that municipalities facing higher unemployment rates tend to adopt more conservative revenue forecasts, likely due to the economic uncertainty associated with lower employment levels. Municipalities may anticipate reduced tax

revenues and, thus, adjust their revenue expectations downward to avoid budgetary imbalances. Budget surplus also exhibits a negative relationship with forecasting errors, reflecting a more cautious approach to fiscal planning in municipalities that maintain a surplus. This is consistent with fiscal conservatism, where surplus-generating entities are likely more disciplined in their forecasting practices.

Additionally, inflation and population growth both positively influence revenue forecasting errors. Higher inflation rates can erode the accuracy of fiscal projections, as inflationary pressures create volatility in tax revenues and economic activity. The positive impact of population growth on errors likely stems from the challenges municipalities face in predicting the revenue needs of a rapidly expanding population, where infrastructure demands and service provisions become increasingly difficult to estimate. Taken together, these findings underscore the intricate relationship between local economic conditions and revenue forecasting accuracy, as influenced by both political and economic factors.

Table 6

Panel regression results for expenditure model

	Coef.	Std. err	z	P > z	[95% conf. interval]	
BDM	-0.0023	0.0269	-0.09	0.929	-0.0551	0.0503
INF	0.0046	0.0012	3.62	0.000***	0.0021	0.0071
UNP	-0.0089	0.0043	-2.05	0.040**	-0.0173	-0.0004
GDP	0.0001	0.0005	0.22	0.830	-0.0008	0.0011
EIR	0.0017	0.0084	0.20	0.839	-0.0147	0.0181
PGR	0.0008	0.0012	0.70	0.482	-0.0015	0.0033
RLP	-0.0489	0.0346	-1.41	0.158	-0.1167	0.0189
REL	-0.0221	0.0280	-0.79	0.429	-0.0770	0.0327
ELC	0.1060	0.0334	3.17	0.002***	0.0405	0.1715
_cons	0.2063	0.0717	2.88	0.004	0.0657	0.3469
R-sq	within	0.2848		Obs. per group	min	12
	between	0.1755			avg	12
	overall	0.2706			max	12
Number of obs.		180		Number of groups		15
Wald chi2(9)						64.5300
Prob > chi2						0.0000
sigma_u						0.0332
sigma_e						0.1569
rho						0.0429

Source: Author's calculations.

The results of the expenditure forecasting errors model, presented in table 6, provide further evidence of the role that economic and political variables play in determining the accuracy of budget forecasts in metropolitan municipalities. Here, inflation, unemployment, and election periods significantly affect expenditure forecasting errors, with inflation and election periods achieving the highest level of significance at the 1% level, while unemployment is significant at the 5% level.

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

The positive and significant impact of election periods on expenditure forecasting errors highlights the well-documented phenomenon where political cycles lead to increased public spending in the lead-up to elections. This practice, often referred to as "political budget cycles", reflects the tendency of incumbent governments to enhance public expenditures on visible projects or services to attract voter support, often at the expense of long-term fiscal sustainability. The sharp increase in expenditure forecasting errors during election periods suggests that municipalities may face difficulties in accurately predicting the fiscal impact of politically motivated spending, which tends to deviate from normal expenditure patterns.

Inflation also positively contributes to expenditure forecasting errors. As inflation rises, the unpredictability of cost increases for goods, services, and wages complicates budget planning. Municipalities facing high inflation may struggle to adjust their expenditure estimates to reflect real-time price changes, leading to larger discrepancies between forecast and actual expenditures. This is particularly relevant in contexts where inflation rates are volatile, making accurate budgeting even more challenging.

In contrast, unemployment exerts a negative influence on expenditure forecasting errors. Similarly to its effect on revenue forecasts, higher unemployment tends to make municipalities more cautious in their fiscal projections, possibly due to concerns about economic contraction and the resulting need for austerity measures. This conservatism may result in more accurate expenditure forecasts, as municipalities adopt tighter controls over their spending to align with anticipated reductions in revenue or increased demand for social services.

While other variables such as budget surplus, GDP, and population growth do not show significant effects in the expenditure model, the results overall reflect the importance of inflation and electoral cycles in shaping expenditure forecasting accuracy. Election periods, in particular, stand out as a significant disruptor of fiscal discipline, while inflation introduces additional uncertainty into the budgeting process, complicating efforts to maintain accurate and reliable forecasts. These findings contribute to a growing body of literature emphasizing the influence of both economic conditions and political factors on budgetary outcomes in local governments.

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

7 DISCUSSION AND POLICY RECOMMENDATIONS

The findings of this study offer significant insights into the factors influencing budget forecasting errors in Turkish metropolitan municipalities. In the revenue model, budget surpluses and unemployment are found to reduce forecasting errors, while inflation, population growth, and election years increase them. These results align with established literature in several key areas.

Firstly, the impact of inflation on forecasting errors is consistent with previous research that identifies inflation as a critical factor influencing forecast accuracy. Studies have demonstrated that high inflation rates can lead to increased forecasting errors due to the difficulty in predicting economic conditions under volatile price levels (Gentry, 1989; Allan, 1965; Islam, 1999; Afonso and Silva, 2012; Sedmihradská and Čabla, 2013; Aizenman and Hausmann, 2000). This study reinforces these findings by showing that inflation continues to be a significant factor contributing to forecasting inaccuracies.

Secondly, the effect of unemployment on forecasting errors is corroborated by several studies, which suggest that higher unemployment levels can reduce forecasting errors by reflecting economic downturns and reduced fiscal pressures (Gentry, 1989; Mayper, Granof and Giroux, 1991; Boukari and Veiga, 2018; Brogan, 2012). However, some studies have produced mixed results, indicating that the relationship between unemployment and forecasting errors can vary depending on the economic context (Sedmihradská and Čabla, 2013; Afonso and Silva, 2012). This study's findings are in line with the notion that unemployment can act as a stabilizing factor in forecast accuracy.

Regarding population growth, the study's results align with existing literature that highlights the complexity of its impact on forecasting errors. Previous research has shown that rapid population growth can complicate budget forecasting due to the challenges in predicting increased demand for public services and infrastructure (Gentry, 1989; Mayper, Granof and Giroux, 1991; Lago-Peñas and Lago-Peñas, 2008; Benito, Guillamon and Bastida, 2015; Deus and de Mendonça, 2017). The current study supports the view that population growth exacerbates forecasting errors, highlighting the need for accurate demographic projections in budgeting processes.

The influence of election years on forecasting errors is another critical finding of this study. Previous research has extensively documented how political cycles impact forecasting accuracy, with incumbents often manipulating revenue forecasts to enhance their re-election prospects (Alesina and Paradisi, 2017; Bee and Moulton, 2015; Bohn, 2010, 2011; Boukari and Veiga, 2018; Brogan, 2012; Haan and Mink, 2005; Krol, 2013; Lalvani, 1999; Mink and de Haan, 2006; Ríos et al., 2018; Sturm, Jong-A-Pin and de Haan, 2012). This study reinforces the existing evidence by showing that election years significantly increase forecasting errors, underscoring the need for mechanisms to counteract political biases in budget forecasting.

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

The introduction of the export-to-import ratio as a variable is a novel aspect of this study. While the existing literature does not incorporate foreign trade variables into the analysis of forecasting errors, this study's inclusion of the export-to-import ratio reflects Turkey's unique economic context. As a developing country with substantial foreign trade, this variable provides valuable insights into how external trade dynamics might influence local budget forecasting. The inclusion of this variable highlights the potential for expanding traditional forecasting models to include trade-related factors, which could be relevant for other developing economies with significant trade activities.

Based on these findings, several policy recommendations can be made.

Refine forecasting models: Municipalities should enhance their budget forecasting models by incorporating variables such as inflation, population growth, and election cycles. Additionally, integrating foreign trade indicators like the export-to-import ratio could provide a more comprehensive understanding of economic influences on budgeting.

Stabilize economic indicators: Policymakers should focus on managing inflation and supporting sustainable population growth to minimize forecasting errors. Measures aimed at controlling inflation and accurately projecting population changes can improve the reliability of budget forecasts.

Mitigate political influence: To address the impact of election cycles on forecast accuracy, it is essential to ensure transparency and objectivity in budget forecasting processes during election periods. Establishing independent forecasting bodies or committees can help mitigate potential biases introduced by political considerations.

Incorporate trade data: The integration of foreign trade variables into budget forecasting models should be explored. Understanding how trade dynamics, such as the export-to-import ratio, affect local budgets can enhance forecasting accuracy and financial planning.

Enhance capacity building: Investing in training for municipal finance and budgeting officials on advanced forecasting techniques and tools will improve budget prediction accuracy. Continued education in forecasting methodologies will support better financial management and planning.

Implementing these recommendations can help Turkish metropolitan municipalities enhance the accuracy of their budget forecasts and achieve more effective financial management.

8 CONCLUSION

The accuracy of revenue and expenditure forecasts in metropolitan municipalities is critically significant for effective public resource allocation and budget management. Reliable forecasts are essential for sound budget planning and strategic decision-making processes. Inaccurate forecasts, on the other hand, can lead to resource misallocation, budget deficits, and disruptions in public services, which can undermine the operational efficiency and financial sustainability of municipalities. This study addresses a notable gap in the literature by focusing on forecasting errors within Turkish metropolitan municipalities, thereby contributing valuable insights into the factors affecting forecast accuracy and municipal efficiency.

The analysis reveals substantial errors in both revenue and expenditure forecasts, with a tendency towards overestimation. This overestimation indicates that municipalities frequently project revenues and expenditures that can be seen to have been optimistic when the outcomes can be considered. The magnitude of these forecasting errors is significantly larger than that of errors observed in central government forecasts. This pattern suggests a risk-averse approach in municipal budget planning, where forecasters may prefer to err on the side of caution to avoid potential deficits, thereby constituting a conservative forecasting strategy.

In the revenue forecast model, several key factors were identified as influential. First, the presence of a budget surplus was associated with a reduction in forecasting errors. This finding indicates that during periods of surplus, municipalities might rely on historical revenue trends that reflect higher-than-expected revenues, leading to more accurate forecasts. The reliance on past financial performance during surplus years helps municipalities achieve more conservative forecasts and reduces forecasting errors.

Inflation was found to have a positive impact on revenue forecasting errors. The analysis highlights the significant effect of the inflation surge during the debt/foreign exchange crisis that began in 2018[3]. The astronomical rise in inflation rates during this period likely contributed to substantial forecast inaccuracies as forecasters struggled to adjust their predictions amidst severe economic volatility. This finding underscores the challenge of accurately predicting revenues in the face of high inflation, which creates substantial unpredictability in revenue streams.

The impact of the unemployment rate on revenue forecasting errors was unexpected and diverges from theoretical expectations. Contrary to the assumption that higher

[3] In 2018, Turkey faced a severe currency and debt crisis that significantly impacted its economy. The crisis began with a dramatic fall in the value of the Turkish lira, which plunged against major currencies such as the US dollar and the euro. This depreciation was driven by a combination of factors including high inflation, a large current account deficit, and rising political tensions, particularly with the United States. The Turkish government's response to the crisis included raising interest rates and seeking financial support from international institutions, but the measures had limited success in stabilizing the currency. The crisis exacerbated Turkey's already challenging economic conditions, leading to increased borrowing costs, higher inflation rates, and a strain on both public and private sector finances. This period marked a significant economic downturn, with widespread repercussions for the Turkish economy and its financial stability.

unemployment rates would exacerbate forecasting errors, the results indicate that increased unemployment was associated with reduced forecasting errors. This counterintuitive result may be due to a more conservative approach adopted by forecasters in response to rising unemployment, where they might anticipate lower revenue collection and adjust their forecasts accordingly. This anomaly highlights the need for further investigation into why increased unemployment might lead to more accurate revenue forecasts. Possible explanations could include adjustments in forecasting methods or shifts in revenue expectations that better align with economic realities during periods of high unemployment. Further comprehensive analyses are required to validate this interpretation and explore the underlying mechanisms.

Population growth was found to increase revenue forecasting errors, consistently with theoretical expectations. Rapid population growth imposes additional pressure on municipal resources, complicating accurate revenue forecasting. As municipalities face the challenge of accommodating a growing population, managing resources and services becomes increasingly complex, leading to larger forecasting errors. The increased demand for public services and infrastructure due to population growth amplifies the difficulties in predicting revenue needs accurately.

Election periods emerged as a significant factor affecting revenue forecasting errors, supporting the election cycle theory observed in the literature. The substantial impact of election cycles on forecast accuracy suggests that municipalities may adjust their forecasts during election years to present a more favourable fiscal outlook or align with political objectives. This manipulation reflects the broader influence of political cycles on financial planning and forecasting accuracy, highlighting how electoral considerations can shape municipal budget forecasts.

Turning to the expenditure forecasting model, inflation again demonstrated a positive relationship with forecasting errors. The findings suggest that inflation exacerbates expenditure forecasting inaccuracies, particularly concerning current expenditures, which are inflexible and challenging to adjust. The high forecasting errors observed post-2018 are attributed to inflationary pressures that complicate the prediction of expenditure needs, reflecting the difficulties in managing budgets during periods of high inflation.

The impact of the unemployment rate on expenditure forecasting errors was similarly unexpected. Contrary to theoretical expectations that higher unemployment would lead to increased social expenditures and, consequently, greater forecasting inaccuracies, the results show that higher unemployment rates were associated with reduced expenditure forecasting errors. This finding diverges from the conventional belief that increased unemployment would inflate social spending and complicate budget forecasting. This discrepancy warrants further analysis to understand why unemployment might lead to more accurate expenditure

forecasts. Potential reasons could include adjustments in budget allocations or changes in expenditure patterns during periods of high unemployment. Detailed investigations are needed to reconcile these findings with theoretical models and understand the underlying dynamics.

Election periods were also found to significantly influence expenditure forecasting errors, with election periods proving to be the most influential variable in the expenditure model. This result aligns with the notion that municipalities may manipulate expenditure forecasts during election years to present a favourable fiscal situation. The significant impact of election periods on expenditure forecasts underscores the political dimensions of budget management in Turkey, highlighting how political cycles can influence financial planning and forecast accuracy.

Table 7

Results of hypothesis

No	Hypothesis	Status	
		Revenue	Expenditure
1	Budgets are forecasted with a high degree of inaccuracy	Accept	Accept
2	Forecasting errors are mostly in the negative direction	Accept	Accept
3	A budget surplus affects budget forecasting errors	Accept	Reject
4	An increase in inflation affects the forecasting error in a positive direction	Accept	Accept
5	An increase in the unemployment rate affects revenue forecasting errors negatively and expenditure forecasting errors positively	Accept	Accept
6	An increase in per capita GDP increases errors in a positive direction	Reject	Reject
7	As the export-to-import ratio increases, forecasting errors also increase in a positive direction	Reject	Reject
8	As the population growth rate increases, forecasting errors also increase in a positive direction	Accept	Reject
9	Mayor's political party affiliations affect the forecasting error	Reject	Reject
10	Mayor's candidacy in the next elections affects revenue forecasting errors negatively and expenditure forecasting errors positively	Reject	Reject
11	Election periods affect revenue forecasting errors negatively and expenditure forecasting errors positively	Accept	Accept

Source: Author's calculations based on tables 4, 5 and 6 results.

In summary, the findings from this study illustrate that budget forecasting errors in Turkish metropolitan municipalities are significantly influenced by a range of macroeconomic variables and political factors. While the impact of inflation and election periods on forecasting errors aligns with theoretical expectations, the role of unemployment presents a noteworthy deviation from conventional wisdom. The unexpected negative relationship between unemployment and revenue forecasting errors suggests that forecasters may adopt more conservative strategies

during periods of high unemployment, warranting further investigation to understand the underlying mechanisms. Similarly, the reduction of forecasting errors in expenditure models during a period of high unemployment contradict theoretical predictions, indicating potential shifts in expenditure patterns or forecasting approaches.

To address these complexities and enhance the accuracy of budget forecasts, several recommendations can be made. Firstly, municipalities should consider incorporating more nuanced economic indicators and forecasting methods that account for the unique dynamics of unemployment and inflation. Developing adaptive forecasting models that can better handle economic volatility and demographic changes may lead to more reliable predictions. Additionally, increasing transparency in the budgeting process and incorporating regular reviews can help mitigate the impact of political cycles on forecasting accuracy. Policymakers should also focus on improving data collection and analysis techniques to better capture the effects of macroeconomic variables on budget forecasts. Further research is essential to explore the observed anomalies and refine forecasting practices, ultimately contributing to more effective budget management and financial sustainability in metropolitan municipalities.

Disclosure statement

The author has no conflict of interest to declare.

REFERENCES

1. Afonso, A. and Silva, J., 2012. The Fiscal Forecasting Track Record of the European Commission and Portugal. *Lisbon: ISEG Economics Working Paper*, No. 37/2012/DE/UECE. https://doi.org/10.2139/ssrn.2181117
2. Agostini, S. J., 1991. Searching for a Better Forecast: San Francisco's Revenue Forecasting Model. *Government Finance Review*, 7, pp. 13-16.
3. Aizenman, J. and Hausmann, R., 2000. The Impact of Inflation on Budgetary Discipline. *Journal of Development Economics,* 63(2), pp. 425-449. https://doi.org/10.1016/S0304-3878(00)00111-5
4. Alesina, A. and Paradisi, M., 2017. Political Budget Cycles: Evidence from Italian Cities. *Economics & Politics,* 29(2), pp. 157-177. https://doi.org/10.1111/ecpo.12091
5. Allan, C. M., 1965. Fiscal Marksmanship, 1951-1963. *Oxford Economic Papers,* 17(2), pp. 317-327. https://doi.org/10.1093/oxfordjournals.oep.a040992
6. Asher, M. G., 1978. Accuracy of Budgetary Forecasts of Central Government, 1967-68 to 1975-76. *Economic and Political Weekly,* 13(8), pp. 423-432.
7. Auld, D. A., 1970. Fiscal Marksmanship in Canada. *The Canadian Journal of Economics,* 3(3), pp. 507-511. https://doi.org/10.2307/133664
8. Bağdigen, M., 2002. How Accurate is Revenue Forecasting in Turkey? An Empirical Analysis. *Yapi Kredi Economic Review,* 13(2), pp. 29-37.
9. Beckett-Camarata, J., 2006. Revenue Forecasting Accuracy in Ohio Local Governments. *Journal of Public Budgeting, Accounting & Financial Management,* 18(1), pp. 77-99. https://doi.org/10.1108/JPBAFM-18-01-2006-B004
10. Bee, A. and Moulton, S., 2015. Political Budget Cycles in U.S. Municipalities. *Economics of Governance*, 16(4), pp. 379-403. https://doi.org/10.1007/s10101-015-0171-z
11. Benito, B., Guillamon, M.-D. and Bastida, F., 2015. Budget Forecast Deviations in Municipal Governments: Determinants and Implications. *Australian Accounting Review,* 25(1), pp. 45-70. https://doi.org/10.1111/auar.12071
12. Bhattacharya, B. B. and Kumari, A., 1988. Budget Forecasts of Central Government Revenue and Expenditure: A Test of Rational Expectation. *Economic and Political Weekly,* 23(26), pp. 1323-1327.
13. Bischoff, I. and Gohout, W., 2006. Tax Projections in German States – Manipulated by Opportunistic Incumbent Parties? *Finanzwissenschaftliche Arbeitspapiere,* No. 74.
14. Bohn, F., 2010. *Disinformation and Political Budget Cycles.*
15. Bohn, F., 2011. *Political Budget Cycles: Can Disinformation Explain Country Group Differences.*
16. Botrić, V. and Vizek, M., 2012. Forecasting Fiscal Revenues in a Transition Country: The Case of Croatia. *Zagreb International Review of Economics & Business,* 15(1), pp. 23-36.
17. Boukari, M. and Veiga, F. J., 2018. Disentangling Political and Institutional Determinants of Budget Forecast Errors: A Comparative Approach. *Journal of Comparative Economics,* 46(4), pp. 1030-1045. https://doi.org/10.1016/j.jce.2018.03.002

18. Boylan, R. T., 2008. Political Distortions in State Forecasts. *Public Choice,* 136(3), pp. 411-427. https://doi.org/10.2139/ssrn.941227
19. Bretschneider, S. and Gorr, W. L., 1992. Economic, Organizational, and Political Influences on Biases in Forecasting State Sales Tax Receipts. *International Journal of Forecasting,* 7(4), pp. 457-466. https://doi.org/10.1016/0169-2070(92)90029-9
20. Bretschneider, S. [et al.], 1989. Political and Organizational Influences on the Accuracy of Forecasting State Government Revenues. *International Journal of Forecasting,* 5(3), pp. 307-319. https://doi.org/10.1016/0169-2070(89)90035-6
21. Brogan, M., 2012. The Politics of Budgeting: Evaluating the Effects of the Political Election Cycle on State-Level Budget Forecast Errors. *Public Administration Quarterly,* 36(1), pp. 84-115.
22. Brouthers, L. E., 1986. Parties, Ideology and Elections: The Politics of Federal Revenues and Expenditures Forecasting. *International Journal of Public Administration,* 8(3), pp. 289-314. https://doi.org/10.1080/01900698608524519
23. Brück, T. and Stephan, A., 2005. Do Eurozone Countries Cheat with their Budget Deficit Forecasts? *European University Viadrina Working Paper Series,* No. 2005, 5.
24. Buettner, T. and Kauder, B., 2015. Political Biases Despite External Expert Participation: An Empirical Analysis of Tax Revenue Forecasts in Germany. *Public Choice,* 164(3), pp. 287-307. https://doi.org/10.1007/s11127-015-0279-2
25. Calabrese, T. and Williams, D., 2019. Bias Associated with Centrally Budgeted Expenditure Forecasts. In: D. Williams and T. Calabrese, eds. *The Palgrave Handbook of Government Budget Forecasting*. Cham: Palgrave MacMillan, pp. 201-215. https://doi.org/10.1007/978-3-030-18195-6_10
26. Couture, J. and Imbeau, L., 2009. Do Governments Manipulate Their Revenue Forecasts? Budget Speech and Budget Outcomes in the Canadian Provinces. In: L. M. Imbeau, ed. *Do They Walk Like They Talk? Speech and Action in Policy Processes*. New York: Springer, pp. 155-166. https://doi.org/10.1007/978-0-387-89672-4_9
27. Davis, J. M., 1980. Fiscal Marksmanship in the United Kingdom, 1951-78. *The Manchester School,* 48(2), pp. 187-202. https://doi.org/10.1111/j.1467-9957.1980.tb00719.x
28. Deus, J. D. and de Mendonça, H., 2017. Fiscal Forecasting Performance in an Emerging Economy: An Empirical Assessment of Brazil. *Economic Systems,* 41(3), pp. 408-419. https://doi.org/10.1016/j.ecosys.2016.10.004
29. Deus, J. D. and de Mendonça, H. F., 2015. Empirical Evidence on Fiscal Forecasting in Eurozone Countries. *Journal of Economic Studies,* 42(5), pp. 838-860. https://doi.org/10.1108/JES-04-2014-0054
30. Fedotov, D. Y., 2017. Forecasting of Regional Economic Development and Budget Based on the Example of Irkutsk Oblast. *Studies on Russian Economic Development,* 28(4), pp. 416-422. https://doi.org/10.1134/S1075700717040050
31. Feenberg, D. [et al.], 1989. Testing The Rationality of State Revenue Forecasts. *The Review of Economics and Statistics,* 71(2), pp. 300-308. https://doi.org/10.2307/1926976

32. Forrester, J. P., 1991. Budgetary Constraints and Municipal Revenue Forecasting. *Policy Sciences,* 24(4), pp. 333-356. https://doi.org/10.1007/BF00135880
33. Fullerton, T., 1989. A Composite Approach to Forecasting State Government Revenues: Case Study of the Idaho Sales Tax. *International Journal of Forecasting,* 5(3), pp. 373-380. https://doi.org/10.1016/0169-2070(89)90040-X
34. Gentry, W. M., 1989. Do State Revenue Forecasters Utilize Available Information? *National Tax Journal,* 42(4), pp. 429-439. https://doi.org/10.1086/NTJ41788812
35. Geys, B., Goeminne, S. and Smolders, C., 2008. Political Fragmentation and Projected Tax Revenues: Evidence from Flemish Municipalities. *International Tax and Public Finance,* 15(3), pp. 297-315. https://doi.org/10.1007/s10797-007-9021-4
36. Grizzle, G. and Klay, W. E., 1994. Forecasting State Sales Tax Revenues: Comparing the Accuracy of Different Methods. *State & Local Government Review,* 26(3), pp. 142-152.
37. Haan, J. D. and Mink, M., 2005. Has the Stability and Growth Pact Impeded Political Budget Cycles in the European Union? *CESifo Working Paper Series*, No. 1532. https://doi.org/10.2139/ssrn.812329
38. Heinemann, F., 2006. Planning or Propaganda? An Evaluation of Germany's Medium-term Budgetary Planning. *FinanzArchiv / Public Finance Analysis,* 62(4), pp. 551-578. https://doi.org/10.1628/001522106X172698
39. Holm-Hadulla, F., Hauptmeier, S. and Rother, P., 2012. The Impact of Expenditure Rules on Budgetary Discipline over the Cycle. *Applied Economics,* 44(25), pp. 3287-3296. https://doi.org/10.1080/00036846.2011.572855
40. Islam, A. R., 1999. *Forecast Performances of Provincial Government Revenue Estimates in Canada.* Simon Fraser University, Doctoral Thesis.
41. Jena, P. R., 2006. Fiscal Marksmanship: Link between Forecasting Central Tax Revenues and State Fiscal Management. *Economic and Political Weekly,* 41(37), 3971-3976.
42. Jones, V. D., Bretschneider, S. and Gorr, W., 1997. Organizational Pressures on Forecast Evaluation: Managerial, Political, and Procedural Influences. *Journal of Forecasting,* 16(4), pp. 241-254. https://doi.org/10.1002/(SICI)1099-131X(199707)16:4<241::AID-FOR658>3.0.CO;2-P
43. Kara, B., 2024a. The Performance of Medium-Term Budgeting in Türkiye: An Analysis of Budget Forecasts. *Yönetim ve Ekonomi Dergisi*, 31(4), pp. 659-676. https://doi.org/10.18657/yonveek.1521261
44. Kara, B., 2024b. *Türkiye'de Kamu Bütçesi Tahminlerinin Gerçekliği*. Ankara: Gazi Kitabevi.
45. Kauder, B., Potrafke, N. and Schinke, C., 2017. Manipulating Fiscal Forecasts: Evidence from the German States. *CESifo Working Paper*, No. 6310. https://doi.org/10.2139/ssrn.2920679
46. Khan, A., 2019. *Fundamentals of Public Budgeting and Finance.* Palgrave Macmillan. https://doi.org/10.1007/978-3-030-19226-6

47. Khan, T., Hussain, A. and Malik, Z. K., 2018. Fiscal Marksmanship in Pakistan: With Special Focus on Province Khyber Pakhtunkhwa. *Pakistan Journal of Economic Studies,* 1(1), pp. 21-43.
48. Krause, G. A. and Corder, J., 2007. Explaining Bureaucratic Optimism: Theory and Evidence from U.S. Executive Agency Macroeconomic Forecasts. *The American Political Science Review,* 101(1), pp. 129-142. https://doi.org/10.1017/S0003055407070074
49. Krol, R., 2013. Evaluating State Revenue Forecasting under a Flexible Loss Function. *International Journal of Forecasting,* 29(2), pp. 282-289. https://doi.org/10.1016/j.ijforecast.2012.11.003
50. Lago-Peñas, I. and Lago-Peñas, S., 2008. Explaining Budgetary Indiscipline: Evidence from Spanish Municipalities. *Public Finance and Management,* 8(1), pp. 1-43. https://doi.org/10.1177/152397210800800102
51. Lalvani, M., 1999. Elections and Macropolicy Signals: Political Budget Cycle Hypothesis. *Economic and Political Weekly*, pp. 2676-2681.
52. Larkey, P. and Smith, R., 1989. Bias in the Formulation of Local Government Budget Problems. *Policy Sciences,* (22), pp. 123-166. https://doi.org/10.1007/BF00141382
53. Lazar, C. and Andrei, J., 2006. The Budget – an Instrument for Forecasting. Multiyear Budgeting. *Economic Insights – Trends and Challenges,* 3, pp. 41-46.
54. Leal, T. [et al.], 2008. Fiscal Forecasting: Lessons from the Literature and Challenges. *Fiscal Studies,* 29(3), pp. 347-386. https://doi.org/10.1111/j.1475-5890.2008.00078.x
55. Lee, T.-H. and Kwak, S., 2020. Revenue Volatility and Forecast Errors: Evidence From Korean Local Governments. *Local Government Studies,* 46(1), pp. 1-16. https://doi.org/10.1080/03003930.2019.1708726
56. Mayper, A. G., Granof, M. and Giroux, G., 1991. An Analysis of Municipal Budget Variances. *Accounting, Auditing & Accountability Journal,* 4(1), pp. 29-50. https://doi.org/10.1108/09513579110003358
57. McCollough, J. and Frank, H., 1992. Incentives for Forecasting Reform Among Local Finance Officers. *Public Budgeting and Financial Management,* 4(2), pp. 407-429.
58. Merola, R. and Pérez, J., 2013. Fiscal Forecast Errors: Governments versus Independent Agencies? *European Journal of Political Economy,* 32, pp. 285-299. https://doi.org/10.1016/j.ejpoleco.2013.09.002
59. Mink, M. and de Haan, J., 2006. Are There Political Budget Cycles in the Euro Area? *European Union Politics,* 7(2), pp. 191-211. https://doi.org/10.1177/1465116506063706
60. Oliver, X. and Villalonga, J., 2018. The Determinants of Regional Budget Forecast Errors in Federal Economies: Spain 1995-2013. *Hacienda Pública Española / Review of Public Economics,* 226(3), pp. 85-121. https://doi.org/10.7866/HPE-RPE.18.3.4
61. Penner, R. G., 2001. *Errors in Budget Forecasting.* Washington D.C.: The Urban Institute.

62. Pina, Á. M. and Venes, N., 2011. The Political Economy of EDP Fiscal Forecasts: An Empirical Assessment. *European Journal of Political Economy,* 27(3), pp. 534-546. https://doi.org/10.1016/j.ejpoleco.2011.01.005
63. Reddick, C. G., 2008. Evaluating Revenue Forecasting in City Governments: A Survey of Texas Finance Directors. In: J. Sun and T. Lynch, eds. *Government Budget Forecasting Theory and Practice*. New York: Taylor & Francis Group, pp. 305-324. https://doi.org/10.4324/9781315093444
64. Ríos, A.-M. [et al.], 2018. The Influence of Transparency on Budget Forecast Deviations in Municipal Governments. *Journal of Forecasting,* 37(4), pp. 457-474. https://doi.org/10.1002/for.2513
65. Schroeder, L., 2007. Forecasting Local Revenues and Expenditures. In: A. Shah, ed. *Local Budgeting*. Washington: The World Bank, pp. 53-79. https://doi.org/10.1596/978-0-8213-6945-6
66. Sedmihradská, L. and Čabla, A., 2013. Budget Accuracy in Czech Municipalities and the Determinants of Tax Revenue Forecasting Errors. *Ekonomická revue – Central European Review of Economic Issues,* 16(4), pp. 197-206. https://doi.org/10.7327/cerei.2013.12.01
67. Stevenson, W. J., 2012. *Operations Management*. New York: The McGraw-Hill Irwin.
68. Strauch, R., Hallerberg, M. and Hagen, J., 2004. Budgetary Forecasts in Europe – the Track Record of Stability and Convergence Programmes. *European Central Bank Working Papers,* No. 307. https://doi.org/10.2139/ssrn.515069
69. Sturm, J.-E., Jong-A-Pin, R. and de Haan, J., 2012. Using Real-Time Data to Test for Political Budget Cycles. *KOF Working papers*, No 12-313. https://doi.org/10.2139/ssrn.2152268
70. Voorhees, W., 2006. Consistent Underestimation Bias, the Asymmetrical Loss Function, and Homogeneous Sources of Bias in State Revenue Forecasts. *Journal of Public Budgeting, Accounting & Financial Management,* 18(1), pp. 61-76. https://doi.org/10.1108/JPBAFM-18-01-2006-B003
71. Williams, D. W. and Calabrese, T., 2016. The Status of Budget Forecasting. *Journal of Public and Nonprofit Affairs,* 2(2), pp. 127-160. https://doi.org/10.20899/jpna.2.2.127-160
72. Willoughby, K. and Guo, H., 2008. The State of the Art: Revenue Forecasting in US State Governments. In: J. Sun and T. Lynch, eds. *Government Budget Forecasting: Theory and Practice*, pp. 27-42. https://doi.org/10.1201/9781420045833.ch3
73. Zakaria, M. and Ali, S., 2010. Fiscal Marksmanship in Pakistan. *The Lahore Journal of Economics,* 15(2), pp. 113-133. https://doi.org/10.35536/lje.2010.v15.i2.a6

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

APPENDIX

HAUSMAN TEST RESULTS FOR REVENUE MODEL

The Hausman test, developed by Jerry A. Hausman in 1978, is a statistical test used in econometrics to evaluate the consistency of estimators in panel data models. Specifically, it is employed to determine whether a fixed effects model or a random effects model is more appropriate for the data at hand. The test compares the estimators from both models under the null hypothesis that the preferred model is the random effects model, which assumes that individual-specific effects are uncorrelated with the explanatory variables. If the null hypothesis is rejected, it indicates that the random effects model is inconsistent, due to the correlation between the individual effects and the regressors, thus favouring the fixed effects model. The test statistic is calculated as the difference between the estimators, scaled by their respective variances, and follows a chi-square distribution. A significant Hausman test result suggests the presence of endogeneity, affirming that the fixed effects model should be used to obtain unbiased and consistent parameter estimates. This test is crucial for ensuring the reliability of inferences drawn from panel data analyses. In this context, a test was first conducted for revenue models, and the results are shown in the table A1.

TABLE A1

Hausman test results for revenue model

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fixed	**Random**	**Difference**	**S.E.**
BDM	-0.0426	-0.0405	-0.0021	0.0046
INF	0.0021	0.0021	0.0000	0.0004
UNP	-0.0107	-0.0100	-0.0006	0.0028
GDP	-0.0004	-0.0004	-0.0000	0.0002
EIR	0.0029	0.0014	0.0015	0.0034
PGR	0.0018	0.0018	-0.0000	0.0006
RLP	-0.0316	-0.0265	-0.0051	0.0177
REL	-0.0484	-0.0265	-0.0218	0.0112
ELC	0.0652	0.0671	-0.0018	0.0037
chi2(8)				7.8000
Prob>chi2				0.4531

According to the test results ($p<0.05$), it was determined that the random effects model should be used for the revenue model.

HAUSMAN TEST RESULTS FOR EXPENDITURE MODEL

Subsequently, the same test was conducted for the expenditure models.

Table A2

Hausman test results for expenditure model

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fixed	**Random**	**Difference**	**S.E.**
BDM	-0.0184	-0.0023	-0.0161	0.0091
INF	0.0050	0.0046	0.0003	0.0008
UNP	-0.0062	-0.0089	0.0026	0.0050
GDP	-0.0001	0.0001	-0.0002	0.0004
EIR	-0.0010	0.0017	-0.0027	0.0066
PGR	-0.0002	0.0008	-0.0011	0.0011
RLP	-0.0625	-0.0489	-0.0135	0.0330
REL	-0.0621	-0.0221	-0.0400	0.0218
ELC	0.1001	0.1060	-0.0058	0.0067
chi2(8)				13.5000
Prob>chi2				0.0957

The test result for the expenditure model ($p<0.05$) also indicated that the random effects model should be used.

BREUSCH AND PAGAN LAGRANGIAN MULTIPLIER TEST FOR RANDOM EFFECTS

The Breusch-Pagan Lagrange Multiplier (BP-LM) test assesses the presence of random effects. Its null hypothesis posits that the error variance components specific to individuals or time are zero. If the null hypothesis is accepted, it suggests a preference for pooled ordinary least squares (OLS) estimation; however, rejection of the null hypothesis indicates the superiority of the random effects model. This test is instrumental in determining the appropriate model for the dataset, providing valuable insights into the potential impact of individual or time-specific factors on the observed outcomes. The results of the test for both revenue and expenditure models are shown in the table A3.

Table A3

BP-LM test results

	Models				
	Revenue			**Expenditure**	
	Var	**sd = sqrt(Var)**		**Var**	**sd = sqrt(Var)**
REV	0.0175	0.1325	EXP	0.0349	0.1870
e	0.0131	0.1147	e	0.0246	0.1569
u	0.0035	0.0594	u	0.0011	0.0332
chibar2(01)		18.8800	chibar2(01)		3.2800
Prob > chibar2		0.0000	Prob > chibar2		0.0352

According to the test results, both for revenue and expenditure, we reject the null hypothesis in favour of the random group effect model ($p<0.05$).

PUBLIC SECTOR ECONOMICS
49 (2) 273-307 (2025)

LAGRAM-MULTIPLIER (WOOLDRIDGE AUTOCORRELATION) TEST RESULTS

The Lagrange Multiplier (Wooldridge Autocorrelation) test is employed to detect the presence of serial correlation in panel data models. The test evaluates whether the error terms are serially correlated, which can lead to inefficient estimates and biased standard errors if not addressed. The null hypothesis of the Wooldridge Autocorrelation Test posits no first-order autocorrelation among the residuals. A significant test result, indicated by a p-value less than the chosen significance level, leads to the rejection of the null hypothesis, thereby confirming the existence of serial correlation. Addressing serial correlation is crucial for ensuring the reliability and accuracy of panel data model estimations. The results of the test for both revenue and expenditure models are shown in the table A4.

Table A4

The Lagrange Multiplier (Wooldridge Autocorrelation) test results

	Models	
	Revenue	**Expenditure**
F (1, 14)	0.463	2.032
Prob > F	0.507	0.176

The results of the Lagrange Multiplier test indicate that both mowdels have p-values greater than 0.10. This suggests that, based on the Lagrange Multiplier test, there is no significant evidence of the issue tested (e.g., heteroscedasticity, omitted variable bias, or other specification errors) in either model at the 10% significance level. Consequently, the models do not exhibit significant evidence of the specified problem, supporting the robustness of the model specifications.

PESARAN'S CROSS-SECTIONAL DEPENDENCE TEST (CD)

Pesaran CD test is utilized to detect the presence of cross-sectional dependence in panel data models. This test assesses whether the residuals are correlated across cross-sectional units, which can compromise the efficiency and consistency of the estimators if unaddressed. The null hypothesis of the Pesaran CD Test posits no cross-sectional dependence among the residuals. A significant test result, indicated by a p-value less than the chosen significance level, leads to the rejection of the null hypothesis, thus confirming the presence of cross-sectional dependence. Recognizing and addressing cross-sectional dependence is essential for ensuring the validity and robustness of panel data model estimations. The results of the test for both revenue and expenditure models are shown in the table A5.

Table A5

Pesaran CD test results

	Models	
	Revenue	**Expenditure**
Pr	0.177	0.112
Average absolute value of the off-diagonal elements	0.306	0.418

The results of Pesaran's CD test for both models indicate that the p-values exceed 0.1. This suggests that there is no statistically significant evidence to reject the null hypothesis of no cross-sectional dependence among the residuals. Consequently, we can infer that the residuals of the models are not correlated across the cross-sectional units. This lack of cross-sectional dependence implies that the estimators used in these panel data models are likely to be efficient and consistent, ensuring the reliability of the model estimations.

Climate finance, institutions and innovation systems in Sub-Saharan Africa

FRANK ADU, Ph.D.*
ROSHELLE RAMFOL, Associate Professor*

Article**
JEL: H23, H30, H50, I30, N17, O10
https://doi.org/10.3326/pse.49.2.6

* The authors would like to thank two anonymous reviewers for their valuable comments.

** Received: October 9, 2024
Accepted: February 20, 2025

Frank ADU
College of Accounting Sciences, University of South Africa P.O. Box 392, Pretoria, 0001, South Africa
e-mail: frankadu64@gmail.com
ORCiD: 0000-0003-0072-882X

Roshelle RAMFOL
College of Accounting Sciences, University of South Africa P.O. Box 392, Pretoria, 0001, South Africa
e-mail: ramfor@unisa.ac.za
ORCiD: 0000-0002-4682-2558

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

Abstract

To enhance climate finance's effectiveness in Sub-Saharan Africa (SSA) and explore how it can be deployed to boost innovation, this study has explored the effect of climate finance combined with institutional quality on innovation while emphasizing the multidimensional measurement approach to innovation. Using data from twenty-three (23) countries in SSA spanning the period 2011 to 2022 and the system Generalized Method of Moment (GMM) estimator, the results from the study show a negative and significant effect of climate finance on innovation in SSA. Also, we found that institutional quality has a positive and significant effect on innovation. Further, we realized from the conditional effect results that when the level of institutions in SSA is highly effective, the positive effect of climate finance on innovation is magnified. Given these findings, this study recommends that policies to improve climate finance in SSA should be pursued simultaneously with policies promoting strong institutions.

Keywords: climate finance, innovation, institutions, climate mitigation, climate adaptation, Sub-Saharan Africa

1 INTRODUCTION

Climate change continues to pose significant obstacles to achieving sustainable development goals, with Sub-Saharan Africa disproportionately suffering the consequences despite contributing less than 4% to global greenhouse gas emissions. According to the 2018 World Bank report, climate-related disasters, including rising sea levels, droughts, floods, and episodes of extreme heat, are expected to push more than 100 million people into poverty, with Sub-Saharan Africa and South Asia being the most brutally hit (Mouleye et al., 2019). These challenges are further intensified by the inability of many African countries to mobilise the necessary financial resources to reduce emissions and effectively build their resilience to climate change (Doku et al., 2021a, 2021b; Mekonnen et al., 2021; Mekonnen and Hoekstra, 2014). To address these effects, some developed countries have pledged to mobilise funds from various sources in the form of Official Development Assistance (ODA), classified as climate finance, to support less developed nations to mitigate and adapt to climate change. The commitment has sparked discussions on the impact of climate finance on various development outcomes.

As Trutnevyte et al. (2019) and Shi, Wang and Wang (2018) noted, the pursuit of new and efficient solutions to climate challenges is essential to mitigate the risk of environmental devastation. As a result, innovation is seen as a sure dynamic capability that nations can deploy to achieve sustainable development while improving environmental quality through reduced carbon emissions (Apostu et al., 2023). In 2015, the Paris Agreement strongly affirmed the critical role of innovation, emphasising that "accelerating, encouraging, and enabling innovation is essential for an effective, long-term global response to climate change." Indeed, current literature supports the notion that innovation is a critical driver of sustained economic growth (Anttila and Jussila, 2019; Maradana et al., 2017; Pradhan et al., 2019). Advanced technologies create opportunities to transform products and services and promote sustainable practices (Lopes de Sousa Jabbour, 2018). Innovation is

essential for achieving green economy goals, particularly zero pollution, while fostering value creation, employment, and national development (Gerguri and Ramadani, 2010; López and Figueroa, 2016; Pradhan et al., 2019; Silvestre and Ţîrcă, 2019).

Current literature (Lee et al., 2022; Ryan Hogarth, 2012) has theoretically hinted at climate finance's potential impact as a crucial mechanism for facilitating innovation. It is, therefore, unsurprising that some scholarly interest has been expressed in explanations of how climate finance can influence innovation (Ryan Hogarth, 2012; Lee and Shin, 2022; Pradhan et al., 2023).

Despite these interests, the empirical findings on the relationship have been mixed and remarkably inconsistent. Moreover, Sharma, Sousa and Woodward (2022) and Ryan Hogarth (2012) have indicated that the effect of climate finance on innovation is highly context dependent. Accordingly, researchers must account for these relevant boundary conditions when exploring this vital relationship. This notwithstanding, the mechanisms through which climate finance impacts on innovation remain poorly understood in the literature, particularly those regarding SSA.

Our literature scan reveals that one critical and yet-to-be-studied mediating factor in the literature is institutional quality. A closer examination of institutional dynamics can offer valuable insights into how climate finance fosters innovation across different contexts. The quality of institutions may be pivotal in shaping the climate finance-innovation nexus. This is because institutions must establish regulatory and policy frameworks that foster an environment conducive to innovation (Porter and Linde, 1995). Secondly, they are pivotal in safeguarding intellectual property rights (IPR), essential for stimulating innovation (Sharma, Sousa and Woodward, 2022). Institutions also contribute by reducing transaction costs associated with information asymmetry and innovation (Williamson, 1985). Furthermore, they can strengthen the effect of climate finance on innovation by providing financial support and research-and-development (R&D) incentives (Bérubé and Mohnen, 2009; David, Hall and Toole, 2000). Additionally, institutions play a key role in cultivating a culture of innovation by creating environments that value and support creative endeavours (Grindle, 2004). Finally, effective institutions ensure transparency and accountability throughout innovation (North, 1990).

The above assertions establish a foundation for an empirical inquiry. This study addresses a key policy question: Is climate finance directed towards SSA countries effectively fostering innovation on the continent? Furthermore, does the quality of institutions in SSA mediate the relationship between climate finance and innovation on the continent? Several important stylised facts, policy concerns, and gaps in the empirical literature have driven the undertaking of this study. The second question is fundamental because climate change is closely tied to institutional frameworks and ideologies (Hulme, 2009), which is pivotal in shaping how climate finance is utilised. Institutional factors not only directly influence innovation but also have the potential to affect innovation indirectly through their impact on the allocation and effectiveness of climate finance.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

The current study departs from the findings of the reviewed literature in many ways. First, it seeks to investigate the direct and indirect effects of climate finance and institutional quality factors on innovation in SSA. Very little is known about the effects of climate finance on improving innovation in Africa. This study makes a bold claim, asserting that the relationship among climate finance, institutional quality and innovation has yet to be explored in empirical economic literature. The most closely related research is by Pradhan et al. (2023), which examined the relationship between overall foreign aid, institutions, and innovation in middle-income countries. However, our study diverges by focusing specifically on bilateral and multilateral climate finance in Sub-Saharan Africa, as reported by the Organization for Economic Co-operation and Development (OECD), rather than ODA. Additionally, we use the innovation output sub-index from the Global Innovation Index (GII) to measure innovation outcomes, a metric not considered in Pradhan's study. The Innovation Output Index effectively captures critical drivers of innovation, including knowledge and technology outputs (such as knowledge creation, impact, and diffusion) and creative outputs (intangible assets, creative goods, services, and online creativity) (Osei, 2024).

We enhance the measurement of institutional quality using principal component analysis (PCA) on the World Bank's Worldwide Governance Indicators (WGI), providing a more precise measure (Tashtamirov, 2023). We employ the system GMM estimator, which robustly addresses endogeneity, lag differences, and simultaneity rather than error correction and ARDL models, improving on studies by Pradhan et al. (2023) and Nadeem et al. (2020).

Further, Gilder and Rumble (2020) have argued that climate finance is often more donor-centric than recipient-focused; enhancing the effectiveness of climate funding in African countries requires a shared understanding between donor and recipient nations. This study will contribute to that understanding through the examination of the interactions among climate finance, institutions, and innovation in Sub-Saharan Africa. It provides insights that will help improve collaboration and policy alignment, highlighting how effective strategies can bolster institutional development, innovation, and climate finance. These insights aim to shape a more sustainable economic development trajectory for the region.

This paper follows the following structure: section 2 reviews the literature on the interrelationships of climate finance, innovation, and institutional quality, highlighting their interconnections and formulating the study's hypotheses. Section 3 details the data, variables, and econometric model used to test these hypotheses. Section 4 presents the empirical findings and interpretations. The fifth and last sections conclude the study by summarising our contributions, discussing policy implications for policymakers and practitioners, acknowledging the limitations, and suggesting directions for future research.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

2 STYLIZED FACTS ABOUT CLIMATE FINANCE IN AFRICA

The political nature of climate finance has kept its definition subject to ongoing debate, with no universally accepted standard. The United Nations Framework Convention on Climate Change (UNFCCC) offers one of the most widely accepted descriptions, defining climate finance as "local, national, or transnational financing – sourced from public, private, and alternative funds – intended to support mitigation and adaptation efforts aimed at addressing climate change."[1] Gebreyesus (2017) states that one way to classify climate finance is as aid, but as an addition to the "0.7%" ODA target. In Africa, climate finance predominantly takes the form of Official Development Assistance (ODA) due to the continent's limited financial capacity and underdeveloped markets, which restrict access to private sector climate funds.

Of Africa's total climate finance needs, adaptation constitutes only 24%, while mitigation dominates, accounting for 66% of the required funding for 2020-2030. Africa is highly dependent on external public climate finance (86%)[2], which is disbursed as ODA. Unfortunately, the flow of climate finance from external sources in Africa has been low and does not meet the required amount needed for mitigation and adaptation. The Climate Policy Initiative estimates that between 2020 and 2030, African countries will need about 2.8 trillion, or 2,800 billion United States dollars annually, to implement all the Nationally Determined Contributions (NDCs). This is much more than the average of USD 30 billion received annually, which makes up only 12% of the required funding.[3] According to Tamasiga et al. (2023), weak institutional structures are headlined by the absence of any specialist climate finance units, poor coordination between donors and government institutions, and lax legal and regulatory systems. Moreover, unstable and unpredictable climate finance flows compound the challenges, with climate funds flows fluctuating depending on voluntary donor contributions.

Moreover, according to Ahenkan (2020), the allocation of adaptation funds has suffered from poor donor coordination. Some donors continue to bypass multilaterally agreed-upon principles in their disbursement, complicating donor efforts to plan and implement long-term climate projects that require sustained support.

Another problem accounting for the shortfall in climate finance is the failure of developed countries to meet the 2020 $100 billion climate finance target. This has eroded trust and undermined confidence in developed countries' efforts against climate change.

[1] Refer to: https://unfccc.int/topics/introduction-to-climate-finance
[2] See: https://www.weforum.org/agenda/2023/12/cop28-bridging-the-climate-finance-gap-in-africa-and-beyond/
[3] See: https://www.weforum.org/agenda/2023/12/cop28-bridging-the-climate-finance-gap-in-africa-and-beyond/

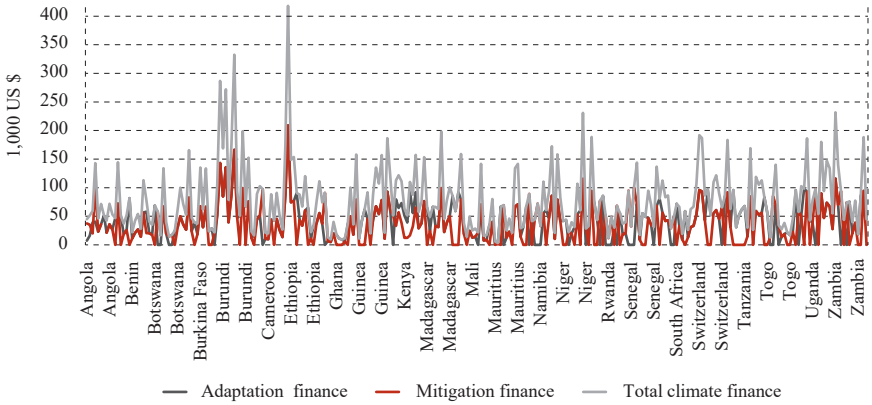
PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

Lastly, according to Musah-Surugu et al. (2018), climate finance seems fragmented. The various funds have different priorities and eligibility criteria, making it difficult for African countries to access them. This fragmentation reflects inefficiencies and deeper political divisions in climate finance (Biermann et al., 2009).

Figure 1 shows that aside from Burkina Faso, Guinea and Cameroon, all the SSA countries sampled in this study have experienced unchanging or decreasing climate finance.

FIGURE 1

Trend analysis of climate finance among SSA countries



Source: Authors.

3 THEORETICAL REVIEWS

3.1 THE LINK BETWEEN CLIMATE FINANCE AND INNOVATION

We outline two primary channels through which the impact of climate finance on innovation can manifest. Firstly, it can work through investment in green technologies and sustainable practices. Climate change mitigation requires investment in green technologies (e.g., PV installations) and sustainable practices with less environmental impact (Lee et al., 2022; Ryan Hogarth, 2012). Interestingly, providing a conducive environment for green technologies will foster a culture of innovation, encouraging firms and other businesses to innovate in areas like green packaging, renewable energy, energy efficiency, and carbon capture technologies, and finally, through funding for research and development. This channel is critical where climate finance directly aids the development of new technologies and climate-related solutions. Providing financial support for research and development will create the space for researchers and organisations to explore and develop innovative approaches for climate resilience.

3.2 LINK BETWEEN INSTITUTIONAL QUALITY, CLIMATE FINANCE AND INNOVATION

The link between institutional quality, climate finance and innovation can be understood through two broad channels. First, climate finance may be enhanced when some clear policies and measures align with climate goals and commitments. Institutions are crucial in shaping emission levels by implementing environmental regulation policies. Therefore, weak institutions often lead to poor regulations and higher emissions, whereas strong institutions facilitate eco-friendly practices and ensure lower emissions through rigorous regulatory frameworks. This is fundamentally the "Porter hypothesis" basis, further illustrating the link between institutions and the environment. This hypothesis suggests that stringent regulatory policies stimulate innovation in technologies that reduce pollution. Such innovations can provide a competitive edge, ultimately balancing environmental costs and enhancing economic efficiency (Zhang and Baranzini, 2004; Alavuotunki, Haapanen and Pirttilä, 2019).

Concerning the second channel, strong institutions can effectively enforce the rules and regulations that protect intellectual property rights, which are central to innovation development. According to Sharma, Sousa and Woodward (2022), institutions play a crucial role in enhancing innovation because they lower transaction costs arising from information asymmetry, bargaining and coordination and enforcement of contracts. For instance, in an economy where the authorities use their legal discretion to reward cronies (North, 1993; Rodrik, 2000), economic inefficiency will result, impeding innovation development. Further, studies have shown that strong institutions can stimulate innovation performance by providing direct R&D subsidies, tax incentives and knowledge transfer (Bérubé and Mohnen, 2009; David, Hall and Toole, 2000). Institutions thus mediate innovation by directing economic resources to productive sectors that will yield beneficial economic outcomes (Sindzingre, 2005). As Sen (1981) opined, effective institutions play a critical role in fair resource allocation and access, which is crucial for innovation development.

In conclusion, good governance, marked by robust institutional frameworks, is essential for effective climate finance implementation and equitable resource allocation. This necessitates institutions that establish fair laws, administer public services efficiently, cultivate capable human capital, and ensure transparency and public accountability (Grindle, 2004).

3.3 RELEVANT EMPIRICAL REVIEWS

A considerable number of studies have argued that climate finance promotes economic growth and environmental sustainability through better capital allocation (Han and Jun, 2023; Lee et al., 2022; Mahat et al., 2019; Romano et al., 2017; Steckel et al., 2017; Tol, 2009). Their arguments emanate from climate finance serving as a new form of financial buffer that can cushion firms to adopt green technology in their operations to ensure sustained growth and reduce carbon emissions.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

Despite the beneficial influence of climate finance on environmental sustainability and growth, recent literature has highlighted the possible influence of climate finance on innovation. This is because the success of every economy depends mainly on the ability of the productive and distribution sectors to innovate. Notwithstanding, studies in this domain of research have produced remarkably inconsistent findings. For example, Pradhan et al. (2023), Warren (2020), Czarnitzki and Hottenrott (2011) and Dakhli and De Clercq (2004) revealed a restrictive effect of climate finance on innovation. Studies such as those by Ryan Hogarth (2012), Bannert (2020), Gorodnichenko and Schnitzer (2013), and Ryan Hogarth (2012) have shown that climate finance has a beneficial effect on innovation. Interestingly, the study by Blind (2012) found no significant relationship between the two indicators in developing economies and suggested that the impact of climate finance on innovation depends on the structures and fundamentals of an economy and called for better institutional regulation.

Given this call, past studies such as Osei (2024), Sharma, Sousa and Woodward (2022) and Nadeem et al. (2020) investigated the effect of institutional quality on innovation and confirmed that better institutions promote innovation by enforcing rules and regulations that protect intellectual property rights. Also, the authors contended that effective institutions foster policies that can direct climate funds into the productive sectors of the economy to yield positive outcomes on innovation. While the influence of institutions on innovation has been examined at various levels (Pradhan et al., 2023; Rodríguez-Pose and Zhang, 2020; Oluwatobi et al., 2016), there remains a notable vacuum in the literature regarding the mediation effect of institutional quality on climate finance-innovation nexus. A critical examination of the literature suggests that only Nadeem et al. (2020) have investigated the mediation effect of institutional quality in the relationship between the foreign aid-innovation nexus. Thus, the theoretical specification on how institutional quality can be adopted to bridge the climate finance-innovation gap lacks rigorous empirical investigation in the literature, especially that relating to SSA. An important implication of this gap in the literature is that knowledge is lacking on how this relationship works in less-developed economies. Specifically, how institutional qualities can direct climate funds to the productive sectors of the economy to enhance innovation remains unexplored in SSA. Therefore, the current study aims to fill this gap by providing compelling evidence on the African perspective regarding the impact of climate finance on innovation by considering the role that institutional quality plays.

This gap is significant given that SSA economies top the chart as the major recipients of climate finance. Therefore, understanding how this relationship works in the African context is essential to guide policies and laws in the climate finance space.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

4 METHODOLOGY

To probe into how climate finance can be adopted to enhance innovation in SSA mediated by institutional quality, we grouped this section into three main sub-sections: data and variable description, empirical model specification, and estimation methods employed.

4.1 DATA AND VARIABLE DESCRIPTION

This study primarily focused on balanced panel data of twenty-three countries in SSA from 2011 to 2022. It should be noted that the sample frame of this study was chosen due to the easy accessibility and availability of data on the main variable of interest. Also, we sample the twenty-three countries in SSA for this empirical investigation because these countries have complete data for the main constructs. Data for this study were sourced from three different databases. Specifically, innovation and climate finance data were extracted from the World Intellectual Property Organization (WIPO) and the OECD databases, respectively. Moreover, the other variables such as institutional quality index, foreign direct investment, human capital, gross domestic product per capita, digital infrastructure index, inflation and government expenditure were sourced from World Development Indicators (WDI).

This study measured innovation as the innovation output sub-index of the GII as the dependent variable because its focus is to assess the determinants of innovation in SSA, primarily focusing on climate finance and institutional quality. It should be noted that all the control variables were adopted from past studies such as Osei (2024), Pradhan et al. (2023), and Sharma, Sousa and Woodward (2023). We report the abridged version of the data sources and how they were measured in table 1.

Table 1
Variable description

Variable	Notation	Measurement	Source
Dependent variable			
Innovation	INNOV	Innovation output sub-index (score 0–100)	WIPO
Independent variable			
Climate finance	CF	Climate-related development finance Commitment (Current USD thousand)	OECD
Mediating variable			
Institutional quality index	IQ	It is computed as an average of Kaufmann's six indicators of institutional quality (Regulatory quality, government effectiveness, rule of law, control of corruption, voice and accountability, political stability, and lack of violence)	WDI
Control variables			
Human capital	HC	School enrolment, tertiary (% gross)	WDI
GDP per capita	GDPPC	GDP per capita (constant 2015 US$)	WDI
Government expenditure	GE	General government final consumption expenditure (% of GDP)	WDI

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

Variable	Notation	Measurement	Source
Digital infrastructure	DIFRA	Mobile cellular subscriptions (per 100 people), Individuals using the Internet (% of the population), Fixed telephone subscriptions (per 100 people) and Fixed broadband subscriptions (per 100 people)	WDI
Financial development		Domestic credit to private sector (% of GDP)	WDI

Note: WIPO, OECD and WDI represent the World Intellectual Property Organization, Organization for Economic Co-operation and Development and World Governance Indicators, respectively.

Source: Authors.

4.2 THEORETICAL AND EMPIRICAL MODEL

This study modifies the innovation model proposed by Howitt and Aghion in 1998 to assess the effect of climate finance on innovation in SSA. According to Howitt and Aghion, innovation is determined by knowledge acquisition, human capital development and the financial resources a country controls or possesses. These financial resources include donations, aid, total revenue mobilisation, etc. (Anselmi, Lagarde and Hanson, 2015). Interestingly, this study conceptualizes the financial resources that developing nations receive to mitigate climate emissions as climate finance. According to Romano et al. (2017), climate finance enhances the financial capacity of developing nations. It enables them to develop and deploy new technologies and innovative solutions essential for zero low-carbon emissions. Therefore, this study specifies a linear function relationship between innovation, climate finance and human capital development in equation 1 as follows:

$$INNOV = f(CF, HC) \tag{1}$$

where INNOV, CF and HC represent innovation, climate finance and human capital, respectively. Interestingly, following Osei (2024) and Sharma, Sousa and Woodward (2022), who postulated that innovation in an economy is not dependent solely on human capital and financial resources but on other economic and institutional factors, we extended equation (1) to capture both economic and institutional factors such as institutional quality, GDP per capita, digital infrastructure development, government expenditure and financial development. Hence, equation (1) was remodelled to incorporate these aforementioned factors and the interaction between institutional quality and climate finance as specified in equation (2) below:

$$INNOV = f(CF, IQ, CF * IQ, HC, GDPPC, DIFRA, GE, FD) \tag{2}$$

The symbols IQ, CF*IQ, GDPPC, DIFRA, GE and FD indicate institutional quality, the interaction between climate finance and institutional quality, GDP per capita, digital infrastructure development, government expenditures, and financial development, respectively.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

The estimate form of equation (2) is specified in equation (3) as:

$$lnINNOV_{it} = \delta_0 + \theta_1 lnINNOV_{it-1} + \theta_2 CF_{it} + \theta_3 IQ_{it} + \theta_4 (CF * IQ)_{it} + \theta_5 lnGDPPC_{it} + \theta_6 DIFRA_{it} + \theta_7 lnGE_{it} + \theta_8 lnFD_{it} + \epsilon_{it} \quad (3)$$

$$\epsilon_{it} = \mu_{it} + \varphi_i + \vartheta_t \quad (4)$$

It must be noted that all the variables have already been explained. δ_0, ln, ϵ, i and t represent the constant term, natural logarithm, error term, and the number of countries and periods employed. The symbols μ_{it}, φ_i and ϑ_t represent idiosyncratic error term, unobserved country-specific and time-specific effect so, θ's (1, 3…, 8) denote the unknown parameters to be estimated.

4.3 ESTIMATION TECHNIQUE

To assess the effect of the interaction between climate finance and institutional quality on innovations in SSA, we employed the two-step system generalized method of moment (system-GMM) estimator proposed by Blundell and Bond (1998). We adopted the two-step system-GMM in this study because it provides efficient and unbiased results due to the additional moment conditions it uses. The system-GMM estimator is applicable when the time period is smaller than cross-sectional units. Furthermore, it employs the lags of the endogenous regressor as internal instruments to mitigate any potential endogeneity issues that may develop because of the introduction of the lagged dependent variable as part of the regressors. Therefore, the system-GMM specification of equation (3) is expressed as follows:

$$lnINNOV_{it} - lnINNOV_{it-1} = \sigma_0 (lnINNOV_{it-1} - lnINNOV_{it-2}) + \rho'(lnX_{it} - lnX_{it-1}) + (\epsilon_{it} - \epsilon_{t-1}) \quad (5)$$

It is interesting to note that all the variables are already explained in the previous equations. X represents a vector of variables captured in the previous equations. In selecting an instrument for this study, we used the first difference of innovation as a valid instrument. This is because Arellano and Bover (1995) suggested that using a lagged level of the dependent variable as the instrument will be a poor instrument, especially if the variable is close to a random walk. As a result, we applied $lnINNOV_{it-2} - lnINNOV_{it-3}$ as an appropriate instrument for $lnINNOV_{it-1} - lnINNOV_{it-2}$. Further, we applied Arellano and Bond (1991) and Hansen (1982) J tests to validate the absence of second-order serial correlation and the validity of the instruments, respectively. The null hypothesis of these tests reveals the absence of second-order serial correlation and instrument validity. Therefore, we tested the null hypothesis against the alternative hypothesis at 5% significance level. Interestingly, we will fail to reject the null hypothesis and conclude that the estimates have no problem if the probability values are higher than 5% significance level.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

After estimating the interactive effect of climate finance and institutional quality, we advanced the analyses. We computed the marginal effect of climate finance and institutional quality for stimulating innovation by applying the partial differentiation method proposed by Brambor, Clark and Golder (2006). Given equation (3), the partial differentiation approach can be written as:

$$\frac{\partial INNOV_{it}}{\partial CF_{it}} = \theta_1 + \theta_3 IQ_{it} \tag{6}$$

This approach allows us to ascertain the actual influence of climate finance on innovation ($\theta_1 + \theta_3 IQ_{it}$) rather than interpreting the unconditional estimate of θ_3.

Further, this study has applied the Dumitrescu and Hurlin (2012) panel causality test to inspect the causal interrelationship of climate finance, institutional quality and innovation in SSA. According to Khan et al. (2020), the Dumitrescu and Hurlin causality test is appropriate regardless of $T > N$ or $T < N$ and controls for cross-sectional dependence and heterogeneity in the slope coefficients. The general specification of this regression is given by:

$$Y_{it} = \varphi_i + \sum_{p=1}^{P} \theta_{ip} Y_{it-p} + \sum_{p=1}^{P} \gamma_{ip} X_{it-p} + \epsilon_{it} \tag{7}$$

It should be noted that Y and X are the stationary variables for country i and period t. The coefficients are allowed to differ across countries but are assumed to be time-independent. The lag order P is assumed to be the same for all the countries, and the panels must be balanced.

From equation (6), we express the null and alternate hypothesis of this test as:

$$H_0 : \theta_{i1} = \ldots = \theta_{iP} = 0 \quad \text{for} \quad i = 1, 2, 3, \ldots, N_1 \tag{8}$$

$$H_1 : \theta_{i1} \neq \ldots. \theta_{iP} \neq 0 \tag{9}$$

The non-rejection of the null hypothesis indicates the absence of any causal relationship among the variables.

Lastly, to ensure that the dataset employed passed preliminary checks like cross-sectional dependency (CD) and no unit root, we used the cross-sectional dependency test by Pesaran (2004) to inspect the cross-sectional dependency of the sampled variables employed. Also, the Im, Pesaran and Shin (2003) and Pesaran (2007) cross-sectionally augmented unit root tests were applied to ascertain the stationary properties of the variables. Interestingly, the null hypothesis of all the tests suggests no cross-sectional independence and unit root, whereas the alternative hypothesis proposes otherwise. Therefore, rejection of the null hypothesis reveals that there is cross-country correlation and non-stationarity in the variables.

5 INTERPRETATION AND DISCUSSION OF RESULTS

This section presents and discusses the results, including descriptive statistics, correlation among the variables employed, scatter plots, unit root results, and estimated results.

5.1 DESCRIPTIVE STATISTICS

This study reports the descriptive statistics of the sampled variables used in table 2.

Table 2

Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min.	Max.	Measurement unit
INNO	276	22.152	12.735	0.300	71.800	Index score 0-100
CF	275	43.724	33.943	11.000	209.102	Current USD thousand
IQ	276	0.502	0.310	0.000	1.000	Index score 0-1
GDPPC	276	5,669.880	17,113.000	262.185	90,057.030	US$
HC	276	89.880	72.415	1.000	222.000	%
IFRAI	276	0.525	0.236	0.000	0.992	Index score 0-1
GE	276	15.233	5.837	6.697	36.143	%
FD	276	26.672	27.283	0.000	128.838	%

Note: INNOV, CF, IQ, GDPPC, HC, IFRAD, GE and FD indicate innovation, climate finance, institutional quality index, gross domestic product per capita, human capital, infrastructure development, government expenditure and financial development.

Source: Authors.

Using innovation output as a measure of innovation in this study, the study found that the mean value of innovation in SSA is 22.15, indicating that, on average, innovation in SSA is low. The difference between the minimum (0.30) and the maximum (71.80) values of innovation reveals the extent of the disparity in innovation among the sampled economies in SSA. This was established by the huge standard deviation value of 12.74. Also, the study detected that climate finance and institutional quality index have a mean value of 43,730 US dollars and a 0.502 score, respectively. Additionally, the results showed that the maximum value of climate finance was 209,100 US dollars. With the control variables, we observed that GDP per capita in SSA averaged 5669.887 US dollars. Further, human capital, infrastructure development index, government expenditure and financial development were found to have mean values of 89.88%, 0.525 scores, 15.23% and 26.67%. Furthermore, we found that the highest standard deviation among the variables used for this analysis is GDP per capita. In conclusion, we realized that all the variables do not deviate significantly from their respective means.

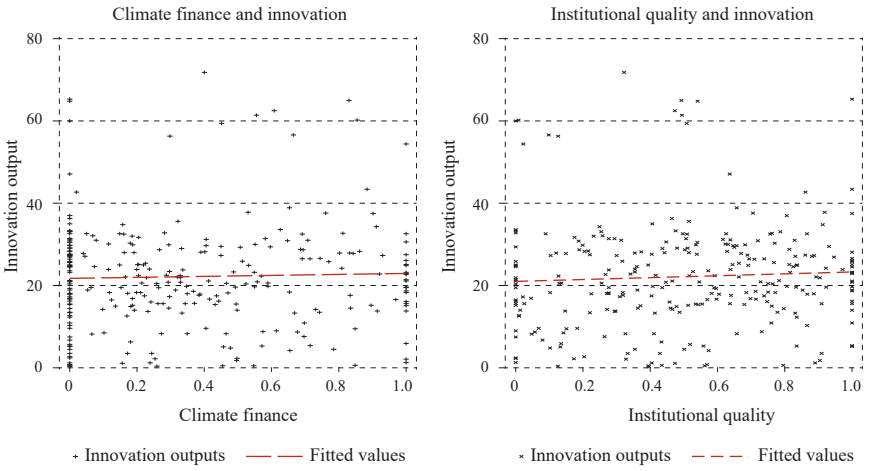
PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

5.2 EXPLORATORY ANALYSIS OF PATTERNS AND RELATIONSHIPS OF CLIMATE FINANCE, INSTITUTIONAL QUALITY AND INNOVATION IN SSA

This section of the study explores the patterns and relationships between innovation, climate finance and institutional quality in SSA and the results are displayed in figure 2.

FIGURE 2

Scatter plot between climate finance, institutional quality and innovation in SSA



Source: Authors using STATA 15.1.

Figure 2 shows that climate finance and institutional quality demonstrate a modest positive relationship with innovation in SSA. However, institutional quality exerts a more pronounced positive impact on innovation than climate finance.

5.3 CORRELATION MATRIX

In addition to the scatter plots, we conducted a pairwise correlation test to validate the linear association among climate finance, institutional quality, and innovation in SSA. The results for this estimation are reported in table 3.

The results reported in table 3 indicate that except for government expenditure, the rest of the variables used in this study have a positive association with innovation in SSA. It is evident from the correlation coefficients that real GDP per capita has a strong positive correlation with innovation. In contrast, the rest of the indicators showed weak and moderate positive or negative correlations with innovation in SSA. Since climate finance and institutional quality move in tandem with innovation in SSA, we can conclude that enhancing these indicators in SSA will be crucial for innovation development.

Table 3

Pairwise correlation among the variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) INNO	1.000							
(2) CF	0.031	1.000						
(3) IQ	0.056	-0.036	1.000					
(4) GDPPC	0.696	0.082	-0.114	1.000				
(5) HC	0.283	0.036	0.029	0.285	1.000			
(6) IFRAI	0.022	0.023	-0.101	0.157	0.168	1.000		
(7) GE	-0.069	0.026	-0.060	-0.086	0.085	0.050	1.000	
(8) FD	0.207	0.041	0.052	0.060	0.042	0.154	0.307	1.000

Source: Authors.

5.4 WEAKLY CROSS-SECTIONAL DEPENDENCY TEST

Given that cross-country correlation can bias the estimates, we employed Pesaran's (2015) weak cross-sectional dependence test to inspect the cross-sectional dependence among the variables. The results are reported in table 4.

Table 4

Weakly cross-sectional dependency test

Variable	CD test	Prob. value
INNOV	16.921	0.000
CF	9.680	0.000
IQ	2.348	0.019
GDPPC	21.806	0.000
HC	4.205	0.000
INFRAI	11.204	0.000
GE	2.088	0.037
FD	8.552	0.000

Note: The null hypothesis is that errors are weakly cross-sectionally dependent and the alternative hypothesis is that errors are strongly cross-sectionally dependent.

Source: Authors.

In table 4, none of the variables employed for this investigation exhibited cross-sectional dependence. The null hypothesis of weakly cross-sectional dependence is rejected at the 5% and 1% significance levels in all the variables tested. Since there is strong cross-sectional dependence among the variables, we adopted a stationarity tests that accounts for this issues in the variables employed.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

5.5 UNIT ROOT TEST

Table 5 reports the outcomes of Cross-Sectional Augmented Dickey Fuller and Cross-Sectional Augmented IPS (CIPS) unit root test.

Table 5

Unit root test results

	CIPS test		CADF test	
Variable	**I(0)**	**I(1)**	**I(0)**	**I(1)**
INNOV	-1.771	-2.692***	-1.012	-2.610***
CF	-2.455**	-6.279 ***	-1.925*	-2.273**
IQ	-2.311**	-3.044***	-1.954*	-2.740***
GDPPC	-1.545	-2.267**	-2.081**	-2.610***
HC	-1.493	-2.938**	-0.992	-2.610***
INFRAI	-2.645***	-4.061***	-2.034**	-2.475***
GE	-2.129*	-3.533***	-1.450	-2.394***
FD	-0.885	-2.180**	-0.702	-2.611***

*Note: ***, ** and * represent significant at 1%, 5% and 10% significance level. *, **, *** represent stationarity.*

Source: Authors.

Given the results in table 5, we observed that innovation, real GDP per capita and human capital and financial development were not stationary in the levels using both CIPS and cross-sectional augmented Dickey Fuller (CADF) unit root tests. Though institutional quality was stationary in the levels when we applied CIPS, the results were also stationary when we employed the CADF unit root test. However, in both tests, all the variables were stationary at the first difference. After confirming the stationarity properties of the variables, we continued to estimate the unknown parameters.

5.6 EFFECT OF CLIMATE FINANCE AND INSTITUTIONAL QUALITY ON INNOVATION IN SSA (SYSTEM-GMM RESULTS)

Here, we report the estimations obtained for assessing the impact of climate finance and institutional quality on innovation in table 6. It should be noted that we used the difference GMM estimation technique as a robustness check.

The results show that the previous level of innovation has a negative and significant effect on the current innovation level in SSA. Improvement in the previous innovation will lead to a fall in the current level of innovation in SSA by 0.31 to 0.18 scores, holding all the covariates unchanged. This finding indicates that innovation in the context of SSA converged.

Table 6
Effect of climate finance and institutional quality on innovation in SSA

Variable	Coefficient	
	System-GMM	Difference GMM
$lnINNOV_{it-1}$	-0.306*** (0.069)	-0.184* (0.108)
lnCF	-1.003*** (0.376)	-0.438** (0.227)
IQ	3.039** (1.334)	1.430* (0.775)
lnCF_IQ	2.074** (0.757)	0.974* (0.580)
lnGDPPC	-0.980 (1.339)	1.413 (4.054)
HC	0.011** (0.004)	0.003 (0.005)
IFRAD	-1.874* (1.084)	-0.918 (1.039)
lnGE	-10.193** (4.511)	-1.441 (2.577)
lnFD	5.289 (3.899)	0.847 (3.372)
Net/marginal effect	3.039** (1.334)	1.430* (0.775)
Constant	19.887 (12.593)	
AR(2) test statistic	-0.670	-0.880
AR(2) P-value	0.505	0.377
Hansen test statistic	4.940	5.890
Hansen P-value	0.895	0.751
No. groups	22	22
No. instruments	20	20

*Note: ***, ** and * represent significant at 1%, 5% and 10% significance level.*
Source: Authors.

Concerning climate finance, we found a negative and statistically significant effect on innovation in SSA. The negative coefficients, which are significant at 5% and 1% levels, indicating that climate finance diminishes innovation. The coefficient suggests that a 1% increase in climate finance will cause innovation to fall by 1.00 and 0.44, respectively. These results imply that international donor communities do not have innovation development in SSA as part of their policy agenda. This is because the climate finance received in SSA comes from international donor communities and governments in developed economies. This is particularly concerning, as innovation must be part of the strategies for combating climate change. If climate finance directed towards Africa fails to prioritize innovation, it poses a significant challenge to the continent's ability to develop sustainable solutions, leaving its prospects uncertain. The lack of emphasis on innovation could be attributed to minimal or non-existent allocation of climate finance to research and

development. Consequently, there may be insufficient investment in adaptation and mitigation efforts related to innovation and technology development. However, Warren (2020) contended that these donor communities and governments prioritise sectors like energy and transport systems with rewarding outcomes rather than investing in disruptive innovations. This finding aligns with the empirical evidence by Ryan Hogarth (2012), who highlighted the negative effect of climate finance on innovation in developing economies.

It was also revealed in table 6 that institutional quality has a positive and significant effect on innovation in SSA. The result suggests that improvement in institutions in SSA will enhance innovation by scores of 3.04 and 1.43. This finding implies that an economy with solid institutions can effectively enforce the rules and regulations that protect intellectual property rights and encourage fair competition, which are central to innovation. This result aligns with the evidence provided by Sharma, Sousa and Woodward (2022), Anselmi, Lagarde and Hanson (2015) and Simón-Moya, Revuelto-Taboada and Guerrero (2014), indicating that in countries with more robust political stability, the rule of law and integrity of contracts consistently perform better across a range of economic indicators including innovation. However, the finding contradicts the study by Rodríguez-Pose and Zhang (2020), which argued that innovation tends to be stifled in an economy where acquiring patents and trademarks for innovation is bureaucratic.

Given that institutional quality enhances innovation, we further explored its mediating role in the relationship between climate finance and innovation. As reported in table 6, the interaction term results indicate that robust institutional frameworks are essential for climate finance to positively and significantly impact innovation in SSA. The coefficient of the interaction term reveals that an increase in climate finance can boost innovation scores by 2.07 and 0.97 points when institutions in SSA are effective. This finding is not unexpected, as strong institutions can direct climate finance towards projects with the highest innovation potential. Consequently, effective institutions act as a crucial conduit for enhancing innovation, particularly in SSA, where innovative capacities are currently underdeveloped.

Turning to the control variables, the study found that real GDP per capita negatively and insignificantly affects innovation in the system GMM estimation. In the difference GMM method, the effect was positive but not statistically significant. Specifically, a 1% increase in real GDP per capita is associated with a 1.41-point increase in innovation. This positive relationship aligns with the findings of Saldanha et al. (2021) and Osei (2024). Additionally, human capital was shown to positively and statistically significantly impact innovation. This suggests that human capital accumulation, particularly through tertiary education, is crucial in generating knowledge for innovation. Educated individuals contribute specialised knowledge, creative solutions, and novel approaches that support innovation. This result corroborates the studies by Dakhli and De Clercq (2004) and Oluwatobi et al. (2016). We also found that financial development does not significantly impact innovation, according to both the system GMM and difference GMM methods.

Additionally, our analysis revealed that government expenditure and infrastructure development in Sub-Saharan Africa appear to hurt innovation.

As the effect of climate finance and institutional quality on innovation may be non-linear, we assessed the non-linear effect of climate finance, institutional quality, and their interaction on innovations in SSA. Even though this estimation is not the prime focus of this study, it made us more optimistic about knowing whether climate finance and institutional quality have a non-linear relationship with innovations. The results are reported in table A1 in the appendix. The results reveal that the square of climate finance negatively affects innovation, implying that overreliance on climate finance in the context of SSA will diminish innovation development. Also, we recognized that the square of institutional quality improves innovations in SSA. This result points to the view that strong institutional systems have an amplificatory effect on the fostering of innovations in SSA. After accounting for the squared interaction between climate finance and institutional quality, we found a negative impact on innovation. Interestingly, this result suggests that SSA economies will not enhance innovation through institutional development if they depend solely on climate finance as their resource construction.

Given that the institutional quality index positively affects innovation systems, we extended the analyses to look into the multidimensional constructs of institutional quality by considering the influence of control of corruption and political stability. The results reported in table A2 in the appendix show that corruption control has a positive effect on innovation in SSA. Additionally, the interaction between climate finance and corruption was found to have a positive and significant effect on innovation, suggesting that corruption control serves as a key channel through which climate finance impacts the innovation system in SSA. As far as political stability is concerned, we realize a positive and significant impact on innovation. Surprisingly, we also found that the interaction between climate finance and political stability as reported in Model 2 in the appendix was positive and significant. This result suggests that political stability is not a prime factor necessary for SSA economies to drive substantial climate finance and enhance innovation. It is important to note that all econometric tests, including the second-order serial correlation test and Hansen test for over-identification restrictions, were passed, as indicated by the non-rejection of the null hypothesis in both AR (2) and Hansen tests.

5.7 MARGINAL EFFECT OF CLIMATE FINANCE ON INNOVATION

Although table 6 indicates that the interaction between climate finance and institutional quality is positive and significant, the actual impact of climate finance on innovation can be determined through the marginal effect (conditional effect). We report the marginal effect result in table 7.

The marginal effect results in table 7 show that at the lower percentile levels (10th and 25th) of institutional development, an increase in climate finance negatively and significantly affects innovation in SSA. Undoubtedly, in an economy where the institutions are weak, climate funds will be diverted and not invested in novel

technologies that will drive innovation development. This finding supports the results of Sharma, Sousa and Woodward (2022) and Donges et al. (2023). Further, we noticed that at the medium (50th) percentile of institutional development in SSA, the coefficient of the interaction between climate finance and institutional quality is positive but insignificant.

Table 7

Marginal effect of climate finance on innovation

Percentile	Percentile values	System-GMM	Difference GMM
10	0.021	-0.959**	-0.418
		(0.361)	(0.316)
25	0.261	-0.461**	-0.184
		(0.216)	(0.184)
50	0.509	0.053	0.058
		(0.172)	(0.084)
75	0.762	0.577*	0.304**
		(0.291)	(0.148)
90	0.922	0.910**	0.460**
		(0.397)	(0.232)

*Note: ** and * represent significance at 5% and 10%, respectively.*

Source: Authors.

The findings connote that at the median level of institutional development, climate finance in SSA will not yield beneficial outcomes in enhancing innovation due to the endemic nature of corruption persisting in SSA. Moreover, at the higher level (75th to 90th) of institutional development in SSA, we found that climate finance positively and significantly affects innovation. The result suggests that the full benefits of climate finance on innovation can be realised when institutions are highly effective. This finding implies that climate funds can be directed to innovative programs only when institutions in SSA experience significant improvement.

5.8 DUMITRESCU–HURLIN PANEL CAUSALITY TEST RESULTS

We adopted Dumitrescu and Hurlin's (2012) panel causality test to analyse the causal link among the main variables of interest. The results are reported in table 8.

Table 8

Dumitrescu-Hurlin panel causality test results

Variables	W-bar-Stat.	Z-bar-Stat.	Prob. value	Conclusion
INNO > CF	2.758	1.818	0.069*	↔
CF > INNOV	3.836	4.403	0.000***	
INNO > IQ	7.047	12.102	0.000***	↔
IQ > INNOV	4.472	5.927	0.000***	
CF > IQ	3.366	3.275	0.001***	↔
IQ > CF	5.222	7.725	0.000***	

*Note: *** and * denote significance at 1% and 10% levels, respectively; > denotes the direction of causality; ↔ signifies a bidirectional causality, and → denotes a one-way causality.*

Source: Authors.

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

Regarding the result reported in table 8, we discovered a bidirectional causal relationship between climate and innovation in SSA. Although the causal link between innovation and climate finance was weak, the findings suggest that a rise or decline in climate finance will raise or dwindle innovation development in SSA. This outcome is in line with the findings from Pradhan et al. (2023), Kim, Kwon and Kwon (2015), and Udvari and Ampah (2018).

Furthermore, the study detected a bidirectional causality between institutional quality and innovation. This result implies that strong institutions in the context of SSA are necessary to ensure innovation development. The result confirms the evidence by Donges, Meier and Silva (2023) and Sharma, Sousa and Woodward (2022). Lastly, we observed a two-way link between institutional development and climate finance in this study. This finding implies that international donors and private financial institutions closely examine the institutional development level before providing climate funds. Countries with poor institutional structures will attract low climate funds, whereas countries with better institutional structures will amass considerable donations (Ballesteros et al., 2010). Therefore, to secure substantial climate funding, the sub-regions in SSA should strengthen their institutional development.

6 CONCLUSION

Innovation has gained more traction in the 21st century since it is recognized as a sure tool for economic development. Scholars have postulated that innovation is a critical dynamic resource that brings about variations in growth, productivity, and competitiveness among countries and firms. As a result, a nation's ability to enhance its innovative capability is deemed critical. However, empirical evidence on how climate finance can be directed to enhance innovation and achieve competitive advantage has been dominated by data from developed and emerging economies, ignoring less developed nations like those in SSA. As SSA economies top the chart as the highest recipients of climate finance, it is prudent to investigate how climate finance can ensure innovation development. In line with this, the current study examines the effect of climate finance on innovation by allowing the link to be mediated by institutional quality in SSA. Employing the system-GMM estimation technique on a balanced panel dataset covering 2011 to 2022, the results established two impacts of climate finance on innovation: a direct unconditional and a conditional impact. While climate finance directly reduces innovation in SSA, its indirect effect – through institutional quality – is positive, suggesting that strong institutions help channel climate finance toward fostering innovation. Given these findings, the study concludes that climate finance can improve innovation in SSA when strong institutions direct the funds to productive sectors from which innovation will benefit. As a result, making institutions in SSA work better and stronger is necessary to allow the economies to reap the full benefit of climate finance on innovation. Therefore, we recommend that policymakers and governments in SSA institute policy measures geared toward improving the effectiveness and performance of institutions. However, these measures should be

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

tilted towards ensuring political stability and intensifying the rules that specify contract rights and control of corruption. These will ensure a stable environment conducive to the attraction of climate funds and other investment packages to enhance innovation systems in SSA.

Disclosure statement

The authors have no conflict of interest to declare.

REFERENCES

1. Ahenkan, A., 2020. Financing climate change mitigation: An assessment of the private sector investment opportunities in Ghana. *Business Strategy & Development*, 3(1), pp.143-150. https://doi.org/10.1002/bsd2.84
2. Alavuotunki, K., Haapanen, M. and Pirttilä, J., 2019. The effects of the value-added tax on revenue and inequality. *The Journal of Development Studies*, 55(4), pp. 490-508. https://doi.org/10.1080/00220388.2017.1400015
3. Anselmi, L., Lagarde, M. and Hanson, K., 2015. Equity in the allocation of public sector financial resources in low-and middle-income countries: a systematic literature review. *Health Policy and Planning*, 30(4), pp. 528-545. https://doi.org/10.1093/heapol/czu034
4. Anttila, J. and Jussila, K., 2019. Striving for benefits of sustainability from the interactivity of quality and innovation. *Journal of Cleaner Production*, 212, pp. 409-419. https://doi.org/10.1016/j.jclepro.2018.11.061
5. Apostu, S. A. [et al.], 2023. Exploring the Influence of Innovation and Technology on Climate Change. *Energies*, 16(17), 6408. https://doi.org/10.3390/en16176408
6. Arellano, M. and Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies,* 58(2), pp. 277-297. https://doi.org/10.2307/2297968
7. Arellano, M. and Bover, O., 1995. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1), pp. 29-51. https://doi.org/10.1016/0304-4076(94)01642-D
8. Ballesteros, A. [et al.], 2010. Power, responsibility, and accountability: Rethinking the legitimacy of institutions for climate finance. *Climate,* 50(1), pp. 261. https://doi.org/10.1163/CL-2010-013
9. Bannert, F., 2020. Climate finance, trade and innovation systems. *The Handbook of Global Trade Policy*, pp. 555-577. https://doi.org/10.1002/9781119167402.ch21
10. Bérubé, C. and Mohnen, P., 2009. Are firms that receive R&D subsidies more innovative? *Canadian Journal of Economics / Revue canadienne d'économique*, 42(1), pp. 206-225. https://doi.org/10.1111/j.1540-5982.2008.01505.x
11. Biermann, F. [et al.], 2009. The fragmentation of global governance architectures: A framework for analysis. *Global Environmental Politics*, 9(4), pp. 14-40. https://doi.org/10.1162/glep.2009.9.4.14
12. Blind, K., 2012. The influence of regulations on innovation: A quantitative assessment for OECD countries. *Research policy*, 41(2), pp. 391-400.
13. Blundell, R. and Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), pp. 115-143. https://doi.org/10.1016/S0304-4076(98)00009-8
14. Brambor, T., Clark, W. R. and Golder., M., 2006. Understanding Interaction Models: Improving Empirical Analyses. *Political Analysis*, 14(1), pp. 63-82. https://doi.org/10.1093/pan/mpi014

15. Czarnitzki, D. and Hottenrott, H., 2011. R&D investment and financing constraints of small and medium-sized firms. *Small Business Economics*, 36, pp. 65-83. https://doi.org/10.1007/s11187-009-9189-3
16. Dakhli, M. and De Clercq, D., 2004. Human capital, social capital, and innovation: a multi-country study. *Entrepreneurship and Regional Development*, 16(2), pp. 107-128. https://doi.org/10.1080/0898562041000167783 5
17. David, P. A., Hall, B. H. and Toole, A. A., 2000. Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research Policy*, 29(4-5), pp. 497-529. https://doi.org/10.1016/S0048-7333(99)00087-6
18. Doku, I., Ncwadi, R. and Phiri, A., 2021a. Determinants of climate finance: Analysis of recipient characteristics in Sub-Sahara Africa. *Cogent Economics and Finance*, 9(1), 1964212. https://doi.org/10.1080/23322039.2021.1964212
19. Doku, I., Ncwadi, R. and Phiri, A., 2021b. Examining the role of climate finance in the Environmental Kuznets Curve for Sub-Sahara African countries. *Cogent Economics and Finance,* 9(1). https://doi.org/10.1080/23322039.2021.1965357
20. Donges, A., Meier, J. M. and Silva, R. C., 2023. The impact of institutions on innovation. *Management Science*, 69(4), pp. 1951-1974. https://doi.org/10.1287/mnsc.2022.4403
21. Dumitrescu, E. I. and Hurlin, C., 2012. Testing for Granger non-causality in heterogeneous panels. *Economic Modelling*, 29(4), pp. 1450-1460. https://doi.org/10.1016/j.econmod.2012.02.014
22. Gebreyesus, K. Z., 2017. *The Impacts of combining climate finance with ODA on the volume of development finance.* Doctoral thesis.
23. Gerguri, S. and Ramadani, V., 2010. *The impact of innovation into the economic growth*. University Library of Munich.
24. Gilder, A. and Rumble, O., 2020. Improving sub-Saharan African access to climate change finance: An alternative view. *SAIIA Policy Briefing*, No. 194.
25. Gorodnichenko, Y. and Schnitzer, M., 2013. Financial constraints and innovation: Why poor countries don't catch up. *Journal of the European Economic Association*, 11(5), pp. 1115-1152. https://doi.org/10.1111/jeea.12033
26. Grindle, M. S., 2004. Good enough governance: poverty reduction and reform in developing countries. *Governance*, 17(4), pp. 525-548. https://doi.org/10.1111/j.0952-1895.2004.00256.x
27. Han, S. and Jun, H., 2023. Growth, emissions, and climate finance nexus for sustainable development: Revisiting the environmental Kuznets curve. *Sustainable Development*, 31(1), pp. 510-527. https://doi.org/10.1002/sd.2406
28. Hansen, L. P., 1982. Large sample properties of generalized method of moments estimators. *Econometrica: Journal of the Econometric Society*, pp. 1029-1054.
29. Howitt, P. and Aghion, P., 1998. Capital accumulation and innovation as complementary factors in long-run growth. *Journal of Economic Growth*, 3, pp. 111-130. https://doi.org/10.1023/A:1009769717601
30. Hulme, M., 2009. *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge University Press. https://doi.org/10.1017/CBO9780511841200

31. Im, K. S., Pesaran, M. H. and Shin, Y., 2003. Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1), pp. 53-74. https://doi.org/10.1016/S0304-4076(03)00092-7
32. Khan, Z. [et al.], 2020. Consumption-based carbon emissions and international trade in G7 countries: The role of environmental innovation and renewable energy. *Science of the Total Environment*, 730, 138945. https://doi.org/10.1016/j.scitotenv.2020.138945
33. Kim, J., Kwon, H. D. and Kwon, Y., 2015. Effect of ODA on the Donor's Economy: Localization and Technological Innovation Efforts of Recipient Country and the Sectoral Differentials of Effects. *Asian Journal of Innovation and Policy*, 4(1), pp. 1-18. https://doi.org/10.7545/ajip.2015.4.1.001
34. Lee, C. C. [et al.], 2022. The contribution of climate finance toward environmental sustainability: New global evidence. *Energy Economics*, 111, 106072. https://doi.org/10.1016/j.eneco.2022.106072
35. Lee, K. and Shin, S., 2022. Climate Finance and Innovation: Empirical Insights from Developing Countries. *Climate Policy*, 22(7), pp. 887-905. https://doi.org/10.1080/14693062.2022.2034705
36. Lopes de Sousa Jabbour, A. B. [et al.], 2018. Industry 4.0 and the circular economy: A proposed research agenda and original roadmap for sustainable operations. *Annals of Operations Research*, 270, pp. 273-286. https://doi.org/10.1007/s10479-018-2772-8
37. López, R. E. and Figueroa, B. E., 2016. On the nexus between fiscal policies and sustainable development. *Sustainable Development*, 24(4), pp. 201-219. https://doi.org/10.1002/sd.1622
38. Mahat, T. J. [et al.], 2019. Climate finance and green growth: reconsidering climate-related institutions, investments, and priorities in Nepal. *Environmental Sciences Europe*, 31(1), pp. 1-13. https://doi.org/10.1186/s12302-019-0222-0
39. Maradana, R. P. [et al.], 2017. Does innovation promote economic growth? Evidence from European countries. *Journal of Innovation and Entrepreneurship*, 6, pp. 1-23. https://doi.org/10.1186/s13731-016-0061-9
40. Mekonnen, A. [et al.], 2021. Climate change impacts on household food security and adaptation strategies in southern Ethiopia. *Food and Energy Security*, 10(1), e266. https://doi.org/10.1002/fes3.266
41. Mekonnen, M. M. and Hoekstra, A. Y., 2014. Water footprint benchmarks for crop production: A first global assessment. *Ecological Indicators*, 46, pp. 214-223. https://doi.org/10.1016/j.ecolind.2014.06.013
42. Mouleye, I. S. [et al.], 2019. Effect of global climate change on poverty and inequality in sub-Saharan Africa. In the *Conference on Climate Change and Food Security in West Africa*, November.
43. Musah-Surugu, I. J. [et al.], 2018. Migrants' remittances: A complementary source of financing adaptation to climate change at the local level in Ghana. *International Journal of Climate Change Strategies and Management*, 10(1), pp. 178-196. https://doi.org/10.1108/IJCCSM-03-2017-0054

44. Nadeem, M. A., [et al.], 2020. Innovation and sustainable development: does aid and political instability impede innovation? *Sage Open*, 10(4), 2158244 020973021. https://doi.org/10.1177/2158244020973021
45. North, D. C., 1990. *Institutions, institutional change, and economic performance. Cambridge University Press.* https://doi.org/10.1017/CBO9780511808678
46. North, D. C., 1993. The new institutional economics and development. *Economic History*, 9309002, pp. 1-8.
47. Oluwatobi, S. [et al.], 2016. Human capital, institutions and innovation in Sub-Saharan Africa. *International Journal of Economics and Financial Issues*, 6(4), pp. 1507-1514.
48. Osei, D. B., 2024. Digital Infrastructure and Innovation in Africa: Does Human Capital mediate the Effect? *Telematics and Informatics*, 89, 102111. https://doi.org/10.1016/j.tele.2024.102111
49. Pesaran, H. M., 2004. General diagnostic tests for cross-sectional dependence in panels. *Cambridge Working Papers in Economics*, No. 435.
50. Pesaran, M. H., 2007. A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), pp. 265-312. https://doi.org/10.1002/jae.951
51. Porter, M. E., and Linde, C. V. D., 1995. Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9(4), pp. 97-118. https://doi.org/10.1257/jep.9.4.97
52. Pradhan, R. P. [et al.], 2019. A quantitative assessment of the finance-growth-innovation nexus in EEA countries: Evidence from a multivariate VECM. *Journal of East-West Business,* 25(3), pp. 225-261. https://doi.org/10.1080/10669868.2019.1602575
53. Pradhan, R. P. [et al.], 2023. Does foreign aid affect innovation and institutional quality in middle-income countries? *Evaluation and Program Planning*, 100, 102340. https://doi.org/10.1016/j.evalprogplan.2023.102340
54. Rodríguez-Pose, A. and Zhang, M., 2020. The cost of weak institutions for innovation in China. *Technological Forecasting and Social Change*, 153, 119937. https://doi.org/10.1016/j.techfore.2020.119937
55. Rodrik, D., 2000. Institutions for high-quality growth: what they are and how to acquire them. *Studies in Comparative International Development*, 35, pp. 3-31. https://doi.org/10.1007/BF02699764
56. Romano, A. A. [et al.], 2017. *Climate finance as an instrument to promote the green growth in developing countries*. https://doi.org/10.1007/978-3-319-60711-5
57. Ryan Hogarth, J., 2012. The role of climate finance in innovation systems. *Journal of Sustainable Finance and Investment*, 2(3-4), pp. 257-274.
58. Saldanha, T. J. [et al.], 2021. How information and communication technology shapes the influence of culture on innovation: a country-level analysis. *Journal of Management Information Systems*, 38(1), pp. 108-139. https://doi.org/10.1080/07421222.2021.1870386
59. Sen, A., 1981. Issues in the Measurement of Poverty. In: *Measurement in public choice*. London: Palgrave Macmillan, pp. 144-166. https://doi.org/10.1007/978-1-349-05090-1_11

60. Sharma, A., Sousa, C. and Woodward, R., 2022. Determinants of innovation outcomes: The role of institutional quality. *Technovation*, 118, 102562. https://doi.org/10.1016/j.technovation.2022.102562
61. Shi, J., Wang, Z. and Wang, X., 2018. Innovations in the sustainable management of local government liabilities in China. *The Singapore Economic Review*, 63(4), pp. 819-837. https://doi.org/10.1142/S0217590817420115
62. Silvestre, B. S. and Ţîrcă, D. M., 2019. Innovations for sustainable development: Moving toward a sustainable future. *Journal of Cleaner Production*, 208, pp. 325-332. https://doi.org/10.1016/j.jclepro.2018.09.244
63. Simón-Moya, V., Revuelto-Taboada, L. and Guerrero, R. F., 2014. Institutional and economic drivers of entrepreneurship: An international perspective. *Journal of Business Research*, 67(5), pp. 715-721. https://doi.org/10.1016/j.jbusres.2013.11.033
64. Sindzingre, A., 2005. *Institutions and Development: A Theoretical Contribution*. Mimeo. The Hague, Institute of Social.
65. Steckel, J. C. [et al.], 2017. From climate finance toward sustainable development finance. *Wiley Interdisciplinary Reviews: Climate Change*, 8(1), e437. https://doi.org/10.1002/wcc.437
66. Tamasiga, P. [et al.], 2023. Is Africa Left behind in the Global Climate Finance Architecture: Redefining Climate Vulnerability and Revamping the Climate Finance Landscape – A Comprehensive Review. *Sustainability*, 15(17), 13036. https://doi.org/10.3390/su151713036
67. Tashtamirov, M., 2023. The Role of Institutions in Economic Development and Their Impact on Economic Growth in Different Countries. *SHS Web of Conferences,* 172, 02005. https://doi.org/10.1051/shsconf/202317202005
68. Tol, R. S. J., 2009. The economic effects of climate change. *Journal of Economic Perspectives*, 23(2), pp. 29-51. https://doi.org/10.1257/jep.23.2.29
69. Trutnevyte, E. [et al.], 2019. Societal transformations in models for energy and climate policy: the ambitious next step. *One Earth*, 1(4), pp. 423-433. https://doi.org/10.1016/j.oneear.2019.12.002
70. Udvari, B. and Ampah, I. K., 2018. Impacts of aid for innovation on economic growth in the sub-Saharan African countries. *Mediterranean Journal of Social Science*, 9(4). https://doi.org/10.2478/mjss-2018-0119
71. Warren, P., 2020. Blind spots in climate finance for innovation. *Advances in Climate Change Research*, 11(1), pp. 60-64. https://doi.org/10.1016/j.accre.2020.05.001
72. Williamson, O. E., 1985. *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting.* Free Press.
73. Zhang, Z., and Baranzini, A., 2004. What do we know about carbon taxes? An inquiry into their impacts on competitiveness and distribution of income. *Energy Policy*, *32*(4), pp. 507-518. https://doi.org/10.1016/S0301-4215(03)00152-6

PUBLIC SECTOR ECONOMICS
49 (2) 309-337 (2025)

APPENDIX

Table A1

Effect of climate finance and institutional quality on innovation in SSA (non-linear system-GMM results)

	Coefficient		
Variable	**Model 1**	**Model 2**	**Model 3**
$lnINNOV_{it-1}$	-0.253*** (0.059)	-0.273*** (0.081)	-0.005 (0.012)
SQCF	-1.439* (0.694)		
IQ	1.435** (0.608)		1.541** (0.681)
lnCF		-1.099* (0.570)	-0.052 (0.749)
SQIQ		3.463* (1.871)	
lnCF_IQ	0.805* (0.454)	22.529** (1.078)	
SQCF_SQIQ			-3.085** (1.095)
lnGDPPC	-1.383 (1.549)	-1.369 (1.212)	2.241** (0.788)
HC	0.010 (0.005)	0.015** (0.004)	0.005 (0.005)
IFRAD	-1.464 (1.167)	-0.889 (1.385)	0.046 (0.439)
lnGE	-9.912* (4.972)	-11.830** (4.987)	6.330*** (2.126)
lnFD	6.869* (3.368)	5.634 (3.454)	-7.057*** (1.295)
Net/marginal effect	1.435** (0.608)	3.463* (1.871)	
Constant	18.732 (16.225)	25.500 (17.185)	-8.477 (7.984)
AR(2) test statistic	-1.060	-0.610	0.200
AR(2) P-value	0.290	0.545	0.845
Hansen test statistic	6.880	5.560	10.340
Hansen P-value	0.737	0.724	0.500
No. groups	22	22	22
No. instruments	20	20	20

Table A2

Effect of climate finance and institutional quality on innovation in SSA (system-GMM results)

Variable	Coefficient	
	Model 1 (Corruption)	**Model 2 (Political stability)**
$lnINNOV_{it-1}$	-0.0224*** (0.0077)	-0.0282*** (0.0082)
lnCF	0.2341* (0.1299)	0.2872* (0.1648)
IQ	0.9704 (1.4483)	12.7816*** (4.0337)
lnCF_IQ	0.3464* (0.1786)	0.0278 (0.9146)
lnGDPPC	-2.4345 (1.5679)	-3.2546 (1.6244)
HC	-0.0007 (0.0045)	0.0045 (0.0029)
IFRAD	0.9363 (0.8260)	1.2717** (0.5709)
lnGE	-6.5124 (3.8685)	-6.6579* (3.7287)
lnFD	0.5256 (1.5001)	2.9371 (2.0951)
Constant	35.6356** (17.7762)	36.4524** (17.1689)
AR(2) Test statistic	-0.910	-0.880
AR(2) P-value	0.362	0.379
Hansen test statistic	6.430	7.040
Hansen P-value	0.696	0.633
No. groups	22	22
No. instruments	19	19

Institute of
Public Finance