

CURRENT DEVELOPMENTS AND THEMATIC REVIEWS IN SOCIAL SCIENCES

Editors

Prof. Dursun Balkan, PhD.

Prof. Naci Yilmaz, PhD.

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CHAPTER 1

**The Micro-Structural Origins of
Inflation: Sellers' Inflation and
Granular Shocks in BİST Sectors**

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Introduction

Recent fluctuations in the global economy have made maintaining price stability a fundamental challenge for both developed and developing markets. While controlling inflation has traditionally focused on monetary and fiscal policies, the cost structures and pricing strategies of micro-units, namely businesses, lie at the heart of this macroeconomic phenomenon. Businesses' sales performance and the costs of sales they incur are seen as the most dynamic factors determining not only the level but also the type and persistence of inflation.

Inflation is not merely an increase in the general price level but also an unpredictable redistribution of wealth among economic actors. Gordon (2015) points out that high inflation erodes savers' savings while benefiting borrowers, highlighting the 'arbitrary' and damaging effect of this process on social welfare. At the business level, this widespread uncertainty, as emphasized by Gordon, paralyzes decision-making and makes cost planning difficult for businesses. In an environment where prices fluctuate from month to month, businesses are unable to predict future sales and costs and remain vulnerable to fluctuations in consumer demand. This situation leads businesses to increase their risk premiums and adopt a more aggressive pricing strategy, thus fueling cost inflation.

Inflation, generally defined, is a socioeconomic process characterized by a continuous rise in the general price level and a sustained decline in the value of money. One of the most common tools used to measure this process is the Consumer Price Index (CPI), which tracks changes in the costs of goods and services such as food, housing, healthcare, and education that households consume to maintain their daily lives. In Turkey, weighted averages of these indices are generally used when calculating inflation rates, but the weights of the products included in the indices can be updated according to the economic conjuncture (Kaykusuz, 2001).

The distinction between demand and cost inflation, widely accepted in the inflation literature, is directly tied to changes in business balance sheets. Demand inflation arises when aggregate demand exceeds supply capacity; at the business level, this manifests as higher sales volumes, lower inventory levels, and ultimately higher prices (Mankiw, 2020). By contrast, cost inflation is the process by which businesses pass through price increases in essential production inputs, such as raw materials, energy, labor, and logistics, into their sales prices (Gordon, 2015). In particular, supply chain disruptions and exchange rate shocks trigger a supply-side inflationary spiral by raising businesses' cost of sales (CSC).

However, current discussions show that inflation is not merely a passive consequence of cost increases, but that businesses' market power and strategic pricing decisions are also involved. The concept of "Seller Inflation," proposed by Weber and Wasner (2023), argues that businesses' tendency to use cost increases as an opportunity to expand their profit margins pushes inflation higher

than expected. In this context, analyzing businesses' cost ratios and sales policies shows that combating inflation is possible not only through macroeconomic tools but also by understanding microeconomic behavior.

This study examines micro-level institutional cost structures and macroeconomic price stability across transfer channels, with a particular focus on the Istanbul Stock Exchange (BIST) Food and Beverage and Electric indices. It aims to conduct an empirical analysis of these aspects. In the literature, inflation dynamics, exchange rate pass-through, and monetary size are examined, while this study focuses on business-level data, specifically the Cost of Goods Sold (COGS) item, and on idiosyncratic shocks of leading companies, modeling inflation micro-structurally to their origins. The focus is on the Food-Beverage and Electricity indices. The limitation of the analysis framework to these indices is based on two fundamental economic justifications. Firstly, food and energy (electricity) are strategic sectors with the highest weight in the household consumption basket (CPI) and directly fuel inflationary inertia. Secondly, these sectors are part of the 'Granular Economy' as defined by Gabaix (2011), which argues that shocks from leading firms trigger macroeconomic fluctuations. They must have high market concentration, which is necessary to test the (economy) hypothesis. Exchange rate, interest rate, money supply, and spherical commodity shocks are key macroeconomic determinants controlled within this framework. Companies above and below the axis developed pricing strategies, and recent inflation 'Seller' in the literature, Sellers' inflation, and asymmetric price transfer on the axis by discussing national in your summer important. One methodological void is filled. The aim is to present the theoretical framework on the subject in the following sections of the article, followed by an analysis of the empirical relationship between business data and inflation indicators, and finally, a conclusion, discussion, and recommendations.

Literature

Studies examining the relationship between operating costs and inflation are grouped around three main axes: cost pass-through, accounting methods, and market power. The speed and extent to which firm-level cost increases (energy, raw materials, exchange rates, etc.) are reflected in final sales prices are defined in the literature as "pass-through analysis." Rivera-Torres and Salas-Fumás (2023) analyzed how "cost inflation" transforms into "price inflation" during periods when cost shocks become generalized, using firm-level data. The authors found that firms with high market power behave more strategically and flexibly in passing cost increases through to prices. Similarly, Amiri et al. (2019), by examining the impact of increases in imported input costs on pricing decisions, revealed that exchange rate shocks, in particular, create a decisive reference point for local prices through operating sales costs.

The cost accounting methods of businesses directly affect how inflation is reflected in financial statements and, consequently, managerial pricing decisions. Kantar et al. (2021), in their study of manufacturing companies listed on the Istanbul Stock Exchange (BIST), found that inflation negatively affects profitability ratios and liquidity, but the severity of this effect varies depending on the cost management method used by the business. Çelik and ErKaymaz (2020), who examined the relationship between cost structure and pricing behavior, found that inflation plays a regulatory role in this process; in a high-inflation environment, cost increases are passed through to sales prices more quickly. This finding parallels the results of Y k  and Kaplano lu (2016) on the manufacturing sector, which emphasized the determining role of the share of cost of goods sold (CDS) in sales on profitability.

Sarı (2024), in an analysis covering 2009-2023, examined the pass-through of exchange-rate shocks to both the Producer Price Index (PPI) and the Consumer Price Index (CPI) in the Turkish economy. Using the RALS (Residual Augmented Least Squares) method, the study found that the impact of exchange-rate shocks on prices is both strong and persistent. This finding supports the view of the exchange rate as a critical control variable and cost driver in the process of reflecting cost shocks (CSH) on prices, as examined in this study.

T rkan and Yıldıran (2025) analyzed the fiscal and monetary determinants of inflation in Turkey from 1990 to 2020 using the ARDL (Autoregressive Distributed Lag) method. The authors highlighted the determining role of structural factors in the inflationary process, in addition to traditional macroeconomic variables such as money supply and budget deficits. This study provides a current basis in the national literature for its original approach, which treats inflation not only as a monetary phenomenon but also as a micro-structural and network-based problem, drawing on Gabaix (2011) and Acemoglu et al. (2012).

Unlike traditional cost-push theories, the concept of "Seller Inflation" has been discussed in the literature in recent years. Weber and Wasner (2023) argue that large-scale businesses use supply bottlenecks and cost increases as a "coordination signal." According to this approach, businesses not only pass through cost increases but also deepen the inflationary spiral by raising prices above the cost increase to widen profit margins. In their empirical and theoretical studies, Baqaee and Farhi (2019) examined the macroeconomic repercussions of micro-level supply and operational shocks in the context of input-output networks and market failures. Unlike traditional approaches, the authors showed that, due to complementary relationships between firms and profit margin rigidities in the economy, micro-shocks create nonlinear, asymmetric effects on total output and price stability. In this context, it is emphasized that shocks experienced by granular actors at the center of the supply chain or with high market dominance

are a fundamental source of macroeconomic vulnerabilities and fluctuations in price indices.

Demand inflation is the rise in the general price level when aggregate demand exceeds supply capacity. Mankiw (2020) described this process as "excess money supply chasing a limited quantity of goods" and analyzed how rising aggregate demand, alongside higher business sales, pushes the general price level upward. In the literature, the ratio of business sales growth to production capacity is considered a leading indicator of inflationary pressure. When capacity utilization rates reach a critical threshold, businesses resort to price increases because they cannot meet increased demand, triggering demand-driven inflation (Gordon, 2015).

Cost inflation occurs when increases in the prices of factors of production (labor, capital, raw materials) are passed through to product prices by businesses. The "Triangle Model" developed by Gordon (2015) explains how costs affect prices in the context of supply shocks. In particular, increases in energy and imported input costs shift the aggregate supply curve to the left by raising businesses' Cost of Goods Sold (CGS) ratios. Gordon calls this "Cost-Push Inflation". This study examines the concept of inflation and how businesses pass through increases in raw material and labor costs to their sales prices.

The speed at which businesses respond to changes in cost ratios is referred to in the literature as "price stickiness." Blinder et al. (1998) noted that businesses cannot always immediately pass through cost increases to prices because of factors such as customer loyalty, but this stickiness decreases during periods of high inflation, making businesses much more sensitive to changes in their cost of sales. The study explains how quickly or slowly businesses reflect cost increases in their prices (price stickiness) through field research and shows how business-level decisions are transformed into macroeconomic inflation data. Kantar et al. (2021), in their study of manufacturing firms in Turkey, found that high debt and cost structures make pricing decisions much more aggressive.

Increased sales volume in businesses generally occurs during periods of higher disposable income, boosting aggregate demand and leading to higher prices. Rising raw material, energy, and labor costs prompt businesses to raise prices to protect their profit margins, shifting the supply curve to the left and leading to cost inflation. In the economic literature, increases in production costs (energy, labor, raw materials) are defined as negative supply shocks that shift the aggregate supply curve to the left (Mankiw, 2020). Firms tend to pass on increased costs to final product prices to protect their profit margins. This process is called "Cost Shifting" in the literature. This is also called Pass-Through. In the food sector, the speed at which cost increases are reflected in prices is referred to in the literature as the "Rocket and Feather" phenomenon. This is explained by

the Feathers asymmetry; when costs increase, prices rise rapidly, and when costs decrease, prices do not fall at the same rate (Peltzman, 2000).

Chaudhuri et al. (2013), a pioneering study examining the asymmetric effects of micro-level pricing rigidities on macroeconomic price indices and inflation uncertainty, analyzed the asymmetric distribution (skewness) of sectoral price changes within a regime-dependent model of price rigidities. Empirical findings based on UK data reveal a nonlinear, U-shaped (asymmetric) relationship between inflation and relative price skewness, and that these asymmetric pricing patterns at the micro/sectoral level underlie macroeconomic fluctuations. This approach forms the theoretical basis for the asymmetric response mechanisms that businesses develop to upward and downward cost shocks in a high-inflation environment.

Recent research on the micro-foundations of economic activity shows that the impact of business-level shocks on macroeconomic volatility extends beyond traditional approaches. Gabaix (2011) argues that disruptions in the cost or production structures of very large firms dominating the market cannot be offset by the effects of smaller firms, and this becomes a fundamental source of overall economic fluctuations. This perspective demonstrates that increases in the cost of sales of centrally located large businesses can directly threaten overall price stability. Similarly, Acemoğlu et al. (2012) and Long and Plosser (1983) have shown that, due to the complex structure of input-output networks, sectoral shocks experienced by centrally located suppliers alter the overall equilibrium magnitudes of the economy, and these shocks cannot be absorbed by peripheral firms. Therefore, changes in the cost structures of businesses in strategic sectors act as a lever, spreading in waves through supply chain links and triggering overall inflationary processes (Carvalho & Gabaix, 2013).

Çiçek (2005) empirically examined price stability and inflation inertia during Turkey's disinflation process. Using cointegration and the Augmented Phillips Curve approach, the study found that cost-side shocks and exchange-rate pass-through play a critical role in shaping macroeconomic price indices. The study argues that increases in producer costs and imperfect competition directly affect macroeconomic price anchors through the supply channel; that structural rigidities and cost-side pressures (cost inflation) are effective in the short-term dynamics of inflation; and that these factors become decisive for the success of disinflation programs.

In the current national literature, inflation dynamics are typically examined through exchange-rate pass-through (Sarı, 2024) and monetary and fiscal variables (Türkan & Yıldırım, 2025). This study, however, applies the "granular" economics approach defined by Gabaix (2011) to the inflation problem in Turkey for the first time, directly considering enterprise-level cost structures (ESCs) as the unit of analysis. Thus, the hypothesis that inflation is not only a monetary

phenomenon but also a structural problem fueled by idiosyncratic cost shocks of large-scale firms will be tested. While asymmetry studies in the literature generally focus on exchange rates, this study centers on the current "Seller's Inflation" discussions of Rivera-Torres and Salas-Fumás (2023) and Weber and Wasner (2023). The study shows that firms with high market power tend to pass cost increases through to prices at "rocket" speed, while passing cost decreases through at "feather" slowness (Rockets and The Feathers). The Rockets and The Feathers hypothesis will be empirically supported using Panel Data Regression Analysis.

Dataset, Methodology and Variables

This section first details the Data Set and Sample structure, defining the empirical limits and the institutional observation set of the research, on a sectoral basis, as presented in Table 1. Then, the process for calculating granular residuals, based on the Gabaix (2011) methodology, is presented, along with its mathematical formulation, to measure the idiosyncratic shocks of systemic actors dominating the market. In the third stage, the econometric model and variables designed to test the linear and asymmetric transmission between the price index and corporate cost movements are defined, and the model's functional structure and variable matrix are presented in Table 2. Finally, the Research Hypotheses developed to test the study's theoretical framework are presented, along with their economic justifications, based on the "Seller Inflation" and "Granular Economics" approaches.

Data Set and Sample

The research dataset comprises 28 companies listed on the BIST Food-Beverage and Electricity indices for the period 2014-2025. Data were obtained from annual consolidated financial statements compiled from the Public Disclosure Platform (KAP) and data terminals. The analysis period provides sufficient variation to measure the response of variables to shocks, as it encompasses both low- and high-inflation cycles in the Turkish economy. In this study, annual financial data from the Public Disclosure Platform (KAP) were used. A panel data structure was constructed using TURKSTAT CPI data.

Dependent Variable (P_{it}): Price index (CPI).

Independent Variable (CID): *The "Cost of Goods Sold" item* , representing cost shocks at the enterprise level.

(Γ_i): Big companies .

Control Variable (X_{it}): Company size (Total Assets).

The analysis presents 12 -year (2014-2025) data from 28 businesses in Table 1. will include in a way It is structured.

Table 1

Companies Included in the BIST Electricity and Food & Beverage Indices

Serial Number	Business Code	Business Name
1	AKENR	Akenerji Elektrik Üretim A.Ş.
2	AKFYE	Akfen Yenilenebilir Enerji A.Ş.
3	AKSUE	Aksu Enerji ve Ticaret A.Ş.
4	AYEN	Ayen Enerji A.Ş.
5	ENJSA	Enerjisa Enerji A.Ş.
6	GWIND	Galata Wind Enerji A.Ş.
7	HUNER	Hun Yenilenebilir Enerji Üretim A.Ş.
8	ODAS	Odaş Elektrik Üretim Sanayi Ticaret A.Ş.
9	ZOREN	Zorlu Enerji Elektrik Üretim A.Ş.
10	AEFES	Anadolu Efes Biracılık ve Malt Sanayii A.Ş.
11	AVOD	A.V.O.D. Kurutulmuş Gıda ve Tarım Ürünleri Sanayi Ticaret A.Ş.
12	BANVT	Banvit Bandırma Vitaminli Yem Sanayi A.Ş.
13	CCOLA	Coca-Cola İçecek A.Ş.
14	DARDL	Dardanel Önentaş Gıda Sanayi A.Ş.
15	ERSU	Ersu Meyve ve Gıda Sanayi A.Ş.
16	FRIGO	Frigo-Pak Gıda Maddeleri Sanayi ve Ticaret A.Ş.
17	MERKO	Merko Gıda Sanayi ve Ticaret A.Ş.
18	OYLUM	Oylum Sınai Yatırımlar A.Ş.
19	PENGD	Penguen Gıda Sanayi A.Ş.
20	PETUN	Pınar Entegre Et ve Un Sanayii A.Ş.
21	PINSU	Pınar Su ve İçecek Sanayi Ve Ticaret A.Ş.
22	PNSUT	Pınar Süt Mamülleri Sanayii A.Ş.
23	TATGD	Tat Gıda Sanayi A.Ş.
24	TBORG	Türk Tuborg Bira ve Malt Sanayii A.Ş.
25	TUKAS	Tukaş Gıda Sanayi ve Ticaret A.Ş.
26	ULKER	Ülker Bisküvi Sanayi A.Ş.
27	ULUUN	Ulusoy Un Sanayi ve Ticaret A.Ş.
28	VANGD	Vanet Gıda Sanayi İç ve Dış Ticaret A.Ş.

Calculation of Granular Residues

Granular Residuals. The calculation of Residuals (G_t) uses the "Granular Residual" (G_t) methodology developed by Gabaix (2011) to measure the impact of idiosyncratic shocks at the firm level on total economic fluctuations. This method aggregates each firm's sector-average adjusted cost growth rate ($git - gt$),

weighting it by the firm's market share. Thus, the share of shocks from large firms, especially in the BIST Food-Beverage and Electricity indices, on macroinflation is decomposed. It is a common shock variable representing the granular cost shocks of large firms in the sector and affecting the entire market over time (t). The "Granular Hypothesis" (G_t) put forward by Gabaix (2011) is used. Within the framework of the hypothesis, cost shocks experienced by leading firms, which represent a very large portion of the sector in terms of scale, are included in the model to control for the simultaneous transmission of these shocks to macro-level price indices through market pricing behavior.

To test hypothesis H_1 , a "Granular Residue" (Γ_t) series was generated for each period (t):

$$\Gamma_t = \sum_{i=1}^K \frac{S_{it-1}}{Y_{t-1}} (g_{it} - g_t) \quad (1)$$

S_{it-1} : The company's market share (sales size)

Y_{it-1} : The sales size of the sector

g_{it} : the sales growth rate of company i in period t

g_t : Average growth rate of the sector

This series was included in the model as an independent variable to measure the macroeconomic impact of shocks originating from large firms.

Econometric Model and Variable Definition

To address endogeneity that may arise in the relationship between the price index and operating costs, as well as the persistence of inflation over time, the Panel Regression method was used in the analysis. The econometric model established to empirically test the linear and symmetric transmission of operating costs to inflation is presented in Equation 2:

$$P_t = \beta_0 + \beta_1 \text{COGS}^+_{it} + \beta_2 \text{COGS}^-_{it} + \beta_3 \Gamma_{tit} + \beta_4 \text{COGS}_{it} + \beta_5 X_{it} + \epsilon_{it} \quad (2)$$

P_t : Price index (CPI).

$\text{COGS}^\pm_{it}$: In costs down and above directional changes representation asymmetric negative and positive shock variable,

COGS: Cost of Goods Sold

Γ_t : Idiosyncratic of large firms their shocks reflecting Granular Now the index,

(X_{it}): Control Variable Company size (logAsset Sum - lnsize).

Table 2**Dependent and Independent Variables**

Dependent Variable	P_{it}	Price Index
Independent Variable	$COGS_{it}$	Cost of Goods Sold
Independent Variable	(Γ_t)	Big Companies Shocks
Control Variable	(X_{it})	Business Size

Research Hypotheses

This study tests two primary hypotheses.

H1: A significant portion of the overall inflationary fluctuations and price volatility in Turkey stems from idiosyncratic (firm - specific) cost shocks experienced by granular businesses with high market share in the economy.

H2: Cost shocks at the business level have a positive and significant impact on sales prices in the long run.

Panel Data Regression Analysis

This study used panel data analysis to empirically test the long-term impact of enterprise-level cost elements on macroeconomic inflationary processes. The panel data approach allows simultaneous consideration of both the cross-sectional (firm/sector) dimension, which offers diverse information, and the time-series dimension, which captures dynamic changes. As highlighted by Baltagi (2021) and Wooldridge (2019), panel data models address unobservable heterogeneity (company- or industry-specific, time-invariant characteristics) that can arise when using only time-series or only cross-sectional data. Furthermore, they reduce multicollinearity, increase degrees of freedom, and enable estimators to produce more statistically efficient and consistent results.

Because the mechanism for passing operating costs through to inflation is inherently dynamic, past cost shocks, pricing behavior, and market structure can have lagged effects on inflation.

Due to globalization and financial integration, the panel units are jointly affected by common macroeconomic shocks (crises, exchange rate fluctuations, structural reforms), creating a risk of cross-sectional dependence among the series. The literature shows that classical panel data estimators (Fixed Effects, Random Effects, etc.) yield biased and inconsistent results under cross-sectional dependence. Therefore, tests for cross-sectional dependence and heteroskedasticity were conducted first in the analysis. Before examining the long-term relationships of the variables, Second Generation Panel Unit Root Tests (Pesaran CIPS), which account for cross-sectional dependence, were applied to assess the stationarity of the series. The reliability of the analysis findings was tested using robust standard errors that are resistant to autocorrelation, heteroskedasticity, and cross-sectional dependence.

Descriptive Statistics of Variables

Before proceeding with the empirical analysis of the econometric models established within the scope of the research, descriptive statistics were examined to reveal the general characteristics, distributional properties, and panel structure of the data set. Accordingly, the mean, standard deviation, minimum, and maximum values of the macroeconomic price indices, granular shock structures, asymmetric cost components, and firm-level control variables included in the analysis, as well as the panel data set's observation dimensions, are presented in Table 3.

Table 3
Descriptive Statistics for Variables

Variables	Mean	Standard Deviation	Minimum	Maximum	Number of Observations (N / n / T)
CPI	26,999	20,366	8,170	64.77	N = 336, n = 28, T = 12
G_t	0.0025	0.651	-5.554	4.82	N = 335, n = 28, T = 12
COGS	2.13	6.77	-5.95	6.39	N = 336, n = 28, T = 12
COGS ⁺	0.6404	1.7662	0	20.45	N = 333, n = 28, T = 12
COGS ⁻	-0.0502	0.1811	-1	0	N = 335, n = 28, T = 12
lnSize	23.2503	7.4100	13.4	31.4354	N = 336, n = 28, T = 12

According to the descriptive statistics in Table 3, the average annual Consumer Price Index (CPI) was 26.99. The overall average of the Cost of Goods Sold (COGS) variable was 2.13, with a maximum of 6.39. For the asymmetric shock components derived from firm-level cost change rates, the average of the COGS⁺ series, representing cost increases, was 0.6404, with a maximum of 20.45. In contrast, the average of the COGS⁻ series, representing cost decreases, was nearly zero (-0.0502) and exhibited a very limited range (minimum -1). This sharp difference, clearly observed in the descriptive statistics, empirically confirms that there is very strong rigidity in the cost structures of businesses. While cost decreases in the real sector remain quite limited cyclically, cost increases exhibit a cumulative and dominant intensity. This data characteristic serves as the most fundamental empirical reference in econometric regression models, theoretically explaining the dynamic force behind cost increases that directly drive inflation, while cost decreases are ineffective in bringing prices down.

Cross-Sectional Dependence Test

In panel data analysis, it is crucial to account for both companies affected by the same macroeconomic shocks and interactions among companies in other words, to assess whether the units' error terms are correlated. If cross-sectional

dependence is present, second-generation unit root tests such as CADF and CIPS, which account for cross-sectional dependence, are used instead of first-generation unit root tests (LLC, IPS) to determine whether the series contain unit roots (Pesaran, 2004; Pesaran, 2007).

Table 4
Cross-Sectional Dependence Test Results

Method	Statistics	Probability (p)
Pesaran CD Test	49.155*	0.0000
Friedman R	185.449 *	0.0000
Frees Q	8.685	
Critical values from Frees ' Q distribution		
alpha = 0.10 : 0.4127		
alpha = 0.05 : 0.5676		
alpha = 0.01 : 0.9027		

Note: * indicates a 1% significance level.

When examining the results of the cross-sectional dependence tests in Table 4, cross-sectional dependence among units was detected by the Pesaran (2004) CD, Friedman (1937), and Frees (1995) tests ($p < 0.01$). In line with this finding, second-generation panel unit root tests were used to assess stationarity, and standard errors robust to inter-unit dependence were used in the estimation phase.

Table 5
Unit Root Test Results

Variables	Model	Pesaran CADF (CIPS) Statistics	Length	Probability (p)
CPI	Constant	-4.150*	1	0.0000
	Constant - trend	-4.620*	1	0.0000
Γ_t	Constant	-2.009**	1	0.0220
	Constant - trend	-2.631*	1	0.0040
COGS	Constant	-3.900*	1	0.0000
	Constant - trend	-4.210*	1	0.0000
LnSize	Constant	-4.749*	2	0.0000
	Constant - trend	-4,953*	2	0.0000

Note: * indicates a significance level of 1%, and ** indicates a significance level of 5%.

The Pesaran (2007) CADF/CIPS is a second-generation panel unit root test. The analysis results in Table 5 indicate that the variables CPI, COGS, LnSize, and Γ_t are $I(0)$ at the level ($p < 0.05$).

Heteroskedasticity and Autocorrelation Test

To test the model's basic assumptions, the Modified fixed-effects model was applied. The Wald test detected no intergroup heteroskedasticity ($\chi^2 = 27.26$; $p = 0.7870$). However, autocorrelation was detected by the Durbin-Watson (1.82) tests. The Baltagi-Wu LBI (1.69) and Bhargawa tests were also conducted.

Table 6
Results of Heteroskedasticity and Autocorrelation Tests

Tests	Hypothesis	Test Statistics	Possibility
Modified Wald Test	$H_0: \sigma^2 i = \sigma^2 i$	27.26	0.787
Baltagi Wu LBI	$H_0: \rho=0$	0.81*	1,000
Bhargawa Durbin - Watson	$H_0: \rho=0$	0.91*	1,000

Note: * indicates a 1% significance level .

When the results are evaluated together in Table 6, there is no evidence of heteroskedasticity or autocorrelation in the model. However, given the cross-sectional dependence identified in the previous stage, the Driscoll-Kraay (1998) robust estimator, which produces standard errors robust to cross-sectional dependence, will be used.

Coefficient Estimation with Panel Data Regression Analysis

In this section of the study, the effects of micro-level cost shocks on the macro-level CPI of companies traded on the Food-Beverage and Electricity indices of the Istanbul Stock Exchange (BIST) were empirically estimated. The F-test, Breusch-Pagan LM, and Hausman tests are shown in Table 7. Fixed Effects control for firm-specific, time-invariant heterogeneity, as indicated by the specification tests. The Fixed Effects model was determined to be the most suitable estimator. However, the strong autocorrelation (sequential dependence) detected in diagnostic assumption tests and the cross-sectional dependence shocks revealed by Frees/LM tests carry the risk of causing deviations in the standard errors of the classical Fixed Effects coefficients. To overcome these methodological limitations, the panel regression method with robust standard errors, as described by Driscoll and Kraay (1998), was preferred. Accordingly, the effect of asymmetric positive and negative cost shocks derived from the Cost of Goods Sold (COGS) item on pricing behavior was investigated by pooling the control variables, granular sectoral fluctuations (Γt) and firm size ($\ln \text{Size}$). It has been coefficientized.

Table 7
Selection of the Coefficient Estimation Model

Tests	Test Statistics	(P- value)
F Test	4.41*	0.0000
LM Test (π Breusch -pagan)	0.00	1.0000
Hausman Test Statistic	131.12*	0.0000

Note: * indicates a 1% significance level.

To determine the panel data model to be used in the analysis phase, the F-test, Breusch-Pagan LM test, and Hausman test were applied. To identify the most suitable panel estimator in the linear regression model relating the cost structure to price indices of firms in the BIST Electricity index, the F-test, Breusch-Pagan LM test, and Hausman test were performed simultaneously. First, the F-test, which examines the significance of unit effects, rejected the H_0 hypothesis supporting the pooled OLS model at the 1% significance level and showed that the Fixed Effects (FE) model was more efficient than the linear OLS model ($F = 4.41, p = 0.0000$).

For the Breusch-Pagan LM test, which assesses the variance of unit-specific heterogeneity, the H_0 hypothesis could not be rejected ($p = 1.0000$). While this alone might suggest weak panel effects, the Hausman (1978) test Chi-square statistic, which determines the final model selection, was highly significant at the 1% level ($\chi^2 = 131.12, p = 0.0000$). The strong rejection of the H_0 hypothesis by the Hausman test proves that firm-specific, time-invariant characteristics correlate with the independent variables and that the Random Effects (RE) estimator will produce biased results. When all these diagnostic tests are evaluated together, the Fixed Effects estimator, which controls for unobservable firm heterogeneity and ensures parameter consistency, is considered. The use of the Effects model in the empirical analysis of the study was decided econometrically.

Table 8
Results of Driscoll-Kraay Robust Asymmetric Panel Regression with Standard Error.

Independent Variables	Coefficient	Standard Error	t Statistics	Probability (p)
COGS	7.32	2.45	2.99	0.012**
COGS ⁺	3.8859	1.6632	2.34	0.039**
COGS ⁻	0.0075	6.8703	0.00	0.999
Γ_t	-4.8988	0.9071	-5.40	0.000*
Size	1.3092	0.3738	3.50	0.005*
_cons (Constant Term)	-7.2298	6.9495	-1.04	0.321

$F(5, 11) = 24.81^*$

Probe > F = 0.0000

$R^2: 0.3760$

Number of Observations: 331

Number of Companies: 28

Note: * indicates a significance level of 1%, and ** indicates a significance level of 5%.

The Driscoll-Kraay Fixed Effects model presented in Table 8 confirms that the model has explanatory power and overall significance. The F statistic, which measures the overall validity of the model, was found to be statistically significant at the 1% level ($p = 0.0000$) with a value of 24.81. The Within R^2 value, representing the within-firm explanatory power of the model, was calculated as 0.3760. This ratio indicates that internal asymmetric cost shocks and firms' structural dynamics explain 37.60% of the variation in consumer price index inflation (CPI_Inf).

COGS+ variable, representing positive cost increases at the enterprise level, was calculated as 3.8859 and found to be statistically significant at the 5% significance level ($t = 2.34$, $p = 0.039$). This finding indicates that increases in input costs are transferred to macroeconomic price indices with a very strong and rapid pass-through effect.

COGS- component, which symbolizes reductions and relaxations in costs, took a value extremely close to zero, such as 0.0075, and was statistically completely insignificant ($t = 0.00$, $p = 0.999$).

When these two contrasting empirical findings are considered together, it is determined that firms in the Turkish real sector pass through cost increases they experience in their final prices at a "rocket" speed, but do not use cost reductions resulting from global or local commodity declines to lower prices, exhibiting profit margin rigidity. This situation proves that the phenomenon of "Seller's Inflation," which is fueled by market concentration and advocated by Peltzman (2000) and Weber and Wasner (2023) in the literature, operates rigidly. Furthermore, the coefficient of the COGS variable, which is a linear raw cost component, was found to be positive (7.32) on the scientific notation scale and significant at the 5% confidence level ($t = 2.99$, $p = 0.012$), showing that structural base increases in the cost of goods sold beyond asymmetric shocks push macroinflation trends linearly upwards.

The Role of Granular Shocks (Γ): The Granular Residual (Γ_t) index, constructed using market share weighting in line with the granular economy theory introduced to the economics literature by Gabaix (2011), was found to be statistically significant at the 1% level, with a coefficient of -4.8988 ($t = -5.40$, $p = 0.000$). The negative sign indicates that higher market concentration in food and energy is associated with lower index values. The indices lock actors' scale from their economies, resulting from structural factors with advantages directly related to it. High production volume, thanks to unit per still costs, helps minimize download to his power owner, the one which... This leader business, sectoral average on institutional one growth and productivity shock when they lived, they obtained what they cost advantage, final prices suppress or stabilize for they can use it. Similar in shape and scale of the economy to companies, this provides wide profit margin flexibility, macro at the level, entry cost giant firms in their

increases. These shocks act as a buffer, absorb to and pricing in their decisions. Small environment to companies compared to more controlled their behavior opportunity he recognizes it. This empirical output, perfectly competitive market assumptions, on the contrary, dominant players idiosyncratic operational dynamics and scale based Sunday their powers prices general level on directly strategic one anchor role undertaking by proving the study (Granular Action Hypothesis). This supports hypothesis H₁.

The Size Effect (lnSize): The natural logarithm of the firm's asset size (lnSize), included as a control variable in the model, was found to be positive and statistically significant at the 1% level, with a coefficient of 1.3092 ($t = 3.50$, $p = 0.005$). This finding indicates that in these two critical sectors with high market concentration, the market power transmission leverage of firms over macroeconomic pricing mechanisms and inflation inertia increases linearly with firm scale. Scale serves as a decisive control mechanism for the persistence of macro price fluctuations.

Discussion, Conclusion and Recommendations

This study empirically examines the effects of micro-level structural shocks and asymmetric cost rigidities on macroeconomic inflation (CPI) using a Driscoll-Kraay robust fixed-effects panel regression with panel data from 28 firms traded on the BIST Food & Beverage and Electricity indices for the period 2014-2025. The econometric findings corroborate the study's hypotheses. The Granular Residual Index, representing idiosyncratic shocks from key actors affecting the sector, is a decisive driver of macro pricing. Corporate-level operational shocks do not disappear; on the contrary, they trigger macroeconomic inflationary fluctuations. Positive cost shocks directly increase inflation, while negative cost shocks (cost reductions) have no downward effect on the general price level (statistically insignificant). This pattern reveals the presence of a rigid "Rocket and Feather" mechanism and downward price rigidity in the Turkish real sector. Firm asset size (lnSize) and linear cost increases (LCM) linearly expand firms' market power and pass-through capabilities, pushing macroinflationary trends upward. In summary, the study empirically demonstrates that inflation cannot be explained solely by purely macroeconomic factors such as aggregate demand expansion or monetary aggregates; micro-structural origins such as market concentration, asymmetric rigidities, and granular firm dynamics are also undeniable sources of structural inflation.

Based on the non-speculative, purely empirical coefficients and model diagnostic indicators obtained, the following rational policy recommendations are as follows:

Granular Inflation Monitoring and Competition Policies: Central banks and monetary policy authorities must move beyond traditional tools focused solely on aggregate demand management in combating inflation. Pricing

behavior, profit margin accumulation, and on-balance-sheet cost pass-throughs of leading firms in food and energy indices with high market concentration (I_i) and critical weight in household consumption baskets should be closely monitored at the granular (micro) level by regulatory authorities such as the Competition Authority.

Breaking Downward Price Rigidities: The ineffectiveness of negative cost shocks (COGS) on price indices ($p = 0.999$) indicates that global commodity declines or local input cost easing are not passed on to consumers. To break this asymmetric structure and market failure, policymakers should implement price caps, asymmetric profit margin taxes, or supply-side structural incentive mechanisms to optimize raw material and logistics supply chain networks.

Given the finding that increases in raw material costs (COGS) and scale ($\ln \text{Size}$) linearly fuel inflation, it is essential to improve cost predictability for micro-units. Specifically, to stabilize the operational costs of granular actors involved in locomotive production, futures markets (hedging) should be encouraged, sectoral input-cost insurance mechanisms should be developed, and priority should be given to supply-side micro-reform packages that will increase macroeconomic predictability.

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CHAPTER 2

**From Open Banking to Open Finance:
Current Developments,
Emerging Risks, and Regulatory
Challenges in Banking**

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1. Introduction

Digitalisation has progressively reshaped the boundaries of traditional banking, affecting how financial services are produced, distributed, and accessed. Open banking is one of the clearest outcomes of this transformation. It enables authorised third-party providers to access customer-permissioned account information and payment functionality, usually through application programming interfaces (APIs). Although the model initially developed around payment services, its scope has gradually widened. This evolution has led to the emergence of open finance, which applies similar data-sharing principles to a much broader range of financial products and relationships.

The difference between open banking and open finance is therefore substantive rather than merely terminological. Open banking is mainly concerned with access to payment-account information and payment initiation. The European Commission's proposed framework for financial data access reflects this direction by seeking to establish rights and obligations for sharing customer data beyond payment accounts, while also addressing customer control, technical standardisation, security, competition, and trust (European Commission, 2023).

International experience suggests that the implications of this shift extend well beyond data access itself. Eroglu, Cornelli, Frost, Rühmann, and Shreeti (2026) show that open finance may reduce information silos and asymmetries, facilitate market entry, encourage competition and innovation, and potentially broaden financial inclusion. The economic value of open finance therefore depends as much on the rules governing access, transmission, interpretation, and protection of financial data as on the amount of data that can be shared.

For banks, this shift changes a long-established informational advantage. Banks have traditionally occupied a central position as both providers of financial services and custodians of customer financial data. Open finance therefore creates strategic opportunities for incumbent institutions as well as competitive pressure.

Greater connectivity also changes the nature of risk. Operational failures or cyber incidents involving a third-party provider may affect several institutions simultaneously, while broader data access creates additional concerns relating to privacy, consent management, data quality, API security, fraud, liability, and the commercial use of financial information. The regulatory problem is no longer confined to the security of individual banks; it also concerns how responsibility is distributed among banks, fintech firms, data holders, data users, technology providers, and customers within an interconnected ecosystem (Basel Committee on Banking Supervision [BCBS], 2019; Financial Stability Institute [FSI], 2025).

The European Union illustrates how these competing objectives are reshaping financial regulation. The proposed PSD3 and Payment Services Regulation (PSR) are intended to modernise the PSD2 framework, while the proposed

Financial Data Access framework extends the policy debate beyond payments. A provisional political agreement on the payment-services package was reached in November 2025, followed by further Council-level work during 2026 (Council of the European Union, 2025, 2026; European Commission, 2023; European Parliament, 2026).

Türkiye has followed a related but institutionally distinctive path. Open banking has expanded through the Payment Services Data Sharing Services (ÖHVPS; Turkish: Ödeme Hizmetleri Veri Paylaşım Servisleri) framework. In March 2026, the CBRT announced ÖHVPS version 2.0.0, extending the system to card information and transactions as well as scheduled and recurring payment initiation. At that time, the ecosystem had reached 16.4 million users, an average 12.3 million transactions per day, and 53 participants (Central Bank of the Republic of Türkiye [CBRT], 2026b).

The Turkish regulatory framework also links open banking to wider changes in the structure of banking. Regulation governing digital banks and the Banking-as-a-Service model incorporates open banking into relationships between service banks and interface providers. Open banking in Türkiye therefore needs to be considered alongside digital banking, platform-based banking, fintech-bank partnerships, embedded financial services, and evolving forms of financial intermediation (Banking Regulation and Supervision Agency [BRSA], 2021).

Cross-border interoperability adds another dimension to these developments. The BIS Innovation Hub's Project Aperta, which delivered a successful proof of concept in 2026, demonstrated that domestic open finance frameworks can be connected through a common interoperability layer. The project involved networks in the United Kingdom, United Arab Emirates, Brazil, Hong Kong SAR, and India and explored applications in areas including SME banking and trade finance (Bank for International Settlements [BIS], 2026). Cross-border connectivity could widen the reach and efficiency of financial services, but it also brings more demanding questions concerning jurisdiction, data protection, identity, technical standards, liability, and regulatory coordination.

This chapter examines these developments from the perspective of the banking sector. It first clarifies the conceptual and institutional progression from open banking to open finance and then reviews recent international and Turkish developments. The long-term significance of open finance for banking will depend on whether greater interoperability and innovation can be combined with effective data governance, operational resilience, consumer protection, and clearly defined accountability.

2. From Open Banking to Open Finance: Conceptual Evolution

Open banking has altered the traditional relationship between banks, customers, and financial information. Banks have historically acted not only as

providers of financial services but also as the principal custodians of the transactional and behavioural data generated through their customer relationships. Definitions differ across countries and studies, but customer consent, data portability, third-party access, and the use of application programming interfaces (APIs) are generally regarded as its defining features (Briones de Araluze & Cassinello Plaza, 2022; Xie & Hu, 2024).

APIs are central to the operation of open banking because they provide standardised channels through which different information systems can communicate and exchange data. Yet open banking cannot be reduced to API technology alone. The economic and institutional importance of open banking therefore lies not simply in technological connectivity, but in the change it introduces to the control and portability of financial information.

This change has important implications for competition. He, Huang, and Zhou (2023) show that such portability can influence competition in credit markets by improving fintech lenders' ability to assess borrowers. Open banking is therefore better understood as an institutional change in the distribution and economic value of financial information rather than simply as a technological instrument for increasing competition.

The first generation of open banking frameworks largely concentrated on payment accounts, account information, and payment-initiation services. In the European Union, PSD2 provided the regulatory foundation for authorised third-party providers to access payment-account information and initiate payments with customer consent. The subsequent policy debate increasingly recognised the limitations of confining data portability to payment accounts. The European Commission's proposal for a broader financial data access framework reflects this shift and provides an institutional basis for extending data-sharing principles to other areas of finance (European Commission, 2023).

Open finance develops this logic further. Instead of limiting customer-authorised data sharing to payment accounts, it encompasses a wider range of financial relationships, potentially including savings, credit, investments, insurance, pensions, and other financial products. The framework developed jointly by CGAP, the Bank for International Settlements (BIS), the International Monetary Fund (IMF), the Office of the United Nations Secretary-General's Special Advocate for Financial Health (UNSGSA), and the World Bank describes open finance in terms of customer-permissioned access to and use of financial data held by financial institutions for the provision of new or improved services and the development of innovative business models (CGAP, BIS, IMF, UNSGSA, & World Bank, 2024).

International experience also shows that open finance increasingly forms part of the wider digital financial infrastructure. Eroglu et al. (2026) associate open finance with the potential reduction of information silos and asymmetries, lower

barriers to market entry, greater competition and innovation, and wider financial inclusion. Questions of consent, liability, supervision, security, and consumer protection therefore become integral to the functioning of open finance rather than secondary regulatory concerns.

It is also useful to distinguish open finance from two developments that are increasingly important in digital banking: Banking-as-a-Service (BaaS) and embedded finance. These concepts frequently rely on API-based infrastructures and may coexist within the same ecosystem, but they concern different parts of the financial-services value chain.

BaaS refers to the modular provision of regulated banking capabilities to third parties. Through these arrangements, banking functions such as accounts, payments, card issuance, or other regulated services can be made available to fintech firms and digital platforms through technological interfaces. Its primary focus is therefore not the portability of customer information but the provision of banking functionality. Remolina (2026) emphasises this distinction: open banking and open finance primarily concern access to and portability of financial data, whereas BaaS concerns the modular provision and redistribution of banking services.

Embedded finance operates at a different level. It refers to the integration of financial products and services into customer journeys that originate outside traditional financial channels. BaaS primarily concerns infrastructure and service provision, while embedded finance concerns distribution and the customer interface (Remolina, 2026).

Seen in this way, the progression from open banking to open finance is primarily a change in financial-data governance rather than a simple extension of technology. The relevant question is no longer limited to whether a customer can permit a third party to access bank-account information. It increasingly concerns how financial data from different products and institutions can be shared, combined, reused, and governed across organisational boundaries. As the portability of financial information increases, the boundaries between banks, fintech firms, technology platforms, and other financial-service providers become correspondingly less rigid.

For banks, this evolution changes the basis of informational advantage without eliminating their role in financial intermediation. Customer data are becoming more portable, but banks remain important providers of regulated infrastructure, financial products, risk-management capabilities, and trusted services. Their position may therefore evolve from that of relatively closed financial-service providers toward a wider range of roles as data users, infrastructure providers, platform participants, and ecosystem partners. This conceptual shift provides the foundation for examining how the open banking ecosystem has developed institutionally and technologically.

3. The Evolution of the Open Banking Ecosystem

The development of open banking has been gradual rather than the result of a single regulatory or technological change. Banking systems have moved from institution-specific digital channels toward an environment in which authorised third parties can access data and services through standardised APIs. Although regulatory and market pathways differ across jurisdictions, the overall direction is toward greater interconnection and less rigid organisational boundaries between banks and external providers.

A major regulatory milestone was the adoption of the Second Payment Services Directive (PSD2) in the European Union. Directive (EU) 2015/2366 established the legal basis for services such as account information and payment initiation and created the conditions under which authorised third-party providers could interact with payment accounts held by banks (European Parliament & Council of the European Union, 2015). PSD2 did not impose a single API standard across Europe, but it established an important regulatory principle: with customer authorisation, specified payment-account services could no longer remain exclusively under the control of the account-holding bank.

The United Kingdom developed this principle through a more prescriptive competition-policy approach. The Retail Banking Market Investigation Order 2017 therefore required the nine largest current-account providers to make specified personal and business current-account data available through standardised read/write interfaces (Competition and Markets Authority [CMA], 2017). The UK model consequently combined the broader regulatory requirements of PSD2 with a domestic intervention designed specifically to increase competition in retail banking.

Regulatory opening alone, however, was not sufficient to create a functioning ecosystem. In the United Kingdom, the Open Banking Standard brought together read/write API specifications, security requirements, directory services, and operational and customer-experience guidance within a common framework for account-servicing payment service providers and third-party providers (Open Banking Limited, 2026a). Standardisation therefore helped transform data sharing from a series of bilateral connections into a more scalable infrastructure.

The relationship between banks and fintech firms has consequently become more complex than a simple incumbent-versus-entrant model. Gozman, Liebenau, and Mangan (2018) show more broadly how fintech innovation can unbundle established financial-services business models and create new forms of interaction between incumbent institutions and technology-based entrants. Within open banking, this has encouraged an ecosystem in which value is increasingly created through inter-organisational connections rather than exclusively through vertically integrated service provision.

Recent research also suggests that open banking develops through identifiable stages of institutional maturity. Muthukannan, Gozman, Tan, and Dhavamani (2026) describe a progression from regulatory interpretation and technical codification toward strategic platform expansion and ecosystem orchestration. As the ecosystem matures, banks can use APIs and external relationships to support collaboration and assume a more active role in coordinating fintech firms, technology providers, customers, and other participants.

The scale of mature open banking systems provides evidence of this institutionalisation. In the United Kingdom, open banking user connections reached approximately 16.5 million by December 2025. During 2025, the ecosystem handled around 24 billion API calls and 351 million open banking payments (Open Banking Limited, 2026b). In April 2026, Open Banking Limited released version 4.0.1 of the Open Banking Standard, updating technical specifications, operational guidance, and customer-experience requirements (Open Banking Limited, 2026a).

International expansion has nevertheless produced considerable variation in institutional design. The Basel Committee observed that national approaches differ in areas such as data access, third-party participation, cybersecurity, privacy, and risk management (BCBS, 2019). Such differences remain important because an effective open banking system requires more than technically available APIs. Identity and authentication mechanisms, licensing rules, common data standards, liability arrangements, consent processes, and supervisory structures all influence whether data sharing can operate reliably at scale.

4. Current International Developments in Open Finance

Open finance is developing along different institutional and regulatory paths across jurisdictions. Although the underlying objective is broadly similar—to extend customer-authorised data sharing beyond traditional payment accounts—the design and implementation of open finance vary considerably. Differences can be seen in the scope of data covered, participation requirements, governance arrangements, technical standards, and the role assigned to regulators and market participants. Some jurisdictions rely primarily on mandatory regulatory frameworks, while others favour phased implementation, experimentation, or broader data-portability regimes that extend beyond the financial sector.

The comparison of leading jurisdictions is therefore useful not because it reveals a single model that others should follow, but because it shows how different regulatory systems are responding to similar challenges. The European Union, the United Kingdom, Brazil, and Australia illustrate distinct approaches to expanding financial-data sharing, while emerging cross-border initiatives point to a further stage in which interoperability between national systems may become increasingly important.

4.1. European Union: From PSD2 to the Financial Data Access Framework

The European Union has taken one of the most ambitious approaches to the development of a comprehensive framework for financial-data sharing. PSD2 established the regulatory basis for third-party access to payment-account information and payment-initiation services, but its scope remained largely confined to payments. In response, the European Commission proposed the Regulation on a Framework for Financial Data Access (FiDA) in June 2023 as part of a wider package intended to modernise payment services and support data-driven finance (European Commission, 2023).

FiDA marks a substantial extension of the European open banking model. Rather than concentrating exclusively on payment accounts, the proposal covers a much wider range of customer financial information. Its central principle is that customers should have greater control over data generated through their relationships with financial institutions and should be able to authorise eligible financial-data users to access that information. The proposal also envisages financial data-sharing schemes through which market participants would establish common arrangements for data standards, technical interfaces, contractual conditions, and compensation mechanisms (European Commission, 2023).

One distinctive element of FiDA is its attempt to balance data access with the incentives of institutions that hold and maintain financial information. Unlike the PSD2 model, wider financial-data sharing may involve reasonable compensation for data holders. This reflects a practical concern: open finance requires continued investment in secure, reliable, and high-quality data infrastructure.

The legislative process also demonstrates the complexity of extending open banking principles across the wider financial sector. The Council of the European Union adopted its negotiating position in December 2024, after which interinstitutional negotiations with the European Parliament continued. During 2025 and 2026, discussions addressed questions concerning the scope of the framework, access conditions, financial data-sharing schemes, supervision, restrictions on data use, the position of third-country financial information service providers, and the role of large digital platforms (Council of the European Union, 2024; European Parliament, 2026). FiDA therefore remained part of an ongoing legislative process during 2026 rather than an already operational EU-wide open finance regime.

For banks, FiDA is particularly important because it may alter their informational position well beyond the payments market. Data relating to savings, lending, investments, pensions, and other financial activities could increasingly become accessible within a regulated sharing framework. It may also

create opportunities for institutions that are able to integrate external financial data into more comprehensive, personalised, and competitive services.

4.2. United Kingdom: A Use-Case-Driven Roadmap toward Open Finance

The United Kingdom has taken a different route toward open finance. Building on one of the most mature open banking ecosystems, UK regulators have chosen to develop open finance incrementally rather than through an immediate, economy-wide expansion of mandatory data sharing. In April 2026, the Financial Conduct Authority (FCA) published its *Open Finance Roadmap: Our Vision for a Smart Data Future*, setting out a phased pathway from experimentation toward broader implementation through 2030 (Financial Conduct Authority [FCA], 2026b).

A defining feature of the UK approach is its focus on specific use cases. During 2026, particular attention was given to small and medium-sized enterprise lending and mortgage markets. Policy sprints and structured experiments were used to examine whether wider financial-data access could reduce friction in credit assessment, improve product matching, and support faster financial decision-making (FCA, 2026a).

This approach reflects a preference for evidence-based regulatory development. The initial phase is designed to test practical applications and identify operational, commercial, and consumer-protection barriers before the framework is expanded. The FCA's roadmap envisages further development of governance and regulatory arrangements during 2027, followed by broader implementation and scaling between 2028 and 2030. Interoperability, sustainable commercial incentives, consumer protection, and common governance arrangements are therefore treated as conditions for expansion rather than issues to be addressed only after the market has developed (FCA, 2026b).

The UK model therefore illustrates a gradual transition from mature open banking toward open finance through experimentation, testing, and phased implementation. Its significance lies less in the immediate breadth of data covered than in the attempt to build regulatory and market arrangements around concrete use cases before moving to wider adoption. This makes the UK approach distinct from more comprehensive legislative models and from jurisdictions where open finance has already been implemented at scale.

4.3. Brazil: A Broad and Operational Open Finance Ecosystem

Brazil provides one of the most developed examples of a regulator-led transition from open banking to open finance. The Banco Central do Brasil (BCB) defines Open Finance as an environment in which customers can authorise the sharing of their data, products, and services among regulated financial and payment institutions. The framework is intended to promote competition and

innovation, improve efficiency in credit and payment markets, strengthen financial inclusion, and give customers greater control over their financial information (Banco Central do Brasil [BCB], n.d.).

Implementation has proceeded in stages rather than through a single expansion of data-sharing requirements. The initial phases focused on information concerning participating institutions and financial products. Subsequent phases extended the framework to customer and transactional data, payment initiation, investments, foreign exchange, acquiring services, insurance, pension products, and other financial services (BCB, n.d.). Brazil therefore illustrates a gradual route from open banking to open finance in which both the range of data and the number of services covered have been progressively widened.

The scale reached by the Brazilian system is particularly significant. In May 2025, the BCB reported that Open Finance was serving approximately 52 million customers and processing around 3.3 billion data requests per week (BCB, 2025). These figures indicate that the framework has moved well beyond an experimental stage and has become an established part of the country's digital financial infrastructure.

Large-scale operation has not meant that the framework has stopped evolving. Brazilian authorities have continued to revise technical standards and expand the range of services supported by the system. In July 2026, the BCB issued version 8.0 of the *Open Finance Data and Services Scope Manual*, incorporating requirements associated with credit portability, with the updated provisions scheduled to take effect in November 2026 (BCB, 2026). The Brazilian experience therefore shows that open finance requires continuing regulatory and technical adjustment even after broad market adoption.

4.4. Australia: Open Banking within an Economy-Wide Consumer Data Right

Australia has taken a distinctive approach to data portability through the Consumer Data Right (CDR). Rather than treating open banking as a stand-alone financial-sector initiative, the CDR was designed as a broader framework intended to give consumers greater control over data held across different sectors. Banking was the first sector brought within the framework, and consumer data sharing began in July 2020. The system was subsequently extended beyond banking, first to energy and later to non-bank lending (Australian Competition and Consumer Commission [ACCC], n.d.; ACCC, 2020).

The framework continued to broaden in 2026. From July 2026, relevant non-bank lenders became subject to product-data sharing requirements covering information such as interest rates, fees, charges, and eligibility criteria. Consumer data-sharing obligations for non-bank lenders were scheduled to be phased in

from 9 November 2026, depending on provider size (ACCC, 2026). The inclusion of non-bank lenders is significant because it extends data portability beyond institutions traditionally classified as banks and may support wider comparison, credit assessment, and lending applications.

At the same time, an economy-wide model raises its own governance challenges. The combination of data from different sectors may increase the value of personalised services, but it also makes questions of consent, purpose limitation, data minimisation, privacy, and cross-sector responsibility more complex. The Australian model is therefore important not only because it extends data portability beyond banking, but also because it shows how open finance may increasingly become part of a broader data-governance architecture.

4.5. International Convergence and the Emerging Interoperability Agenda

Despite differences in national design, customer control, interoperability, standardisation, security, and accountability are emerging as common priorities across open finance frameworks (Eroglu et al., 2026).

Cross-border interoperability represents the next stage of this agenda. Most open banking and open finance systems have so far been designed within national regulatory and technological boundaries. Differences in API specifications, data formats, digital identity arrangements, legal responsibilities, and trust frameworks therefore continue to limit the portability of financial data across jurisdictions. Addressing these differences is considerably more complex than achieving interoperability within a single domestic system.

The BIS Innovation Hub's Project Aperta provides an important example of how this problem may be approached. Rather than seeking to replace existing national infrastructures with a single international standard, the project developed and tested a prototype designed to connect different domestic open finance systems through a neutral interoperability layer (BIS, 2026). This "network of networks" approach is significant because it allows participating jurisdictions to retain their domestic architectures while creating mechanisms through which those systems can communicate.

The prototype connected networks involving Brazil, Hong Kong SAR, India, the United Arab Emirates, and the United Kingdom and explored possible applications in areas such as business account opening and trade finance. The project demonstrated the technical feasibility of linking different open finance infrastructures, but it also made clear that technical connectivity alone is not sufficient. Questions relating to legal alignment, digital identity, trust, liability, data protection, and governance remain central to any future cross-border implementation (BIS, 2026).

5. Open Banking and Open Finance Developments in Türkiye

Türkiye has developed a relatively structured open banking ecosystem through legislative reform, common technical infrastructure, regulatory standardisation, and growing participation by banks and non-bank payment service providers. The system has so far remained concentrated mainly on payment services, account information, and payment initiation. It is still important, however, to distinguish between a mature open banking infrastructure and a fully developed open finance regime covering a wider range of financial products and institutions.

The legal basis of open banking in Türkiye was strengthened in November 2019 through amendments to Law No. 6493 on Payment and Securities Settlement Systems, Payment Services and Electronic Money Institutions. Two new payment services were added to Article 12: payment initiation services and services that provide consolidated information on one or more payment accounts held by a customer at payment service providers. These services form the legal basis of the Payment Services Data Sharing Services (ÖHVPS; Turkish: Ödeme Hizmetleri Veri Paylaşım Servisleri) framework (CBRT, 2023).

The Turkish model shares important functional similarities with the European open banking framework, particularly the distinction between payment initiation and account information services established under PSD2. Its implementation architecture, however, has developed differently. Rather than relying solely on bilateral API connections between individual institutions, Türkiye adopted a more centralised technical model. The Interbank Card Center (Bankalararası Kart Merkezi—BKM) was designated as the technical service provider, and a common API infrastructure known as GEÇİT was developed to standardise connectivity among participating institutions (CBRT, 2023).

Participation increased considerably as the infrastructure matured. According to the CBRT's 2025 Annual Report, 34 banks and five electronic money institutions had completed technical certification and were providing services through GEÇİT as account service providers by the end of 2025. The same report noted that 24 banks were operating in the relevant authorised service-provider role and that eight non-bank payment service providers had completed both licensing and technical certification for integration into the system (CBRT, 2026a). The scale of participation indicates that open banking in Türkiye has moved beyond an initial implementation project and become part of the country's financial infrastructure.

A major functional expansion followed in March 2026 with the introduction of ÖHVPS version 2.0.0. The new version broadened account information services and added comprehensive functionality relating to card information and card transactions. It also introduced scheduled and recurring payment-order initiation, enabling the infrastructure to support more continuous payment

relationships in addition to individual account-information requests and one-time payment initiation (CBRT, 2026b).

The size of the ecosystem by 2026 further illustrates its growing operational importance. In its March 2026 announcement, the CBRT reported 16.4 million users, an average of 12.3 million transactions per day, and 53 participants. The announcement also linked the expanded functionality to improvements in customer experience, greater flexibility in financial services, and new opportunities for product and business-model development by banks, payment institutions, and electronic money institutions (CBRT, 2026b). Open banking in Türkiye can therefore no longer be regarded as a limited regulatory experiment.

Open banking also needs to be considered alongside broader developments in digital banking regulation. The Regulation on the Operating Principles of Digital Banks and Service Model Banking, published by the BRSA in December 2021 and effective from January 2022, created a formal regulatory framework for both branchless digital banks and service-model banking. Under this framework, customers can access the systems of a service bank through the interface of another provider using the bank's open banking services (BRSA, 2021).

The practical relevance of service-model banking has increased over time. According to the BRSA's 2025 Annual Report, three banks received permission during the reporting period to provide banking services as service banks through open banking services and fintech interface providers (BRSA, 2026). This indicates that the framework has begun to move from regulatory design into operational use.

These developments should not, however, be interpreted as evidence that Türkiye already operates a comprehensive open finance regime. The formal framework remains centred primarily on payment accounts, payment services, card-related information, and payment initiation. A unified system for customer-authorised portability across investments, insurance, pensions, securities, and other categories of financial data has not yet emerged on a scale comparable with the broader open finance frameworks discussed in the previous section.

The wider digital payments infrastructure provides an additional foundation for such a transition. Türkiye has developed complementary systems including the Instant and Continuous Transfer of Funds System (FAST), the Easy Addressing System (KOLAS), TR QR Code standards, and other layered payment services. The CBRT reported that FAST processed approximately 5.4 billion transactions during 2025 and had 49 participants at year-end, illustrating the scale of the digital payments environment within which open banking is developing (CBRT, 2026a).

Regulatory adjustment has continued alongside these technological developments. Amendments published in the Official Gazette on 4 September

2026 revised provisions concerning remote contractual relationships and customer identity verification in payment services, including biometric methods and identity documents with electronic authentication capabilities. Related amendments were also introduced to the communiqué governing the information systems of payment and electronic money institutions and data-sharing services in the payment-services field (Republic of Türkiye Official Gazette, 2026). These changes do not themselves represent a move to open finance, but they show that the regulatory framework surrounding digital financial services continues to evolve.

The next stage will depend on whether these existing foundations are extended beyond payment-centred open banking toward a broader system of customer-controlled financial-data mobility. Such a shift would involve more than adding further payment functions. It would require an integrated framework covering a wider range of products, data types, and financial institutions. Türkiye therefore occupies an intermediate position in the transition examined in this chapter: its open banking infrastructure is operational and increasingly sophisticated, while the institutional basis for a broader open finance ecosystem is still developing.

6. Implications for Banks and Emerging Business Models

The shift from open banking to open finance has consequences that extend well beyond regulatory compliance and technical connectivity. For banks, the more fundamental issue is how competitive advantage is created in an environment where financial data can move more easily across institutional boundaries. Its strategic effect is therefore better understood as a combination of competitive pressure and new business-model opportunities.

Competition is one of the most immediate areas of change. Evidence from international open banking adoption suggests that access to customer data facilitates fintech entry and can support the formation of new financial-service relationships for both consumers and small and medium-sized enterprises (Babina et al., 2025). As open finance broadens the range of shareable data, similar competitive effects may extend to savings, investments, insurance, and other financial products.

Incumbent banks are not limited to the role of data providers. Lin, Zhang, and Zachariadis (2025) provide evidence from the United States that banks adopting external APIs experienced improvements in information flows and that API adoption was associated with better performance indicators, including return on assets and market valuation. This suggests that open-data infrastructures can create value for established institutions when they are integrated into a broader digital strategy rather than treated solely as a compliance requirement.

The customer interface is likely to become an increasingly important source of competition. Traditionally, customers have accessed financial products mainly

through channels owned by the institution providing the underlying service. Open finance makes it easier to manage products from several institutions within a single application or platform. As a result, the institution that holds the deposit, provides the loan, or processes the payment may no longer control the environment through which the customer experiences the service.

Not all banks are equally positioned to make this transition. Ozcan, Dinckol, and Zachariadis (2026), drawing on UK retail banking, show that incumbent and challenger banks face different strategic advantages and constraints when developing platform models. Platformisation therefore depends on organisational and technological capability, not merely on the availability of APIs.

Banking-as-a-Service (BaaS) adds another dimension to this restructuring. Unlike open banking, which is primarily concerned with data access, BaaS involves the modular provision of regulated banking functionality to third parties. Through API-based arrangements, banks may provide accounts, payment services, card issuance, compliance functions, or other capabilities to fintech firms and digital platforms. In such models, the bank may operate increasingly as an infrastructure provider while another company manages the customer-facing relationship.

The growing use of white-label arrangements illustrates this separation between regulated provision and customer distribution. The European Banking Authority reported in 2025 that approximately 35% of surveyed banks were already using white-labelling models in which products or services provided by regulated institutions are distributed under the brand of another financial or non-financial company (European Banking Authority [EBA], 2025). White labelling is not identical to BaaS, but both reflect a wider trend in which the institution supplying the regulated financial capability and the organisation controlling the customer interface are no longer necessarily the same.

Embedded finance develops this logic further by placing financial services directly within non-financial digital environments. Payments, credit, insurance, or other products can be incorporated into e-commerce platforms and other digital customer journeys without requiring users to move to a separate banking channel. Open finance can reinforce such models by improving access to customer-authorized financial information, while BaaS provides the regulated banking functions needed to deliver embedded products (Remolina, 2026).

Relationships between banks and fintech firms are also becoming more varied. Early debates often presented fintech firms primarily as competitors capable of disintermediating incumbent banks. More recent research points to a mixed pattern of competition and collaboration. Costa, Querci, and Santulli (2025) show that cooperation has become an important strategic response, allowing banks to gain access to specialised technologies while giving fintech firms access to

established customer bases, regulatory expertise, infrastructure, and market credibility.

Collaboration can take many forms, including commercial partnerships, technology procurement, minority investment, joint ventures, accelerator programmes, and acquisitions. The appropriate choice depends on the strategic importance of the capability involved, technological complexity, implementation costs, and the speed with which the bank wishes to enter a market. Alfhaili, Bakoush, and Wolfe (2025) show that banks' existing business models influence their propensity to acquire fintech firms, reinforcing the view that there is no single digitalisation strategy that is optimal for all institutions.

The success of these arrangements also depends on governance. External partnerships do not automatically translate into improved bank performance. Birindelli, Chiappini, and Martino (2026), examining bank-fintech alliances in Europe, find that the relationship between alliances and performance is influenced by digital-governance arrangements, including the formalisation of digital strategy, dedicated leadership roles, and technological expertise at board level. Open finance therefore places organisational governance alongside technological capability as a central determinant of strategic success.

There is, however, an important tension between personalisation and the commercial use of financial information. The FSI notes that open finance can improve customer experience, innovation, competition, and financial inclusion, but that wider data sharing also creates additional risks and supervisory challenges as information circulates among a larger number of providers (FSI, 2025). The strategic use of customer data therefore needs to be balanced against transparency, customer control, and responsible data practices.

7. Emerging Risks and Governance Challenges

The expansion of open banking into open finance changes not only the volume and range of financial data being shared but also the number of institutions and technological systems involved in delivering financial services. Greater connectivity can support innovation, competition, and customer choice, yet it also alters the structure of risk. Vulnerabilities are no longer confined to individual financial institutions. They can originate in fintech firms, technology providers, cloud services, data intermediaries, or other external participants and spread across interconnected networks.

For banks, this means that risk management increasingly extends beyond organisational boundaries. Institutions must assess dependencies and exposures arising from systems and providers that they do not fully control. International work on open finance therefore places considerable emphasis on governance, operational safeguards, consumer protection, and the allocation of responsibility across the ecosystem (CGAP et al., 2024; FSI, 2025).

7.1. Cybersecurity and Operational Resilience

Cybersecurity is one of the most immediate concerns in an open finance environment. Financial-data sharing depends on continuous interaction among APIs, authentication mechanisms, databases, applications, and external service providers. Each additional connection increases the complexity of the system and may create new points of vulnerability. The security problem consequently extends beyond protecting a bank's internal infrastructure to safeguarding an interconnected network of participants.

The financial sector already operates in a demanding cyber-threat environment. The European Union Agency for Cybersecurity identifies banks, payment providers, financial infrastructures, and related institutions as important targets of increasingly sophisticated cyber activity (European Union Agency for Cybersecurity [ENISA], 2025). In open finance, the potential impact of such attacks may be amplified because compromised credentials, weak authentication, insecure APIs, or vulnerabilities in third-party applications can provide indirect access to wider parts of the financial ecosystem.

Operational resilience is therefore as important as prevention. Institutions need to consider not only how cyber incidents can be avoided but also how critical services can continue or recover when disruption occurs. The EU Digital Operational Resilience Act (DORA) reflects this broader understanding by treating ICT risk management, incident reporting, resilience testing, information sharing, and third-party ICT risk as related elements of financial-sector resilience (European Parliament & Council of the European Union, 2022).

7.2. Third-Party Dependency and Concentration Risk

The growing use of external providers creates an additional source of vulnerability. Banks may depend on fintech firms, cloud providers, data aggregators, identity services, API-management platforms, and software vendors, improving efficiency while creating dependencies that may be difficult to replace quickly.

The problem becomes more significant when several institutions rely on the same provider. A disruption affecting a critical technology company can then have consequences for multiple banks at the same time. This creates concentration risk at the ecosystem level rather than merely a bilateral outsourcing problem. DORA recognises this concern by addressing ICT concentration risk associated with critical third-party providers whose failure may impair the ability of financial institutions to perform important functions (European Parliament & Council of the European Union, 2022).

Managing these dependencies requires more than careful provider selection. Banks need to understand which external services support critical activities, monitor performance over time, identify subcontracting chains, and maintain

realistic options for substitution or exit. The European Banking Authority's Guidelines on Outsourcing Arrangements similarly emphasise the identification, assessment, monitoring, and management of risks arising from third-party relationships, particularly where critical or important functions are involved (EBA, 2019).

7.3. Data Privacy, Consent, and Data Governance

Consent in this environment cannot be treated as a one-time administrative requirement. Customers need to know which data are being accessed, by whom, for what purpose, and for how long. They also need effective means of reviewing and withdrawing permission. International guidance on open finance identifies consent, customer authentication, privacy, data protection, and consumer safeguards as essential components of a sustainable framework (CGAP et al., 2024).

This creates a persistent tension between personalisation and privacy. More complete financial information can support better recommendations, improved credit assessment, and more relevant services, but the same information can also be used for extensive profiling. Effective governance therefore requires clear purpose limitation, appropriate data minimisation, access controls, traceability, retention rules, and mechanisms through which customers can review and revoke permissions. Trust depends not simply on whether formal consent was obtained, but on whether subsequent use of the data remains transparent and consistent with the purpose for which access was granted.

7.4. Data Quality, Profiling, and Responsible Data Use

The value of open finance also depends on the quality of the data being exchanged. Financial information must be sufficiently accurate, current, complete, and interoperable if it is to support reliable services. Inconsistent classifications, delayed updates, incomplete records, or incompatible standards can undermine the quality of decisions made on the basis of shared information.

Broader access to financial data also increases the scope for customer profiling. More complete information can improve risk assessment and personalisation, but highly granular classifications may disadvantage customers whose financial histories are incomplete, atypical, or difficult to interpret. The FSI notes that open finance may contribute to financial inclusion while also creating the risk that some groups are left behind if appropriate supporting conditions are absent (FSI, 2025).

The challenge is therefore not to restrict the use of financial data, but to ensure that its use remains proportionate, traceable, and appropriate to the decision being made. Banks and other providers need mechanisms for monitoring data provenance, correcting errors, documenting significant transformations, and reviewing the consequences of data-driven decisions. As open finance widens the

informational base of financial services, responsible data use becomes increasingly important to conventional risk governance.

7.5. Accountability, Liability, and Consumer Protection

The fragmentation of financial-service delivery makes accountability more difficult to allocate. A customer using a single application may in fact interact with several organisations: one may hold the account, another may provide the interface, a third may aggregate data, while other providers support identity verification, analytics, cloud infrastructure, or payment processing. When a service fails or data are misused, identifying the responsible party can therefore become considerably more complicated.

This complexity creates the possibility of governance gaps if different participants assume that responsibility lies elsewhere. Banks and other providers need clear internal and contractual arrangements concerning security incidents, inaccurate data, unauthorised access, fraud, service disruption, and customer complaints. The Basel Committee has long noted that open banking creates operational, cyber, reputational, and third-party risk-management challenges as institutions become more dependent on external providers (BCBS, 2019). These concerns become more pronounced as open finance expands the number of participants and the range of data involved.

Consumer protection is particularly important because customers may not be aware of the institutional complexity behind an integrated digital service. From their perspective, a single application may appear to provide one seamless product even when several entities are involved in its delivery. Responsibility for complaint handling, incident communication, and redress therefore needs to remain clear despite the technological fragmentation of the service.

8. Regulatory Challenges and Policy Directions

Open finance creates a regulatory environment that is more complex than conventional bilateral relationships between financial institutions and their customers. Data and services may move among banks, fintech firms, data holders, data users, technology providers, infrastructure operators, and customers, often within the same service journey. The more difficult task is to create conditions under which data mobility can support competition and innovation without weakening consumer protection, operational resilience, market integrity, or financial stability (CGAP et al., 2024; Eroglu et al., 2026).

8.1. Defining the Regulatory Perimeter and Scope of Data Sharing

A basic policy question concerns the boundaries of open finance: which categories of financial information should be included, which institutions should participate, and whether participation should be mandatory, voluntary, or differentiated by institutional role and size.

A narrowly designed framework may reproduce one of the main limitations of early open banking by confining data portability to a small number of products and institutions. An overly broad framework introduced too quickly, however, may create disproportionate compliance costs and operational complexity before adequate safeguards and technical capacity are in place. International guidance therefore supports a proportionate and risk-based approach in which policy objectives, market structure, institutional capacity, and technological readiness are considered when determining the scope of data-sharing obligations (CGAP et al., 2024).

The European Union's proposed Financial Data Access framework illustrates the difficulty of making these choices. FiDA seeks to extend regulated access well beyond payment accounts while also defining covered data, eligible users, customer permissions, data-sharing arrangements, and the responsibilities of data holders (European Commission, 2023). The continuing legislative process shows that the regulatory perimeter cannot be determined independently of questions concerning privacy, competition, commercial incentives, administrative burden, and the permitted uses of financial information (European Parliament, 2026).

Reciprocity is part of the same debate. Institutions that gain access to customer-authorised data held by competitors may themselves possess information of commercial value. Some degree of reciprocity can prevent firms from benefiting from open finance without contributing to the ecosystem. Equal obligations for every participant, however, may not always be appropriate. Large incumbent institutions, small financial firms, fintech companies, and specialised data providers differ substantially in resources, business models, and regulatory status. Proportionality therefore remains important when participation requirements are designed.

8.2. Consent, Purpose Limitation, and Customer Control

Open finance is usually justified in terms of giving customers greater control over their financial information. In practice, meaningful control requires more than formal consent. Customers need to understand what information is being requested, who will receive it, why it is needed, how long access will continue, and whether the data may subsequently be used for other purposes.

Consent arrangements should therefore be specific, transparent, manageable, and capable of being withdrawn without unnecessary difficulty. Customers should be able to identify which organisations currently have access to their data, what categories of information are involved, and why that access continues. The proposed EU framework follows this general direction by placing customer control over financial-data access and use at the centre of its architecture (European Commission, 2023).

The design of the consent process matters as much as the legal requirement itself. Lengthy explanations, bundled permissions, confusing interfaces, or requests for more information than is necessary can undermine meaningful choice even where formal compliance is achieved. Regulatory attention therefore needs to extend to the way consent works in practice. Dias, Mazer, and Jeník (2026) similarly identify consent journeys and customer outcomes as areas that require active supervisory attention in open finance systems.

8.3. Liability, Redress, and Allocation of Responsibility

Liability becomes more difficult to determine when several organisations contribute to the same financial service. An unauthorised transaction, inaccurate data transfer, security failure, or interruption of service may involve a bank, fintech firm, intermediary, technology provider, or several of these actors at once. Without clear rules, customers may face uncertainty over which organisation is responsible for resolving the problem.

The FiDA proposal reflects this concern by linking data access to broader arrangements concerning customer permissions, contractual relationships, data-sharing schemes, and liability (European Commission, 2023; European Parliament, 2026). International guidance similarly stresses that responsibility should remain identifiable even when several organisations participate in the delivery of the same service (CGAP et al., 2024).

8.4. Interoperability, Technical Standards, and Commercial Sustainability

Open finance also depends on the ability of different systems to communicate reliably. Incompatible data definitions, authentication methods, API specifications, or consent structures increase connection costs and can recreate barriers that data-portability policies are intended to reduce.

Evidence from international experience places interoperability and standardised data-sharing arrangements among the main conditions for effective open finance (Eroglu et al., 2026). Regulators do not necessarily need to determine every technical specification themselves, but they do need to ensure that credible arrangements exist for developing, maintaining, and revising common standards. Depending on the jurisdiction, this role may be performed by public authorities, industry organisations, specialised implementation entities, or combinations of these actors.

The United Kingdom provides an example of a more iterative model. The FCA's 2026 roadmap combines experimentation with the gradual development of governance arrangements, interoperability standards, and commercially sustainable schemes before wider implementation between 2028 and 2030 (FCA, 2026b). This approach recognises that open finance standards cannot remain fixed as technologies, market practices, and use cases evolve.

Commercial incentives are closely connected to this issue. Data holders bear costs associated with infrastructure, security, data quality, and reliable interfaces. If these costs are ignored, institutions may have little incentive to maintain high-quality systems. Excessive charges for access, on the other hand, can discourage entry and weaken competition. Policy therefore needs to find a workable balance between cost recovery and accessibility. Principles governing transparency, reasonable compensation, and non-discrimination may be preferable to arrangements that rely entirely on bilateral bargaining (CGAP et al., 2024).

8.5. Supervision, Regulatory Coordination, and Ecosystem Monitoring

Open finance also requires supervision to move beyond an exclusively institution-by-institution perspective. Traditional financial supervision generally examines whether individual firms comply with prudential, conduct, and operational requirements. In an interconnected data-sharing environment, important problems may arise from the way participants interact rather than from the behaviour of a single firm.

Dias, Mazer, and Jeník (2026) argue that supervisory arrangements should be considered from the design stage of open finance rather than added after implementation. Their analysis identifies areas such as API performance, consent processes, fraud, data misuse, customer outcomes, and the general health of the ecosystem as important supervisory concerns. This implies a broader approach in which authorities assess not only formal compliance but also whether open finance infrastructure is functioning as intended.

Coordination among public authorities is equally important. Open finance may involve central banks, banking supervisors, payment regulators, data-protection authorities, competition agencies, consumer-protection bodies, securities regulators, and insurance or pension authorities. As the scope of data sharing widens, the boundaries between these mandates become less clear. Without coordination, institutions may face inconsistent requirements while important risks fall between supervisory responsibilities.

The nature of the data generated by open finance may also change supervisory practice. API availability, data requests, consent activity, transaction patterns, and service failures can produce high-frequency operational information that is difficult to capture through conventional periodic reporting. Data-driven supervisory tools may therefore become increasingly useful for identifying unusual behaviour, deteriorating service quality, or emerging customer risks at an earlier stage (Dias et al., 2026).

8.6. Cross-Border Regulatory Coordination

Cross-border connectivity adds a further layer of complexity because national open finance systems operate under different rules for financial services, privacy,

cybersecurity, digital identity, consumer protection, and liability. Technical interoperability therefore does not automatically imply legal interoperability.

Project Aperta illustrates both the opportunity and the limitation. The project showed that domestic open finance infrastructures can potentially be connected without replacing their underlying systems. At the same time, such connectivity raises questions about trusted participants, identity, security, liability, data transfers, and governance that cannot be resolved through technical architecture alone (BIS, 2026).

Complete harmonisation of national regulation is unlikely to be necessary or realistic. A more practical objective may be sufficient compatibility between systems. Jurisdictions could retain different institutional arrangements while agreeing on minimum requirements concerning customer authorisation, security, participant eligibility, authentication, data protection, and accountability. Mutual recognition and interoperable trust frameworks may therefore become as important as common technical standards.

8.7. Policy Directions for Türkiye

For Türkiye, the central policy question is how the existing open banking architecture might evolve toward a broader open finance framework without simply reproducing a model developed elsewhere. The country already has an operational ÖHVPS infrastructure, common API connectivity through GEÇİT, growing participation by banks and payment institutions, and an expanding range of account, card, and payment-initiation services. These provide a useful starting point, but extending the framework beyond payments would represent a significant change in regulatory scope.

An initial priority would be to define clearly what a Turkish open finance framework is expected to achieve. Before introducing broader mandatory data-sharing requirements, policymakers would need to determine whether and when areas such as investments, securities, insurance, pensions, and credit should be included, as well as which institutions would act as data holders and data users. A phased approach would allow operational performance, consumer experience, and market effects to be evaluated before the framework is widened further.

Institutional coordination would become increasingly important as the scope expands. Moving beyond payment-centred open banking would involve areas supervised by different authorities. Banking, payments, capital markets, insurance, pensions, competition, and personal-data protection would therefore need to be considered within a more coordinated governance structure. Common approaches to standards, permissions, liability, supervision, and consumer protection would become particularly important where financial products cross traditional regulatory boundaries.

Technical capability, however, should not be treated as equivalent to regulatory readiness. The ability to share more data does not by itself provide a sufficient reason for mandatory expansion. Data quality, customer understanding, cybersecurity, competition, commercial incentives, institutional capacity, and supervisory preparedness need to develop alongside technical infrastructure. International experience suggests that gradual implementation and continued evaluation can help avoid a situation in which technological ambition develops faster than the institutional framework needed to support it (CGAP et al., 2024; FCA, 2026b).

The broader policy challenge is to preserve a workable balance between openness and control. Regulation that is too restrictive may limit innovation and reinforce existing informational advantages, while a framework that expands access without adequate safeguards may weaken trust and increase operational and consumer risks. Whether that balance can be achieved will largely determine whether open finance develops into a durable part of financial infrastructure or remains a collection of disconnected data-sharing arrangements.

9. The Future of Open Finance and Banking

The future of open finance is likely to depend less on the continued expansion of data access in itself than on the ability to build financial systems in which data, services, institutions, and technological infrastructures can interact reliably. Open banking established the principle that customers may authorise third parties to access selected banking information. Open finance broadens that principle across a wider range of financial relationships. The next stage is therefore likely to involve a move from separate data-sharing arrangements toward more integrated forms of financial-data infrastructure.

Current international developments already point in this direction. The European Union's proposed Financial Data Access framework seeks to extend customer-controlled data sharing beyond payment accounts, while the United Kingdom's roadmap sets out a phased transition from experimentation in 2026 toward wider implementation and scaling between 2028 and 2030 (European Commission, 2023; FCA, 2026b). Open finance is therefore increasingly being treated as part of the infrastructure through which financial services are organised rather than as a stand-alone regulatory initiative.

This changing environment does not necessarily reduce the importance of banks. Regulated status, balance-sheet capacity, risk-management expertise, established infrastructure, and customer trust are likely to remain important institutional strengths. What may change is how these capabilities are used. Banks that combine these traditional advantages with interoperable technology and effective ecosystem governance may be well positioned to act as platform organisers, infrastructure providers, and trusted intermediaries in more distributed financial-service environments.

The geographic reach of open finance may also expand over time. Most existing systems remain nationally organised, but Project Aperta has demonstrated the technical possibility of connecting domestic open finance networks through an interoperability layer (BIS, 2026). Significant legal and regulatory obstacles remain, particularly in relation to data protection, digital identity, liability, security, and cross-border governance. Even so, the direction is important. Greater interoperability could eventually support more efficient cross-border account opening, financial-data exchange, SME finance, and trade-related services without requiring jurisdictions to replace their domestic infrastructures.

The pace of this development will depend heavily on trust. Broader access to financial information will have limited value if customers and institutions cannot rely on the quality, security, and appropriate use of the data being shared. Eroglu et al. (2026) emphasise that the benefits associated with open finance depend on interoperability, standardised data-sharing arrangements, payment-system connectivity, and an appropriate regulatory framework. Governance quality is therefore likely to matter as much as technological capability in determining how open finance develops.

10. Conclusion

The shift from open banking to open finance is changing the way financial data, services, and institutional relationships are organised. Open banking initially concentrated on customer-authorised access to payment-account information and payment initiation. Open finance extends the same principle to a wider range of financial products and data, creating a broader environment in which information can move across institutions and be used in new combinations. The significance of this shift therefore lies not only in technological connectivity, but also in the changing governance of financial information.

International experience shows that this transition is taking different forms. The European Union is developing a broader legal framework for financial-data access, the United Kingdom is following a phased and use-case-driven path, Brazil has already established a large-scale operational system, and Australia has embedded financial-data portability within a wider consumer data-right framework. Emerging cross-border initiatives add another dimension by showing that interoperability between domestic systems may eventually become part of the open finance agenda.

For banks, the consequences are both competitive and strategic. Greater data portability can reduce some of the informational advantages traditionally held by incumbent institutions and may weaken exclusive control over the customer interface. At the same time, it gives banks access to new forms of external data and creates opportunities to operate as platform providers, infrastructure suppliers, data users, ecosystem partners, and Banking-as-a-Service providers.

Open finance is therefore more likely to reshape the role of banks than to diminish their importance.

The same process also creates a more demanding risk environment. Cybersecurity, third-party dependency, data quality, consent management, operational resilience, privacy, liability, and consumer protection all become more difficult to manage when services are delivered across several organisations and technological layers. The central governance problem is to ensure that greater openness does not result in weaker accountability. Financial institutions may distribute operational functions, but responsibility for customer outcomes and risk cannot be allowed to become equally fragmented.

Türkiye has built a comparatively advanced open banking infrastructure through ÖHVPS, GEÇİT, growing institutional participation, and the expansion of account, card, and payment-initiation functionality. These developments provide a strong basis for further evolution. They do not, however, amount to a comprehensive open finance regime. Moving beyond the current payment-centred model would require a wider regulatory framework covering additional financial products, institutions, data categories, liability arrangements, customer-control mechanisms, and supervisory responsibilities.

The main conclusion of this chapter is that the future of open finance will depend less on how much financial data can be shared than on how effectively that sharing is governed. Wider access can support innovation, competition, financial inclusion, and more personalised services, but these benefits depend on secure infrastructure, interoperable standards, clear responsibilities, meaningful customer control, and effective supervision.

Open finance should therefore be understood as a broader reorganisation of financial intermediation rather than as a simple technological extension of open banking. Its long-term success will depend on whether regulators and market participants can develop an institutional framework in which openness, trust, resilience, and accountability reinforce rather than undermine one another.

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CHAPTER 3

**Emotion Comprehension in
Turkish Preschool Children:
Developmental Change and
Component-Level Variation in the Test of
Emotion Comprehension**

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Understanding emotion is a central part of children's developing social and cognitive lives. Yet children's knowledge about emotions extends considerably beyond the ability to recognize and label basic emotional expressions. As children develop, they gradually become able to understand the circumstances that give rise to emotional states, the role of desires and beliefs in shaping emotional responses, the influence of memories and previous experiences, and the distinction between what a person feels and what that person chooses to express. They also become increasingly able to understand that emotional responses may be regulated, that different emotions can coexist, and that social and moral considerations can influence how people feel. Emotion comprehension is therefore best understood as a multidimensional developmental domain in which children progressively coordinate information about observable situations with information about internal psychological states and social relationships.

The preschool period is particularly important in this development because it marks a period of substantial change in children's capacity to move beyond the immediately observable aspects of emotional experience. A young child may initially understand an emotion primarily in relation to a visible facial expression or an obvious event, whereas older preschool children increasingly appreciate that two people can respond differently to the same event because they have different desires, beliefs, memories, or interpretations. They also begin to understand that emotional experience and emotional expression are not necessarily equivalent. Thus, although emotion comprehension is often represented by an overall score, the competencies contributing to that score may place rather different demands on children's developing cognitive and social understanding. Recent research with a very large sample of preschool children similarly demonstrates that different aspects of emotion comprehension can show different levels of mastery even within the relatively narrow developmental period from 3 to 5 years (Richard et al., 2025).

One of the most influential attempts to capture the multidimensional nature of emotion comprehension is the Test of Emotion Comprehension (TEC; Pons, Harris, & de Rosnay, 2004). The TEC was developed to assess nine components of children's understanding of emotion: Recognition, External Cause, Desire, Belief, Reminder, Regulation, Hiding, Mixed Emotions, and Morality. These components encompass progressively more complex relations between emotional states and psychological or social information. Recognition concerns the identification of emotions from expressive cues, whereas External Cause concerns understanding that emotional states arise in relation to external events. Desire and Belief require children to understand that emotions depend not only on what happens but also on what an individual wants or believes. Reminder addresses the influence of memories of previous events on current emotional experience, while Regulation concerns children's understanding of ways in which emotional states can be modified. Hiding requires an understanding that

experienced and expressed emotions may differ, whereas Mixed Emotions requires the coordination of more than one emotional response. Finally, Morality concerns emotional responses associated with socially and morally meaningful situations. The TEC consequently provides an unusually broad framework for examining the development of emotion comprehension as a set of related but distinguishable competencies.

Pons et al. (2004) examined these nine components among children between 3 and 11 years of age and proposed a developmental organization consisting of three broad periods. The first period comprised Recognition, External Cause, and Desire; the second comprised Belief, Reminder, and Regulation; and the third comprised Hiding, Mixed Emotions, and Morality. The authors found improvement with age across all nine components and identified correlational and hierarchical relations among components within and across the three periods. The resulting framework was influential because it suggested that emotion comprehension was not simply a collection of independent skills but could be organized developmentally, with children initially understanding relatively observable aspects of emotion and subsequently becoming able to coordinate increasingly complex psychological and social information.

The developmental organization proposed by Pons et al. (2004), however, need not imply that every population of children will display precisely the same relative pattern of performance across the nine components. Indeed, subsequent research has provided evidence for broad developmental similarities alongside component-specific variation across cultural contexts. Tenenbaum et al. (2004), for example, examined children from a Quechua agro-pastoralist community using an adapted version of the TEC. Older children performed better on the overall measure, and age-related differences were particularly apparent for understanding emotions associated with individual desires and moral misdemeanors. The study was important not only because it extended TEC research beyond industrialized Western populations, but also because it demonstrated that children's performance on emotion comprehension could be examined meaningfully within a very different social and cultural environment.

Evidence from comparisons among European samples has similarly suggested that broad developmental patterns may coexist with component-level differences. Molina et al. (2014), in a comparison of Italian and German preschoolers, found broadly comparable patterns of emotion understanding across the two groups, but identified a notable difference in Hiding: Italian children performed better than German children in understanding that an individual's expressed emotion may differ from the emotion actually experienced. The finding is particularly relevant because Hiding belongs to the third developmental period in the Pons et al. framework and therefore illustrates how the relative accessibility of a particular

component may vary even when the broader developmental trajectory remains comparable.

A similar pattern emerged in research with Chinese preschoolers. Tang et al. (2018) found that the overall developmental pattern in emotion understanding was broadly comparable to that observed in Western European samples, but Chinese children performed relatively better on the distinction between real and apparent emotion and relatively less well on the connection between reminders and current emotion. Children's Theory of Mind and verbal ability were also significant predictors of their emotion-understanding performance. These findings suggest that the development of emotion comprehension may be shaped not only by chronological age but also by the cognitive and linguistic resources that children bring to particular emotional problems. More recently, Möller et al. (2022) compared German and Singaporean preschoolers and found that although the two groups differed in emotion recognition, with Singaporean children outperforming German children on the Recognition component of the TEC, the study did not provide evidence for a corresponding difference in overall emotion comprehension. Their findings provide another useful example of the distinction between overall and component-level performance: cultural variation may become visible in a particular aspect of children's emotional understanding without necessarily translating into a difference in overall TEC performance.

The existing literature suggests a useful distinction between developmental progression and developmental organization. There is considerable evidence that children's overall emotion comprehension increases with age, and the broad direction of this developmental change appears across diverse samples. At the same time, the relative performance of individual components is not always identical across populations. This distinction is compatible with psychometric work supporting the TEC's broader three-domain organization across childhood (Cavioni et al., 2020), while leaving open the possibility that particular components may differ in relative difficulty within narrower age ranges and cultural contexts. Recent work with 1,285 preschool children likewise shows that different emotion-comprehension tasks can display different levels of mastery even between ages 3 and 5 (Richard et al., 2025).

The present study builds on this literature by examining emotion comprehension in Turkish preschool children. Turkish research has previously used the TEC in studies of preschool socioemotional development (Buğan et al., 2022), and a Turkish adaptation and psychometric evaluation has been reported for children aged 60–72 months (Karakuş Özdemir & Ömeroğlu, 2022). However, evidence describing the relative performance of the full set of TEC components across the broader preschool period remains limited. The purpose of the present study was therefore not simply to establish whether Turkish children's overall emotion comprehension increases with age, but to examine more closely

how performance across the nine TEC components is distributed between 3 and 5 years and how this profile relates to the developmental organization reported in previous research.

Two questions guided the study. First, does overall emotion comprehension increase between 3 and 5 years of age in Turkish preschool children? Second, does the relative pattern of performance across the nine TEC components correspond to the developmental organization described by Pons et al. (2004), or does the present Turkish sample show a different component profile? The second question is particularly important because component-level variation can be obscured when emotion comprehension is represented only by a total score. At the same time, the present analyses are intended to characterize relative performance rather than to infer a definitive developmental acquisition sequence.

Method

Participants

The present study involved a secondary analysis of two previously collected datasets from Turkish preschool children, both collected by the first author. The first dataset was collected in 2014 in preschools in Bursa as part of the first author's doctoral research (Pala, 2015), whereas the second dataset was collected in 2016 in preschools in İzmir as part of a subsequent research project at Ege University. Although the two datasets originated from separate studies conducted at different times and in different geographical locations, children were assessed using the same Turkish version of the Test of Emotion Comprehension (TEC), the same administration procedure, and the same general type of preschool setting. These methodological similarities provided the basis for combining the datasets for the present secondary analysis, while their distinct geographical and temporal origins were retained as an important consideration in interpreting the findings. The resulting sample consisted of 354 children between 3 and 5 years of age. Children were aged 34–72 months ($M = 53.85$ months, $SD = 9.23$). The sample included 186 girls (52.5%) and 168 boys (47.5%). By age group, there were 101 3-year-olds (55 girls, 46 boys), 137 4-year-olds (73 girls, 64 boys), and 116 5-year-olds (58 girls, 58 boys).

Measure

Test of Emotion Comprehension

Children's emotion comprehension was assessed using the Test of Emotion Comprehension (TEC; Pons, Harris, & de Rosnay, 2004). The TEC is an individually administered, picture-book-based measure designed to assess multiple aspects of children's understanding of emotion. The test is presented as a series of simple illustrated scenarios. For each scenario, the experimenter tells the child a short story while presenting the corresponding picture. The child is then shown several possible emotional outcomes, represented by schematic facial

expressions, and is asked to indicate the face that best represents how the protagonist feels. Thus, responding places relatively limited demands on children's expressive language, as children can indicate their answer by pointing to one of the illustrated emotion alternatives. The TEC assesses nine components of emotion comprehension: Recognition, External Cause, Desire, Belief, Reminder, Regulation, Hiding, Mixed Emotions, and Morality. The components start with the simple recognition of emotional expressions to assess children's understanding of how emotions are related to external events, individual desires and beliefs, memories of previous experiences, strategies for regulating emotion, discrepancies between felt and expressed emotion, the simultaneous experience of different emotions, and morally relevant actions. The illustrated scenarios therefore provide a common child-friendly format through which conceptually distinct aspects of emotion comprehension can be assessed. In the original administration, the components are presented in a fixed sequence broadly corresponding to their proposed developmental organization.

Each component is scored dichotomously according to the TEC scoring criteria, with one point awarded when the criterion for successfully passing the component is met and zero otherwise. For example, the Recognition and External Cause components each contain five items and require at least four correct responses to receive the component point, whereas other components involve specific scenario-based criteria. The nine component scores can be summed to produce a total TEC score ranging from 0 to 9, with higher scores indicating greater overall emotion comprehension.

Procedure and Data Analysis

In both original studies, children were assessed individually in their preschools. The experimenter presented the illustrated TEC scenarios and accompanying questions and recorded children's responses, following the same general administration procedure in the Bursa and İzmir samples. The İzmir study was conducted as part of the Ege University Scientific Research Projects (BAP) project Erken Çocukluk Döneminde Duygu Düzenleme Becerisinin ve Yönetici Zihinsel İşlerin İncelenmesi (Project No. 953; 16 EDB 011). Both original studies were conducted under the ethical approvals obtained for their respective research projects. The existing data from the two studies were brought together, revisited, and recoded at the level of the individual TEC components, and the combined dataset was reanalysed to address the current research questions concerning age-related differences and the relative pattern of performance across the nine components. Thus, although the data originated from two earlier research projects, the component-level analyses reported here were conducted specifically for the purposes of the present study.

The analyses were conducted at two complementary levels. First, children's total TEC scores were examined to determine whether overall emotion

comprehension differed across the three preschool age groups. Second, performance on each of the nine components was examined separately to characterize the component-level profile within the sample. For these analyses, the proportion of children successfully passing each component was calculated for the total sample and separately for the three age groups. The components were then considered in terms of their relative pass rates, and age-related differences were examined statistically. Because the TEC components differ in their content and task demands, these pass rates were treated as descriptive indicators of relative performance within the instrument rather than as psychometrically equivalent measures of developmental difficulty.

This descriptive component profile should be distinguished from a direct estimate of developmental acquisition order. A component successfully passed by a larger proportion of children at a particular age cannot automatically be interpreted as a competency that is acquired earlier in development. The original TEC developmental organization was derived from evidence across a wider age range and from relations among components, rather than from a simple rank ordering of component pass rates (Pons et al., 2004). The present cross-sectional analyses therefore characterize relative performance across emotion-comprehension components during the preschool period but do not, on their own, establish a definitive developmental sequence.

Results

Overall Emotion Comprehension

Overall emotion comprehension increased substantially across the preschool years. Mean total TEC scores increased from 2.38 among three-year-olds to 3.58 among four-year-olds and 4.37 among five-year-olds. The effect of age was statistically significant, $F(2, 351) = 38.60$, $p < .001$, $\eta^2 = .18$, indicating a substantial age-related difference in overall TEC performance. Post-hoc comparisons indicated that five-year-olds performed significantly better than both three- and four-year-olds, while four-year-olds also performed significantly better than three-year-olds. The overall pattern therefore provides clear evidence of developmental growth in emotion comprehension during the preschool period. This finding is consistent with the original TEC study, in which Pons et al. (2004) reported improvement with age across all nine components, and with subsequent research showing age-related increases in overall emotion understanding among children from different cultural contexts (Tenenbaum et al., 2004; Tang et al., 2018).

Performance Across TEC Components

The picture became considerably more differentiated when the nine components were examined separately. Recognition showed the highest overall

pass rate, followed by Morality, Belief, Hiding, External Cause, Desire, Reminder, Regulation, and Mixed Emotions.

Recognition showed one of the clearest age-related increases, rising from 52% among three-year-olds to 77% among four-year-olds and 85% among five-year-olds, $\chi^2 = 18.45$, $p < .001$. External Cause also increased substantially, from 18% among three-year-olds to 39% among four-year-olds and 54% among five-year-olds, $\chi^2 = 16.62$, $p < .001$.

Reminder increased from 18% among three-year-olds to 37% among four-year-olds and 50% among five-year-olds, $\chi^2 = 13.03$, $p < .001$. Regulation showed a more modest but significant increase, from 6% to 18% and 22%, respectively, $\chi^2 = 5.95$, $p < .01$. Hiding increased from 31% among three-year-olds to 45% among four-year-olds and 46% among five-year-olds, $\chi^2 = 3.13$, $p < .05$.

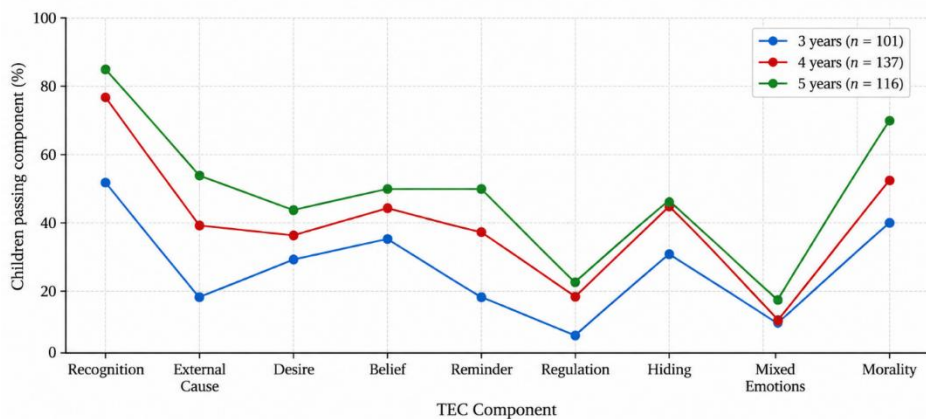
Morality showed a pronounced age-related increase, with successful performance rising from 40% among three-year-olds to 53% among four-year-olds and 70% among five-year-olds, $\chi^2 = 10.58$, $p < .001$.

Desire and Belief also increased descriptively across the age groups, although the corresponding age effects were marginal. Desire increased from 29% to 36% and 44%, while Belief increased from 35% to 44% and 50%. Mixed Emotions remained the least accessible component across the three age groups, with 11%, 10%, and 16% of three-, four-, and five-year-olds, respectively, passing the component; the age-group difference was not significant.

Component-Level Patterns Across Age

Figure 1 presents the percentage of children successfully passing each TEC component separately for the three age groups. Viewed together, the component profiles show that the overall age-related increase in emotion comprehension was not expressed uniformly across the nine components. Recognition and External Cause showed particularly clear increases across the three age groups, as did Reminder and Morality. In contrast, Desire and Belief showed more gradual descriptive increases, while Hiding increased primarily between ages three and four and changed little between ages four and five. Regulation remained relatively difficult despite its significant age-related increase, and Mixed Emotions showed consistently low performance across all three age groups. Thus, the component-level profile suggests that the developmental increase observed in total TEC scores was composed of different patterns of change across the individual competencies, rather than a uniform upward shift across all components.

Figure 1. Percentage of children successfully passing each TEC component by age



As illustrated in Figure 1, the resulting component profile is noteworthy because it does not simply mirror the three developmental periods proposed by Pons et al. (2004). Recognition showed the highest relative performance, consistent with its position within the earliest developmental period. However, the components that followed Recognition did not form the expected pattern of External Cause and Desire, followed by Belief, Reminder, Regulation, and finally Hiding, Mixed Emotions, and Morality. Instead, Morality, Belief, and Hiding showed relatively high pass rates, whereas External Cause, Desire, and Reminder occupied more intermediate positions. These differences should be understood as a profile of relative performance within the present sample, rather than as evidence for an alternative developmental acquisition order.

Discussion

The present study examined emotion comprehension among 354 Turkish preschool children between 3 and 5 years of age using the Test of Emotion Comprehension. At the broadest level, the findings provide a familiar developmental picture: children's overall emotion comprehension increased substantially across the preschool years, with five-year-olds outperforming four-year-olds and four-year-olds outperforming three-year-olds. This pattern is consistent with the original TEC findings of Pons et al. (2004) and with subsequent studies demonstrating age-related improvement in emotion understanding among children growing up in different cultural settings (Tenenbaum et al., 2004; Tang et al., 2018). The more interesting story emerges when this overall developmental progression is considered alongside performance across the nine individual components. The Turkish children did not simply reproduce the relative component pattern that might be expected from a straightforward reading of the Pons et al. (2004) developmental periods. Recognition showed high relative performance, Morality, Belief, and Hiding were also comparatively well understood, and Regulation and Mixed Emotions

remained particularly difficult. This pattern suggests that although emotion comprehension clearly develops during the preschool period, performance across the competencies that constitute this broader domain need not align neatly with a single rank ordering within a restricted age range.

The Central Finding: The Component Profile Was Not a Simple Reproduction of the Canonical TEC Ordering

The most important finding of the present study is therefore not that Turkish children showed a completely different developmental trajectory from that described in previous research. Rather, it is that age-related growth and component-level organization did not map onto one another in a straightforward way. Pons et al. (2004) identified three developmental periods in which Recognition, External Cause, and Desire formed an early period; Belief, Reminder, and Regulation formed a middle period; and Hiding, Mixed Emotions, and Morality formed a later period. The Turkish profile retained some aspects of this organization, most clearly the high accessibility of Recognition and the relative difficulty of Regulation and Mixed Emotions, but it did not reproduce the expected relative ordering of the components.

This distinction is important because the Pons et al. framework was based not simply on the relative percentage of children who passed each component at one age but on developmental patterns across a much wider age range, together with correlational and hierarchical relations among the components. The present study covers a more restricted preschool period and is cross-sectional. Consequently, the fact that Morality or Hiding was successfully passed by a larger proportion of Turkish children than Desire or External Cause does not establish that Morality or Hiding is acquired developmentally before those components. What the findings do demonstrate is that, within the preschool period examined here, these components were relatively accessible to Turkish children.

This interpretation is consistent with evidence that emotion comprehension comprises multiple competencies that do not necessarily show identical developmental rates. Richard et al. (2025), using a sample of 1,285 preschool children, found age-related improvement across ages 3, 4, and 5 while performance differed across the specific emotion-comprehension tasks they examined. Their study did not assess all nine TEC components; its relevance here lies in demonstrating that component- or task-level developmental patterns can differ even within the relatively narrow preschool period. At a broader psychometric level, Cavioni et al. (2020) found support for the TEC's original three-domain structure and measurement invariance across age and gender in a large sample of children aged 3–10. These findings support distinguishing evidence for the TEC's broad developmental architecture from the relative performance of particular components within specific samples.

The cross-cultural TEC literature makes this distinction particularly useful. Tenenbaum et al. (2004) found an overall age-related increase among Quechua children, while Molina et al. (2014) found broadly comparable developmental patterns among Italian and German preschoolers despite a component-level difference in Hiding. Tang et al. (2018) likewise reported an overall developmental trend among Chinese children that was broadly comparable to Western European samples while identifying differences in Hiding and Reminder. Möller et al. (2022) found another version of the same general pattern: German and Singaporean preschoolers showed differences in Recognition despite no corresponding difference in overall emotion comprehension. These studies make it increasingly difficult to interpret the developmental organization of emotion comprehension as either completely universal or completely culture-specific. A more plausible interpretation is that there is a developmental progression in the broad ability to understand emotions, while the relative accessibility of particular competencies may be more variable. The Turkish data fit this broader pattern while also providing a distinctive component profile that can contribute to the growing cross-cultural literature.

Recognition as an Early and Robust Component

Recognition provides the clearest point of continuity between the Turkish findings and the canonical TEC framework. It was the most frequently passed component overall, and performance increased markedly between 3 and 5 years. This finding is consistent with its position in the first developmental period identified by Pons et al. (2004), as well as with more recent evidence showing that recognition of emotional expressions is relatively accessible during the preschool period. Richard et al. (2025), for example, found that context-free facial recognition was more successfully mastered than the understanding and labeling of external causes in their large preschool sample.

The relatively strong performance on Recognition is also relevant to Möller et al.'s (2022) comparison of German and Singaporean preschoolers. Their finding that Singaporean children outperformed German children specifically on Recognition, despite the absence of a corresponding difference in overall TEC performance, demonstrates how a component that appears developmentally robust can nevertheless be sensitive to the characteristics of children's cultural and communicative environments. In the Turkish sample, however, Recognition was not merely another component that showed age-related improvement; it provided the clearest developmental anchor against which the remainder of the profile can be understood. The contrast between Recognition and the less accessible components suggests that children's ability to identify emotional states from relatively observable information is considerably more established by the preschool period than their ability to integrate multiple psychological or situational sources of information. This is broadly compatible with the

developmental logic of the TEC framework, even though the components that follow Recognition in the Turkish profile do not reproduce the original ordering.

Belief and Hiding: Relatively Accessible Competencies Outside the Earliest Period

The relatively high position of Belief and Hiding is more difficult to reconcile with a simple reading of the canonical TEC sequence. Belief was the third most frequently passed component in the Turkish sample, while Hiding was the fourth, placing both above External Cause, Desire, and Reminder. This is particularly interesting because both components involve children's understanding of information that is not directly available from the emotional expression itself. Belief requires children to take into account an individual's representation of a situation, whereas Hiding requires them to understand a distinction between internal emotional experience and external emotional expression.

The Hiding finding is especially noteworthy because it has appeared repeatedly as a component showing variation across cultural samples. Molina et al. (2014) found that Italian preschoolers outperformed German preschoolers on Hiding, while Tang et al. (2018) found relatively stronger performance on the distinction between real and apparent emotion among Chinese children. The convergence of these findings with the relatively high position of Hiding in the Turkish profile suggests that Hiding may be particularly informative for understanding how children's social experiences contribute to the development of emotion comprehension. One possible interpretation concerns children's experience with the distinction between what people feel and what they show. Everyday social interactions may provide opportunities to encounter display rules, concealed disappointment, or situations in which outward expression does not correspond directly to internal emotion. Such experiences could make the distinction between internal and external emotion relatively salient. The present study did not assess display-rule socialization, however, so this possibility should be treated as a hypothesis for future research rather than an explanation established by the current data.

The high position of Belief is also noteworthy because in the Pons et al. (2004) framework, Belief belongs to the second developmental period and therefore represents a transition toward understanding emotions in relation to internal mental representations. Its relatively high pass rate in the Turkish sample suggests that at least some preschool children were able to use information about another person's belief when determining that person's emotional state. Tang et al. (2018) reported significant relations between Theory of Mind and emotion understanding in Chinese preschoolers, providing a useful indication of why belief-related competencies may be particularly important in this domain. Nevertheless, the present data do not allow us to determine whether the relatively high performance on Belief reflects children's broader Theory of Mind abilities,

linguistic competence, familiarity with the scenarios, or characteristics of the particular TEC items. The finding is therefore most appropriately viewed as an important feature of the Turkish component profile rather than as evidence that Belief develops earlier in Turkish children.

The Particularly Puzzling Case of Morality

Morality represents perhaps the most striking feature of the Turkish component profile. Within the original TEC framework, Morality belongs to the third developmental period alongside Hiding and Mixed Emotions, and would therefore be expected to represent a relatively advanced aspect of emotion comprehension. In the present sample, however, Morality was the second most frequently passed component overall, immediately following Recognition. Performance increased from 40% among three-year-olds to 53% among four-year-olds and 70% among five-year-olds, producing a significant age-related difference.

The finding is particularly interesting because it creates a mismatch between the developmental position assigned to Morality in the canonical TEC framework and its relative performance in the present sample. This does not mean that Turkish children possess an earlier-developing form of moral understanding in any general sense. The TEC Morality component assesses children's understanding of emotional responses in morally relevant situations; it should not be equated with moral reasoning or moral development more broadly. The finding instead suggests that the particular relation between morally meaningful situations and emotional responses represented by this component was relatively accessible to many children in the present sample. The cross-cultural literature provides a useful context for considering this possibility. Tenenbaum et al. (2004), in their study of Quechua children, found age-related differences in understanding emotions associated with moral misdemeanors, with older children performing better than younger children. Their study therefore demonstrates that Morality is not uniformly understood across childhood and that its developmental accessibility can vary in different populations. The Turkish pattern is notable because relatively high performance was already apparent within the 3- to 5-year age range examined here.

One possible explanation is that moral-emotional situations may draw on forms of social knowledge that children encounter repeatedly in everyday life. Preschool children are routinely exposed to rules, prohibitions, helping, sharing, wrongdoing, approval, disapproval, and the emotional reactions of adults to these behaviors. In many everyday interactions, the connection between an action and its emotional consequence is made explicit: a child is told that someone is sad because another child has taken something away, that someone feels good after helping another person, or that a person should feel sorry after doing something wrong. Such experiences may provide children with repeated opportunities to

learn relatively direct associations between socially meaningful actions and emotional responses. If this interpretation is correct, children's success on the Morality component would not necessarily indicate that they possess a sophisticated or abstract conception of morality. Instead, it could reflect their familiarity with the emotional consequences of socially regulated behavior. This possibility is consistent with the broader developmental view that children's understanding of emotion is constructed within social environments in which adults provide explanations, labels, expectations, and interpretations of emotional situations. It also fits with the cross-cultural evidence showing that particular TEC components can vary in accessibility without producing a wholesale alteration of the developmental trajectory. At the same time, Morality provides an excellent example of why cultural interpretation must remain cautious. The present study did not measure children's moral reasoning, their parents' or teachers' socialization practices, their exposure to moral language, or their familiarity with the specific situations depicted in the TEC. Since we did not directly compare Turkish children with children from another cultural group using identical procedures, we cannot determine whether the relatively high performance on Morality reflects culturally specific experience, task characteristics, linguistic accessibility, or some combination of these factors. What the data do show is that Morality occupied a surprisingly high position within the Turkish component profile in this dataset, making it an important target for future comparative research.

Mixed Emotions and Regulation: The Other Side of the Pattern

The relatively high performance on Morality becomes even more informative when considered alongside the very low performance on Mixed Emotions and Regulation. These components provide the other side of the Turkish profile: whereas Morality was unexpectedly accessible, Mixed Emotions and Regulation remained difficult across the preschool period. Mixed Emotions was the least accessible component overall. Only 11% of three-year-olds, 10% of four-year-olds, and 16% of five-year-olds passed the component, and the age-group difference was not significant. This pattern contrasts sharply with the relatively high performance on Morality and Hiding, despite all three components being located within the third developmental period in the Pons et al. (2004) framework. The finding therefore provides perhaps the clearest illustration that components grouped within the same broad developmental period do not necessarily show equivalent levels of accessibility within the preschool years. Understanding Mixed Emotions requires children to coordinate two emotional states that may appear to conflict with one another. A situation may be both desirable and undesirable, producing happiness and sadness, or may involve different aspects that generate different emotional responses. Rather than identifying the single emotion that best corresponds to the situation, children must recognize that more than one emotional state can be simultaneously appropriate. This requirement

may place substantial demands on children's ability to coordinate multiple perspectives or representations of the same event. The relative difficulty of Mixed Emotions in the Turkish sample is therefore broadly compatible with its later position in the Pons et al. (2004) developmental framework.

Regulation showed a somewhat different pattern. Performance increased significantly from 6% among three-year-olds to 18% among four-year-olds and 22% among five-year-olds, indicating developmental change, but successful performance remained relatively uncommon. This pattern is again broadly consistent with the position of Regulation in the second developmental period of the TEC, where children are expected to move beyond recognizing emotional states toward understanding how emotions can be modified. The contrast between Regulation and Morality is particularly revealing. Both require children to move beyond the immediate recognition of an emotional state, but they appear to draw on rather different forms of knowledge. Regulation requires children to understand how emotional states can be changed through strategies or actions, whereas the Morality component may rely more heavily on relatively familiar associations between socially meaningful actions and emotional consequences. It is therefore possible that children can understand that a person ought to feel a particular emotion following a socially meaningful event before they can reliably explain how an emotional state can itself be modified.

This interpretation should remain tentative, but the contrast is theoretically useful. It illustrates why a overall TEC score can conceal meaningful developmental differences among the competencies that contribute to emotion comprehension. The Turkish children clearly became better at emotion comprehension as they grew older, but this improvement did not mean that all components advanced in parallel. Some competencies became relatively accessible early in the preschool period, whereas others remained difficult even at age five.

Culture, Experience, or Measurement?

The distinctive Turkish component profile naturally raises the question of why particular components were relatively accessible while others remained difficult. Several explanations are possible, and the cross-cultural TEC literature provides useful evidence for considering them, although none can be established directly from the present study. The first possibility concerns children's social and cultural experiences. Children's emotional knowledge develops within relationships and communicative environments, and different social contexts may provide different opportunities to encounter particular emotional situations. The repeated emphasis on Hiding in previous cross-cultural comparisons is informative in this respect. Molina et al. (2014) found higher Hiding performance among Italian than German preschoolers, while Tang et al. (2018) similarly reported relatively stronger understanding of real versus apparent emotion among Chinese children.

The recurrence of Hiding as a component on which cultural groups differ suggests that the distinction between internal emotional experience and outward expression may be particularly sensitive to children's social and communicative experiences.

The Turkish findings fit this pattern in an interesting way because Hiding was also among the more accessible components. It would be tempting to interpret this convergence as evidence of a shared cultural mechanism, but such a conclusion would go beyond the available evidence. The Italian, Chinese, and Turkish samples differed in language, social environment, educational context, and methodology, and the present study did not directly measure the socialization processes that might account for children's performance. Nevertheless, the repeated observation that Hiding can occupy a relatively accessible position in some cultural groups suggests that the component deserves further investigation as a potentially experience-sensitive aspect of emotion comprehension. Language represents a second possibility. Several TEC components require children to interpret relationships among events, psychological states, and emotional consequences, and these relations may be expressed differently across languages. Tang et al. (2018) found that verbal ability was significantly associated with emotion understanding, alongside Theory of Mind, suggesting that linguistic resources may contribute to children's performance on the TEC. In the present study, the use of a Turkish version of the TEC provides a necessary basis for studying Turkish children, but it also means that the linguistic characteristics of the translated items may influence the accessibility of particular components.

This possibility is particularly relevant for components such as Belief, Reminder, and Mixed Emotions, where children must coordinate information that is not directly observable. The difficulty of Mixed Emotions, for example, might partly reflect the conceptual demands of coordinating two emotional states, but it could also be influenced by how the relevant scenario is linguistically formulated and interpreted. Without item-level linguistic analyses or direct comparisons across language versions, it is not possible to separate these possibilities.

A third possibility concerns familiarity with the social scenarios represented in the TEC. The extent to which children encounter particular situations in their everyday lives may influence how readily they can interpret them in a structured assessment. This possibility is especially relevant to Morality, where the underlying scenarios may involve rules, wrongdoing, helping, or socially appropriate behavior that are highly familiar to preschool children. It may also help explain why a component that appears relatively late in the canonical developmental organization can nevertheless be relatively accessible within a particular population.

Finally, differences in the intrinsic demands of the TEC components themselves must be taken seriously. The nine components are not simply nine

versions of the same task. They differ in the amount and type of information that children must coordinate, ranging from recognition of expressive cues to reasoning about beliefs, memories, regulation, conflicting emotions, and moral consequences. Richard et al. (2025) provide particularly useful contemporary evidence for this point, showing that even within a narrower set of emotion-comprehension tasks, some forms of understanding were consistently more accessible than others among preschool children.

The findings of Möller et al. (2022) are similarly informative. Their German–Singaporean comparison produced a difference in Recognition without a corresponding difference in overall emotion comprehension, demonstrating that component-level variation can emerge even when the broader competence appears comparable. Likewise, Molina et al. (2014) identified a specific difference in Hiding rather than a wholesale divergence in the developmental pattern. These findings caution against interpreting any single component difference as evidence of a culturally distinct developmental trajectory. The most defensible interpretation of the Turkish findings is therefore not that culture, language, experience, or measurement independently explains the observed profile. Rather, the data suggest that these factors may interact with the different cognitive and social demands represented by the TEC components. The present study cannot determine the contribution of each factor, but it demonstrates why such questions are important: the same overall developmental increase in emotion comprehension can coexist with striking differences in the relative accessibility of its component competencies.

Strengths and Limitations

The present study has data from a relatively large sample of Turkish preschool children and examines all nine components of the TEC rather than relying exclusively on an overall score. Turkish studies have previously employed the TEC and have contributed adaptation and psychometric evidence (Buğan et al., 2022; Karakuş Özdemir & Ömeroğlu, 2022), but the present study adds a component-level profile spanning ages 3–5. This allows the study to ask whether relative performance across the nine components within the preschool period corresponds to the broader developmental organization originally proposed by Pons et al. (2004). One consideration in interpreting the present findings is that the sample combines two datasets collected in Bursa in 2014 and İzmir in 2016. The same researcher collected both datasets using the same Turkish TEC version, administration procedure, and general type of preschool setting, providing methodological consistency across the two samples. Nevertheless, because the study was not designed to examine regional or temporal differences, potential variation associated with location or time cannot be disentangled from the observed component profile. The findings should therefore be understood as describing the pattern observed across these two Turkish preschool samples

rather than as representing a population-level profile of Turkish preschool children.

A second limitation concerns the interpretation and comparability of component-level performance. Because the data are cross-sectional and the component profile is based on pass rates, the study cannot establish the precise age at which each competency emerges. In addition, the nine TEC components differ in content and task demands and should not be treated as psychometrically interchangeable units of difficulty. A high pass rate therefore cannot automatically be described as evidence that one competency is developmentally earlier than another. The present findings are best interpreted as evidence concerning relative performance within the TEC, while longitudinal and item-level psychometric research would be required to examine developmental acquisition more directly.

A third limitation is that the study does not directly assess the mechanisms that might explain component-level variation. Children's language abilities, Theory of Mind, emotion-related socialization, moral reasoning, and familiarity with the situations represented in the TEC were not measured. Consequently, the study cannot determine whether the Turkish component profile reflects differences in children's cognitive capacities, social experiences, linguistic interpretation, or task characteristics.

These limitations also point directly toward future research. Cross-cultural studies that administer comparable TEC versions while simultaneously assessing language, Theory of Mind, socialization practices, and children's familiarity with the relevant emotional situations could provide a much stronger basis for determining why particular components vary across populations. Longitudinal research would additionally make it possible to distinguish differences in relative performance at a particular age from genuine differences in developmental timing.

Conclusion

The present study provides evidence of substantial age-related differences in emotion comprehension across the preschool years in two samples of Turkish children, while also demonstrating that these differences cannot be fully understood through an overall TEC score alone. Total emotion-comprehension performance increased between 3 and 5 years, reproducing the broad age-related pattern reported in previous TEC research. At the same time, relative performance across the nine components did not simply reproduce the developmental organization proposed by Pons et al. (2004).

The most striking feature of the Turkish profile reported in this chapter was the relatively high accessibility of Morality, Belief, and Hiding alongside the comparatively low performance observed for Regulation and Mixed Emotions.

This configuration does not justify the conclusion that Turkish children follow a wholly different developmental sequence. Rather, when considered alongside the findings of Molina et al. (2014), Tang et al. (2018), Tenenbaum et al. (2004), and Möller et al. (2022), it contributes to a broader pattern in which the general development of emotion comprehension appears relatively robust while the relative accessibility of particular competencies varies across samples.

The findings therefore support a differentiated view of the developmental organization of emotion comprehension. Existing psychometric evidence supports the TEC's broader developmental architecture (Cavioni et al., 2020), but this does not require the relative performance of all nine components to be identical across populations or within every restricted age range. In the present Turkish samples, component-level variation may reflect an interaction among children's developing cognitive capacities, linguistic resources, social experiences, and the particular demands of the situations through which emotion is represented and assessed. The present data cannot determine the contribution of these influences, but they demonstrate that examining the component profile can reveal information that is not captured by the total score alone. In this respect, the contribution of the present study lies not in proposing a new Turkish developmental hierarchy to replace the Pons et al. (2004) model. Its contribution is more specific: age-related growth in overall emotion comprehension coexisted with a component profile that only partially aligned with a straightforward rank ordering of the canonical developmental periods. Examining overall development and component-level variation together may therefore provide a more informative account of how children come to understand emotion across different developmental and cultural contexts.

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CHAPTER 4

Income Inequality and Struggling: A Comparative Analysis of Socio-Demographic Differences

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1. INTRODUCTION

Many people have little hope for a better future in the societies in which they live. Devoid of a sense of hope, purpose, or dignity, these individuals live on the margins of society while witnessing the increasing prosperity of others. Although many people around the world have escaped extreme poverty, far more still lack the opportunities and resources needed to exercise control over their lives. Gender, ethnicity, and parental wealth remain among the important factors shaping individuals' positions in society (UNDP, 2019). These statements, taken from the *Human Development Report* of the United Nations Development Programme (UNDP), emphasize that despite the significant progress achieved throughout human history, such progress has not benefited all segments of society equally and that inequalities continue to persist.

The unequal distribution of economic resources within a society can undermine social balance and deepen economic and social disparities between individuals. Over time, such inequalities may contribute to growing social discontent, which can develop into mass social movements at the regional or global level. In this context, the Occupy Wall Street movement, which began in New York on September 17, 2011, soon became one of the most prominent social movements to attract worldwide attention. One of the movement's central slogans, "We are the 99 percent," brought criticism of the concentration of economic and political power in the hands of a very small segment of society to the forefront. The slogan became a powerful expression of the shared identity of broad segments of society in opposition to the concentration of economic resources and power among the highest-income groups (Levitin, 2021).

According to Keeley (2015) data, income inequality has increased substantially in many developed countries in recent decades. In the 1980s, the average disposable income of the top 10% of the population in OECD countries was approximately seven times that of the bottom 10%; by the 2010s, this ratio had risen to 9.5. Although discussions of inequality have often focused on the growing income and wealth shares of the top 1%, the economic circumstances of lower-income groups have also received increasing attention. Income inequality should therefore be considered not only in terms of the concentration of income at the top of the distribution, but also in terms of the overall distance between different income groups within society (Keeley, 2015).

The effects of income inequality on individual well-being cannot be explained solely by the absolute amount of income an individual possesses. Individuals may evaluate their own economic circumstances by comparing them with the economic positions of others in the society in which they live. Consequently, two individuals with the same income level may have different life evaluations and

levels of subjective well-being depending on the degree of income inequality in their respective social environments.

Oishi et al. (2011) examined the relationship between national income inequality and individual happiness using data from the U.S. *General Social Survey* for the period 1972–2008. Their main finding was that Americans were, on average, happier in years characterized by lower levels of national income inequality than in years with higher inequality. The authors explained this inverse relationship in terms of perceived fairness and general trust, showing that periods of greater income inequality were associated with lower levels of trust in other people and perceptions of society as less fair. They also found that the negative relationship between income inequality and happiness was evident among lower-income individuals, whereas a similar relationship did not emerge among higher-income individuals. One notable finding was that the decline in happiness among lower-income individuals was explained less by reductions in household income than by perceptions of unfairness and a lack of trust. These findings suggest that the effects of income inequality on individual well-being should be considered not only in terms of material conditions but also in relation to social relationships and perceptions of fairness.

Income inequality is not merely an objective condition reflecting the distribution of economic resources among individuals; it is also related to how individuals perceive their social environment and how their subjective well-being is shaped. In this context, the extent to which individuals perceive income differences within their society as large may be an important factor in understanding the individual consequences of inequality. John, Bless, and Wänke (2025), for example, examine the effects of income inequality on subjective well-being from this perceptual perspective. Rather than focusing solely on objective levels of income inequality or on the extent to which individuals perceive inequality as unfair, the study examines how large individuals perceive the magnitude of inequality to be. Findings from three studies indicate that greater perceived income inequality is associated with lower subjective well-being and that this relationship may emerge even independently of whether inequality is perceived as fair or unfair. These findings suggest that objective economic indicators alone may not be sufficient to fully understand the psychological and social consequences of income inequality. Individuals living within the same income distribution may perceive the magnitude of social inequality differently, and these differences in perception may influence their subjective well-being. Accordingly, the effects of inequality on individuals should be examined not only through the question, “How much inequality exists in society?” but also through the question, “How large do individuals perceive this inequality to be?”

2. INCOME INEQUALITY AND SUBJECTIVE WELL-BEING

Easterlin (1974) examined the relationship between income and happiness using data on subjective happiness collected in 19 countries during the post–World War II period. The study primarily sought to answer whether members of richer societies were happier than those of poorer societies and whether economic growth improved people’s lives. The findings showed a clear positive relationship between income and happiness across income groups within countries. In other words, individuals with higher socioeconomic status tended to report higher levels of happiness within the same society. However, when countries were compared with one another, richer countries were not necessarily found to have proportionately higher levels of happiness. Easterlin explained this pattern by arguing that individuals evaluate their happiness by comparing their current economic circumstances with reference standards derived from past experiences and their surrounding social environment. Thus, in addition to absolute income, individuals’ relative economic positions may play an important role in shaping subjective well-being.

Alesina et al. (2004) similarly examined the relationship between social inequality and happiness. Based on approximately 123,000 survey responses, the study found that individuals were less likely to report being happy in contexts characterized by higher levels of inequality.

Fahey and Smyth (2004) examined the relationship between subjective well-being and economic conditions using life satisfaction data from 33 European societies. Their findings showed that people living in wealthier regions generally reported higher and more stable levels of life satisfaction, whereas those living in poorer regions reported lower and more variable levels of life satisfaction. The study also indicated that the relationship between income inequality and life satisfaction may vary according to a country’s level of economic development. In particular, the association between inequality and life satisfaction appeared to be more pronounced in relatively poorer countries.

Perceived fairness and social trust also play an important role in the relationship between income inequality and subjective well-being. For example, Oishi et al. (2011) found that Americans were, on average, happier during years characterized by lower levels of national income inequality than during years with higher inequality. This pattern was associated with lower levels of trust and perceptions of other people as less fair during periods of greater national income inequality.

Both theoretical and empirical studies have examined the relationship between income inequality and subjective well-being from different perspectives. Verme (2011) used a large cross-national sample to examine the consistency of the relationship between income inequality and life satisfaction. The findings point to a generally negative association between income inequality and life satisfaction, while also indicating that the strength and direction of this relationship may vary across different social and economic contexts. Accordingly, assessments of the relationship between income inequality and subjective well-being should take into account not only individuals' economic positions but also the broader social contexts in which they live.

Ferrer-i-Carbonell and Ramos (2014) examined the relationship between income inequality and happiness. Their findings suggest that individuals tend to report higher levels of happiness in societies characterized not only by economic growth but also by lower levels of inequality and poverty, higher levels of social capital, and better employment opportunities. The study also emphasizes the importance of distinguishing between objective and perceived income inequality. How individuals perceive inequality may be an important factor in understanding the relationship between objective inequality and subjective well-being. At the same time, the existing literature suggests that the negative association between inequality and happiness is more consistently observed in Western societies, whereas findings from non-Western societies are more mixed and less consistent.

Although living standards are closely related to income and consumption, higher-income individuals are not necessarily happier than lower-income individuals. This pattern can be observed both in comparisons among income groups within countries and across countries with different levels of GDP per capita. Accordingly, focusing solely on absolute income may not be sufficient to explain individual happiness. Tavor, Gonen, Weber, and Spiegel (2018) examined income inequality as one of the factors associated with happiness and measured inequality using the Gini index. Their findings indicate that at very high levels of inequality, income inequality is negatively associated with happiness, whereas the effects of changes in the middle range of the Gini index are less clear. These results were reported to hold regardless of the level of GDP per capita.

The fact that income inequality is measured as an objective indicator at the societal level does not mean that individuals experience this inequality in the same way. An individual's economic situation should be considered in relation to their own income, their position within the income distribution, comparisons with their reference group, and the opportunity structure of the society in which they live.

In this context, D'Ambrosio and Frick (2007) empirically demonstrated a strong relationship between individuals' income satisfaction and their experience of relative deprivation. According to their findings, subjective well-being and happiness are related not only to individuals' absolute income but also to the income gap between themselves and those who are better off. Using data from the German Socio-Economic Panel (SOEP), the study highlights several key mechanisms underlying subjective well-being:

- **Limited Role of Absolute Income:** The relationship between income satisfaction and absolute income is relatively modest and becomes weaker when other factors, such as education and unemployment, are controlled for.
- **Importance of Relative Deprivation:** When evaluating their income satisfaction, individuals consider not only their position in the income distribution but also the size of the income gap between themselves and those who are better off. This reflects the role of relative deprivation in shaping economic satisfaction.
- **Reference Group Effects:** The findings indicate that economic satisfaction is related not simply to absolute wealth, but also to individuals' relative well-being compared with the reference groups they observe, such as neighbors or colleagues.

Overall, macro-level measures of inequality acquire greater meaning when considered alongside individuals' perceived position within the social hierarchy and the sense of deprivation they experience in comparison with those who are better off.

More recent studies have also distinguished between objective and subjective relative deprivation and suggest that subjective relative deprivation may have stronger associations with indicators of well-being. In a study conducted in Taiwan, Kuo, Chen, and Liao (2024) examined the objective and subjective dimensions of relative deprivation separately. The study used data from 1,592 adults; objective relative deprivation was measured using the Yitzhaki Index, while subjective relative deprivation was assessed using the *Personal Relative Deprivation Scale-Revised*. The findings showed that both objective and subjective relative deprivation were negatively associated with multidimensional indicators of well-being, including health, happiness, life satisfaction, social relationships, and financial stability. However, subjective relative deprivation demonstrated stronger associations with these outcomes than objective relative deprivation. In addition, individuals experiencing both high objective and high subjective relative deprivation exhibited more adverse well-being outcomes.

These findings suggest that income inequality should be examined not only in terms of the distribution of material resources but also in terms of individuals' relative positions within society and how they perceive those positions.

3. RESULTS

In this section, the relationship between the Gini coefficient, which measures income inequality, and the level of struggling is examined for selected countries. The analysis considers levels of struggling across socio-demographic characteristics such as age, employment status, difficulty in making ends meet, place of residence, and gender, and compares these indicators with the Gini coefficients of the respective countries. Countries are ranked from lower to higher Gini coefficients to assess differences in struggling across socio-demographic groups.

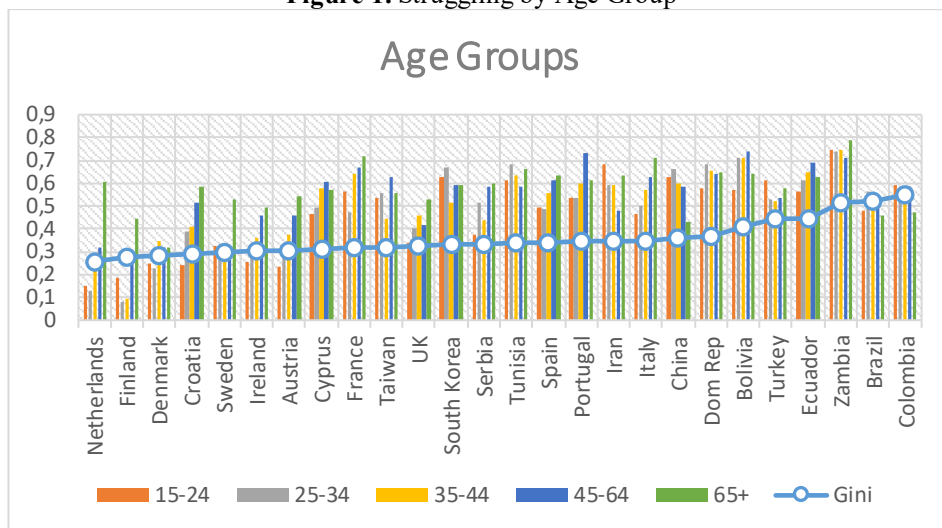
Table 1. Definitions of Variables and Data Sources

Variable	Measurement and Subcategories	Data Source
Struggling	Proportion of individuals classified as Struggling based on their life evaluations	Gallup World Poll, Global Wellbeing Initiative dataset (2020)
Gini Coefficient	Gini index measuring inequality in the distribution of income	World Bank, World Development Indicators
Age Groups	15–24, 25–34, 35–44, 45–64, and 65 years and over	GWP
Gender	Female and male	GWP
Employment Status	Full-time employees working for an employer, unemployed individuals, self-employed individuals, and those not in the labor force	GWP
Difficulty in Making Ends Meet	Living comfortably, just getting by on current income, finding it difficult to make ends meet, and finding it very difficult to make ends meet	GWP
Place of Residence	Living in a large city, in the suburbs of a large city, or in a small town or village	GWP

3.1. Comparison of Struggling Across Age Groups and the Gini Coefficient

This section examines the relationship between the levels of struggling among individuals in different age groups and the Gini coefficients of the countries. Countries are ranked from lower to higher Gini coefficients.

Figure 1. Struggling by Age Group



As shown in the figure, countries with relatively lower levels of income inequality, such as the Netherlands and Finland, generally exhibit lower levels of struggling across different age groups. At the same time, some differences can be observed across age groups within these countries. As the Gini coefficient increases, levels of struggling also show a general upward trend, with this pattern appearing more pronounced among younger populations. This pattern may be associated with factors such as youth unemployment, difficulties in entering the labor market, and the coverage of social protection mechanisms. However, since these factors were not directly examined in the present study, they should be considered as possible contributing factors rather than causal explanations.

Individuals aged 15–24 may be in a more economically vulnerable position because they are often entering the labor market, have relatively lower incomes, and face higher unemployment risks. By contrast, individuals aged 25–34 and 35–44 may attain more stable positions in working life, which may contribute to differences in their levels of struggling. Among individuals aged 65 and over, higher levels of struggling are observed in some countries with relatively high income inequality. Retirement income and the scope of social protection mechanisms may be among the possible explanations for these differences.

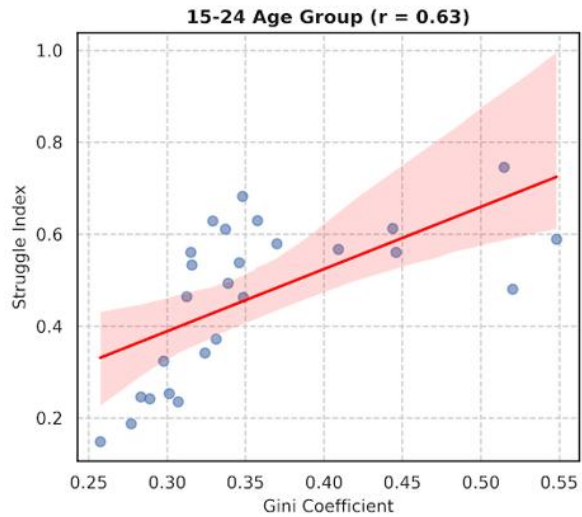
These findings highlight the importance of developing social protection and employment policies that take into account the specific needs of different age groups. Policies that facilitate young people’s transition into the labor market and mechanisms that strengthen the income security of older individuals may be particularly important. However, the effects of such policies were not directly tested in this study.

Overall, the findings indicate a positive association between income inequality and levels of struggling. Countries with higher levels of income inequality generally exhibit higher levels of struggling, while differences across age groups may also become more pronounced. In contrast, countries with lower

levels of income inequality tend to display more similar levels of struggling across age groups.

Following this general assessment, correlation and regression analyses are presented to assess the strength of the relationship between the Gini coefficient and levels of struggling across different age groups.

Figure 2. Relationship Between the Gini Coefficient and Struggling Among Individuals Aged 15–24

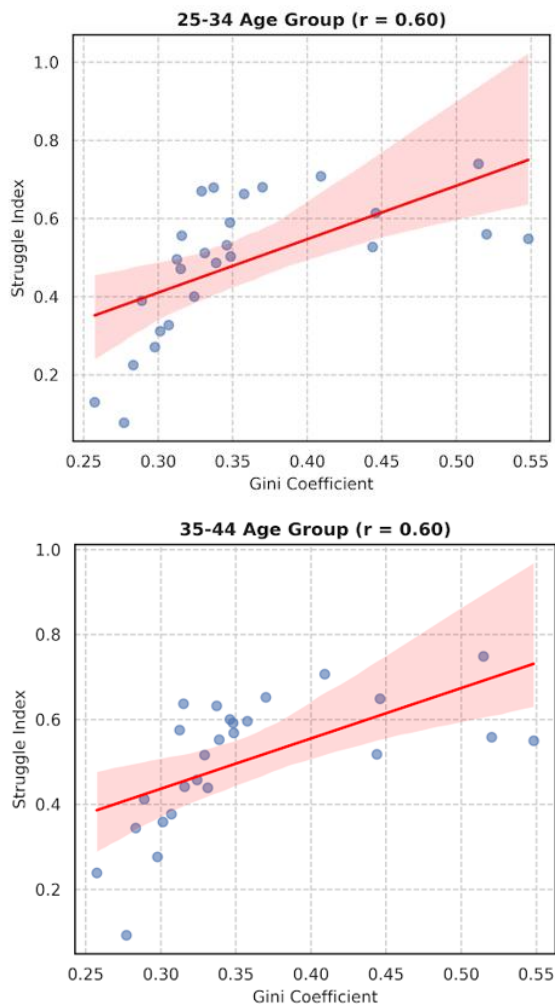


3.1.1. A More Pronounced Association Among Young People

Among individuals aged 15–24, the positive association between the Gini coefficient and struggling is stronger than that observed for the other age groups, with a correlation coefficient of $r = 0.63$. This result indicates that the tendency for levels of struggling among young people to vary together with differences in income inequality across countries is more pronounced in this age group.

This association may be related to factors such as the transition from education to employment, difficulties encountered when entering the labor market, employment opportunities, and housing costs. However, the correlation coefficient alone does not establish the effects of these factors, nor does it demonstrate that income inequality directly causes higher levels of struggling among young people.

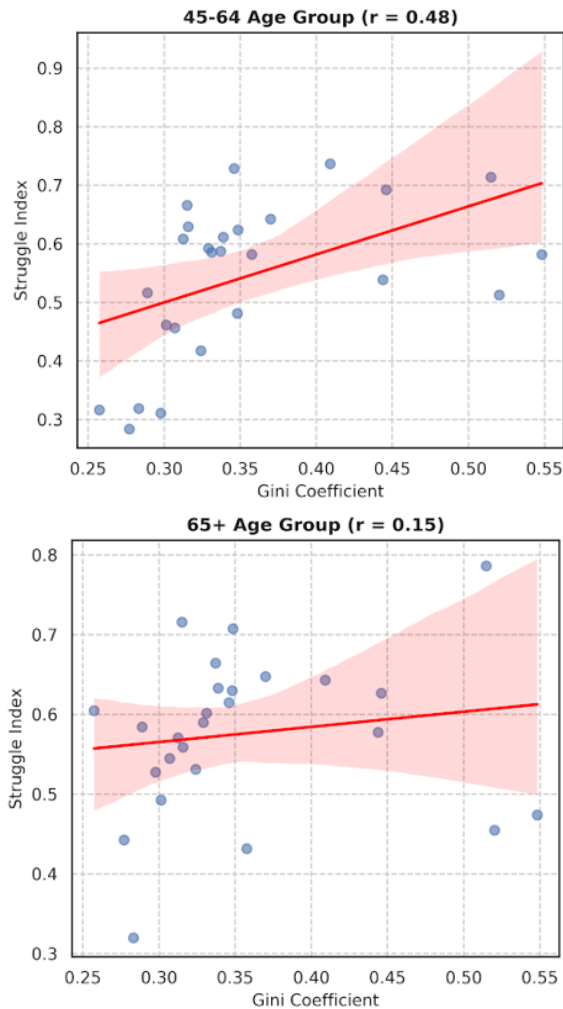
Figure 3. Comparison of the Gini Coefficient and Struggling During the Active Working-Age Period



3.1.2. A Persistent Association During the Working-Age Period

For the 25–34 and 35–44 age groups, the correlation coefficient between the Gini coefficient and the level of struggling is $r = 0.60$. This value indicates a clear positive association between income inequality and struggling in these age groups. During this stage of the life course, when financial responsibilities such as forming a household, purchasing housing, having children, and developing a career may become more prominent, the co-variation between cross-country differences in income inequality and levels of struggling is noteworthy. The positive slopes of the fitted lines are also consistent with this pattern.

Figure 4. Comparison of the Gini Coefficient Among Individuals Aged 45–64 and 65 and Over



3.1.3. A Relatively Weaker Association Among Individuals Aged 45–64

Among individuals aged 45–64, the correlation coefficient between the Gini coefficient and the level of struggling declines to $r = 0.48$. This result indicates a weaker association between income inequality and struggling compared with the younger age groups. One possible explanation is that individuals in this age group have spent a longer period in the labor market and may therefore have accumulated greater economic resources, such as income, assets, or home equity. However, factors such as occupational tenure, wealth accumulation, homeownership, and financial savings were not directly measured in the present analysis; their role in the weaker association should therefore be regarded only as a possible explanation.

3.1.4. A Weak Association Among Individuals Aged 65 and Over

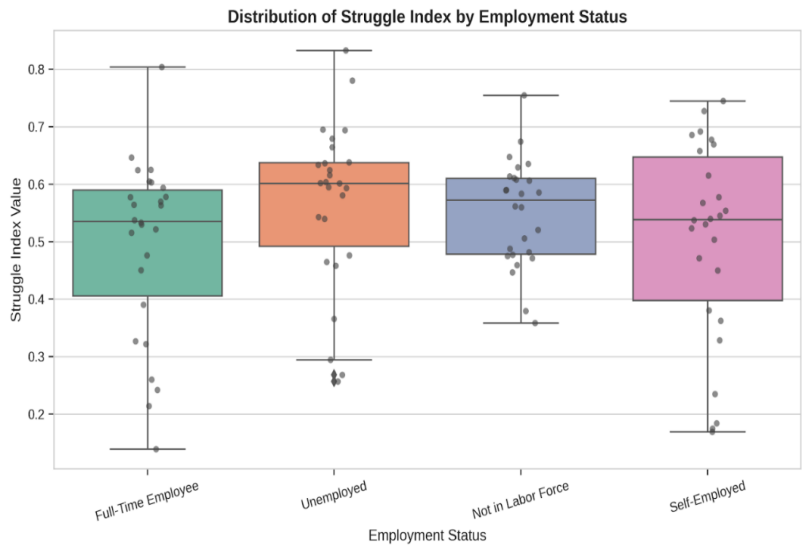
Among individuals aged 65 and over, the correlation coefficient between the Gini coefficient and the level of struggling declines to $r = 0.15$. This value indicates a very weak association between income inequality and struggling in the oldest age group compared with the other age groups. The near-horizontal regression line is also consistent with the weak linear association observed in this group.

Possible explanations for this pattern include retirement income, access to public healthcare, and social protection programs for older adults. However, establishing whether such institutional mechanisms protect individuals aged 65 and over from the effects of income inequality would require the inclusion of variables such as social protection coverage, retirement income, and other socioeconomic indicators in the analysis.

3.2. Comparison of Struggling and the Gini Coefficient by Employment Status

Individuals were classified into four employment-status groups: full-time employees working for an employer, unemployed individuals, self-employed individuals, and those not in the labor force. The levels of struggling in these groups are compared with the Gini coefficients of the respective countries to examine how differences by employment status are associated with income inequality.

Figure 5. Distribution of Struggling by Employment Status



The box plot compares the medians and distributions of struggling across different employment-status groups. The unemployed have the highest median level of struggling, followed by those not in the labor force. Full-time employees and self-employed individuals have lower median values. This pattern suggests that unemployed individuals and those outside the labor force generally report

higher levels of struggling across the countries examined. However, these differences cannot be attributed solely to employment status; income levels, social protection, and country-specific economic conditions may also play a role.

There are also differences in the distribution of struggling across employment groups. Among full-time employees, values range from approximately 0.14 to 0.80, while among self-employed individuals they range from approximately 0.17 to 0.74. The relatively wide interquartile range among the self-employed indicates greater variation across countries in this group. A wide distribution is also observed among the unemployed, with values exceeding 0.80 in some countries. By contrast, the interquartile range is relatively narrower among those not in the labor force.

Figure 6. Struggling and the Gini Coefficient by Employment Status

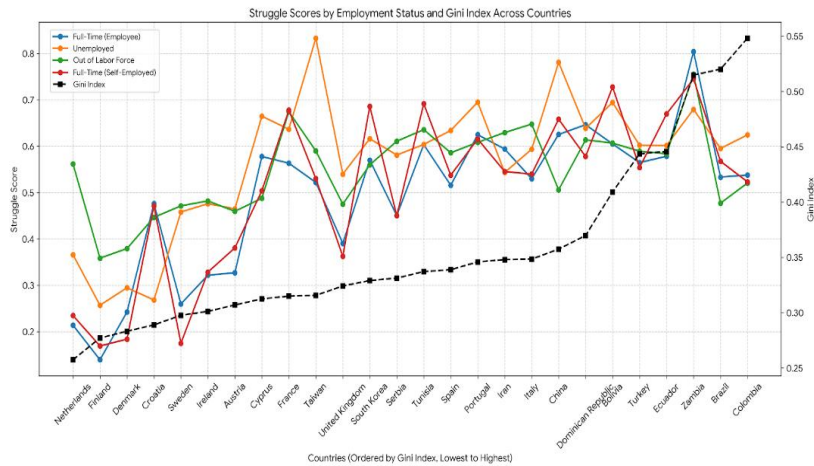


Figure 6 compares levels of struggling among full-time employees, unemployed individuals, those not in the labor force, and self-employed individuals with the Gini coefficients of the respective countries. Overall, as the Gini coefficient increases, levels of struggling also tend to increase across a substantial proportion of the employment groups. However, this pattern is not consistent across all countries, and considerable variation can be observed between employment groups.

Unemployed individuals are among the groups with relatively high levels of struggling in many countries. Particularly high values are observed in countries such as France, Taiwan, the United Kingdom, Tunisia, and China. However, in some countries, other employment groups exhibit higher values than the unemployed, suggesting that differences in struggling cannot be explained by unemployment alone.

Among those not in the labor force, levels of struggling also tend to increase with the Gini coefficient. However, because the composition of this group may differ across countries, these differences should be considered alongside broader economic and social conditions rather than employment status alone.

A similar overall pattern is observed among full-time employees. Countries with relatively low Gini coefficients, such as the Netherlands, Finland, and Denmark, generally show lower levels of struggling among full-time employees, whereas countries with higher levels of inequality, such as Zambia, exhibit higher values. In Zambia, the level of struggling among full-time employees is higher than that among the unemployed. This finding suggests that employment alone does not necessarily guarantee greater economic well-being. The level of income earned through employment and working conditions may also be relevant.

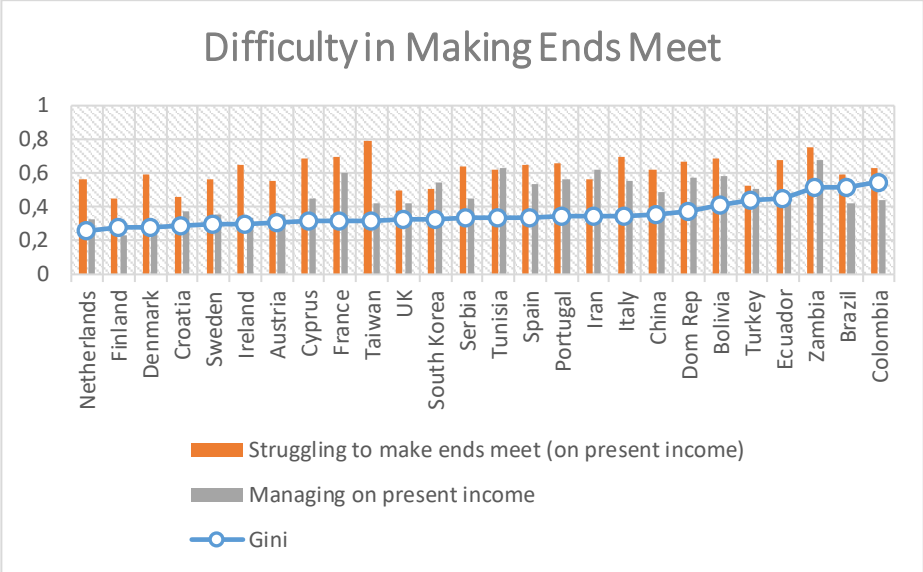
The self-employed also show substantial cross-country variation. In some countries with relatively high Gini coefficients, self-employed individuals exhibit high levels of struggling, whereas in others their values are lower than those of the unemployed. This suggests that the implications of self-employment for living conditions may vary depending on the economic and social context of each country.

Overall, the Gini coefficient shows a positive association with struggling, although the strength of this association varies across employment-status groups and countries. Unemployed individuals and those not in the labor force generally stand out with higher levels of struggling, while some countries with high income inequality also exhibit high values among employed groups. This pattern suggests that, in addition to employment status, income distribution and country-specific economic conditions are associated with individuals' living conditions.

3.3. Comparison of Struggling and the Gini Coefficient by Difficulty in Making Ends Meet

This section examines differences in individuals' levels of struggling according to their ability to make ends meet on their current income, as well as the relationship between these indicators and the Gini coefficient. Individuals are classified into two broad groups: those who have difficulty making ends meet and those who are able to make ends meet on their current income. The levels of struggling among these groups are compared with the Gini coefficients of the respective countries. In addition, the four categories of difficulty in making ends meet are examined separately to assess their relationships with income inequality.

Figure 7. Distribution of Struggling by Difficulty in Making Ends Meet



When levels of struggling are compared according to individuals' ability to make ends meet, those who have difficulty making ends meet generally exhibit higher levels of struggling than those who are able to make ends meet across almost all countries. This difference indicates a clear association between difficulty in making ends meet and struggling.

As the Gini coefficient increases, levels of struggling tend to increase particularly among individuals who have difficulty making ends meet. However, the distribution across countries is not perfectly linear, and countries with similar levels of income inequality may exhibit different levels of struggling. This suggests that difficulty in making ends meet may be associated not only with income inequality but also with broader economic and social conditions.

Although individuals who are able to make ends meet generally report lower levels of struggling, their values also tend to be higher in some countries with relatively high Gini coefficients. Thus, income inequality may be associated not only with the living conditions of those experiencing financial difficulties but also with those of other economic groups.

Figure 8. Relationship Between Difficulty in Making Ends Meet and the Gini Coefficient

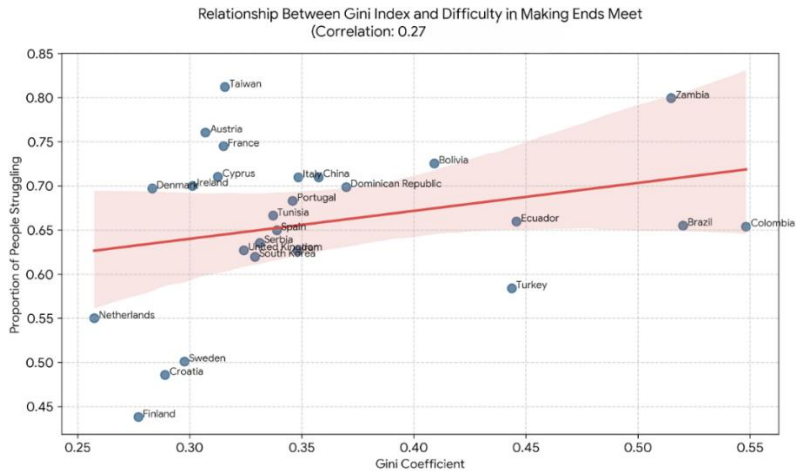
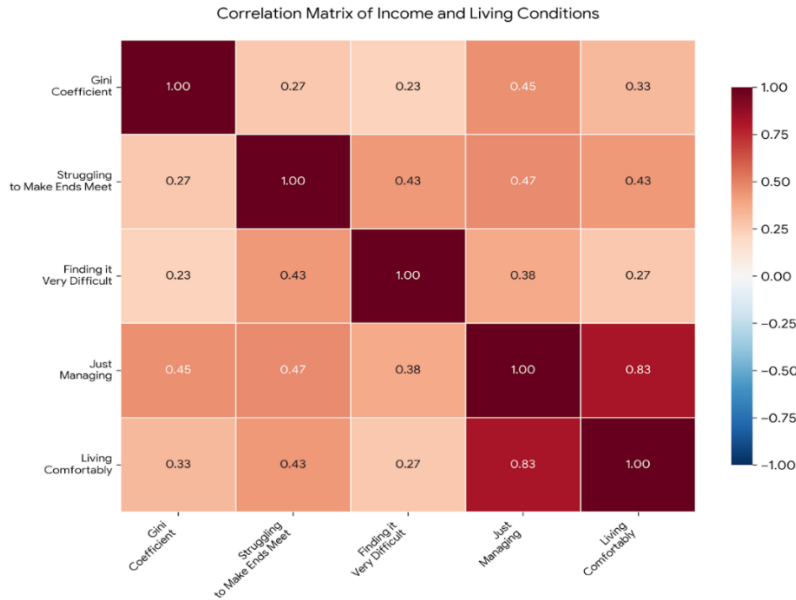


Figure 8 shows the relationship between countries' Gini coefficients and the proportion of individuals who report having difficulty making ends meet on their current income. The Pearson correlation coefficient between the Gini coefficient and difficulty in making ends meet is $r = 0.27$, indicating a weak positive association between the two variables. Countries such as the Netherlands and Finland, which have relatively low Gini coefficients, generally have lower proportions of individuals reporting difficulty making ends meet. By contrast, higher proportions are observed in countries such as Zambia, Colombia, and Brazil, which have relatively higher Gini coefficients.

Figure 9. Correlation Matrix of Income Inequality and Living Conditions



The correlation matrix presents the linear relationships between the Gini coefficient and the different categories of difficulty in making ends meet. The

correlation between the Gini coefficient and the category “just getting by on current income” is $r = 0.45$, the strongest among the categories examined. This finding indicates that countries with higher levels of income inequality tend to have a higher proportion of individuals who are only just able to make ends meet.

By contrast, the correlation between the Gini coefficient and the category “finding it very difficult to make ends meet” is $r = 0.23$, indicating a weak association. This suggests that cross-country differences in severe financial difficulty may not be explained by income inequality alone; factors such as overall income levels, living costs, and social protection may also be important.

The correlation between the Gini coefficient and the category “living comfortably” is $r = 0.33$. The positive association indicates that some countries with higher levels of income inequality also have higher proportions of individuals reporting that they are living comfortably. However, this relationship should be interpreted cautiously because the categories of difficulty in making ends meet are mutually exclusive.

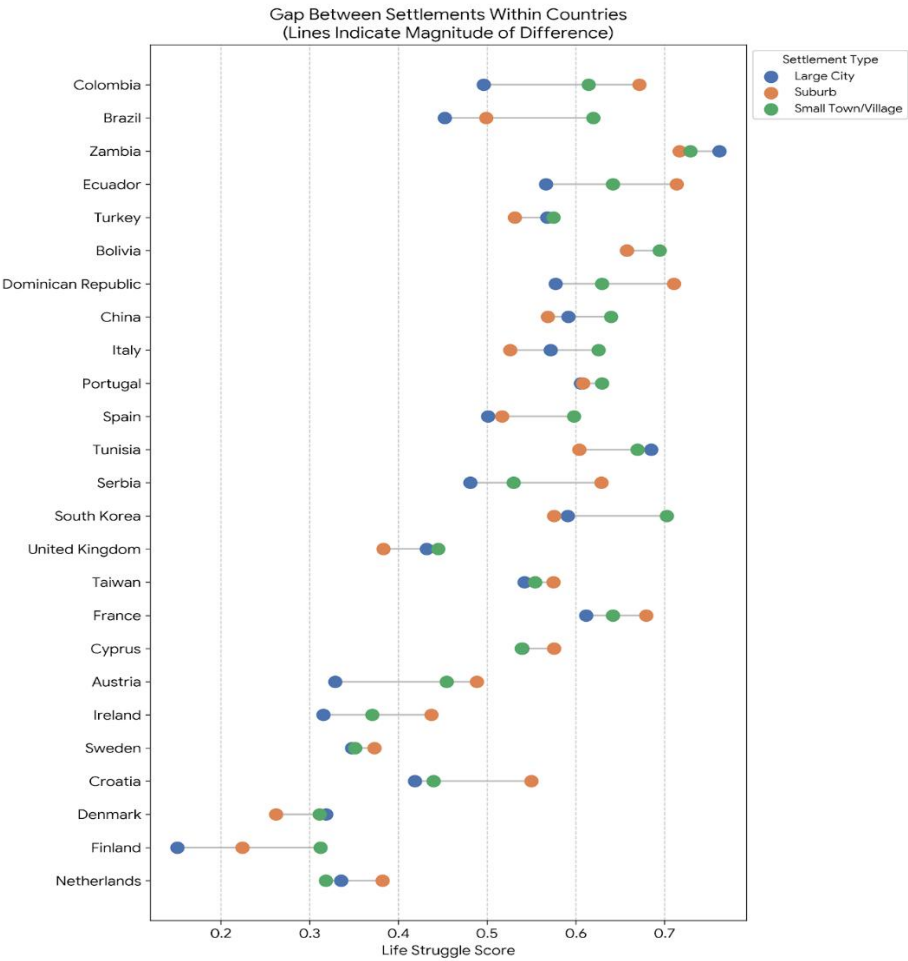
Another notable finding is the strong correlation of $r = 0.83$ between “just getting by” and “living comfortably.” This indicates that these two categories tend to vary together across countries. However, this association cannot be attributed solely to economic conditions. The structure of the categories themselves, as well as broader socioeconomic characteristics of the countries, may also contribute to this pattern.

Overall, individuals who have difficulty making ends meet tend to exhibit higher levels of struggling. The positive but weak association between the Gini coefficient and difficulty in making ends meet suggests that income inequality alone does not fully account for differences in financial strain. Assessments of difficulty in making ends meet should therefore consider income levels, purchasing power, living costs, inflation, and social protection alongside income inequality.

3.4. Comparison of Struggling and the Gini Coefficient by Place of Residence

Individuals were classified into three groups according to their place of residence: those living in a large city, those living in the suburbs of a large city, and those living in a small town or village. The levels of struggling in these groups were examined across countries and compared with the Gini coefficients of the respective countries. This comparison aims to assess the relationship between income inequality and differences in struggling across residential settings.

Figure 10. Distribution of Struggling by Type of Residence and Cross-Country Differences



In the figure, countries are ranked from higher to lower Gini coefficients. Overall, as countries with higher Gini coefficients are considered, levels of struggling across different residential settings also tend to increase. However, this pattern is not consistent across all countries, and the magnitude of differences between residential groups varies across countries.

Countries with relatively low Gini coefficients, such as the Netherlands, Finland, Denmark, and Sweden, generally show lower levels of struggling across different residential groups. By contrast, countries with relatively higher Gini coefficients, such as Zambia, Ecuador, Colombia, and Brazil, generally exhibit higher levels of struggling across most residential groups. This pattern suggests a positive association between income inequality and overall levels of struggling.

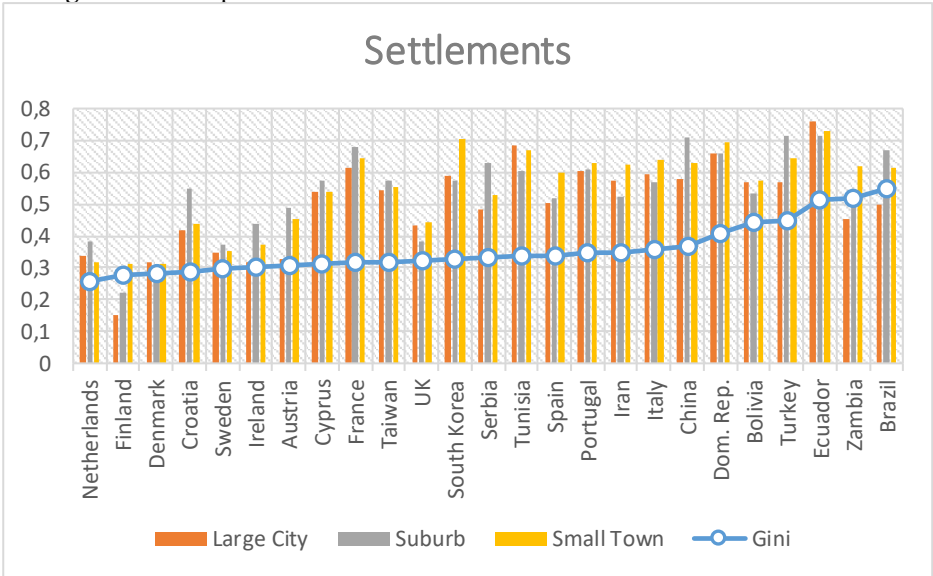
The magnitude of differences between residential groups also varies considerably across countries. More pronounced differences can be observed in countries such as Finland, Colombia, and Austria, whereas the values are relatively similar across residential groups in countries such as Türkiye, Sweden,

and Portugal. This indicates that the association between place of residence and struggling is not homogeneous across countries.

In some countries, residents of large-city suburbs stand out with higher levels of struggling. France, Croatia, Austria, Colombia, and the Dominican Republic provide examples of this pattern. By contrast, individuals living in small towns or villages exhibit higher values in countries such as Brazil, Italy, Spain, and particularly South Korea. In Zambia, levels of struggling are high across all residential groups, although the highest value is observed among residents of large cities.

In countries such as Türkiye, Sweden, and Portugal, the relatively similar values across residential groups suggest that differences in struggling by type of residence may be more limited than in some other countries.

Figure 11. Comparison of Place of Residence and the Gini Coefficient



When residential settings and income inequality are considered together, levels of struggling vary according to both the Gini coefficient and place of residence. In countries with relatively low Gini coefficients, such as the Netherlands, Denmark, and Finland, levels of struggling are generally lower, although differences between residential groups still exist. For example, in Finland, individuals living in large cities have lower levels of struggling, whereas those living in small towns or villages have higher values.

In countries with higher Gini coefficients, levels of struggling are generally higher, but the residential group with the highest value varies across countries. In Zambia, all three groups show high levels of struggling, while suburbs stand out in Colombia and small towns or villages in Brazil. These differences indicate that the association between income inequality, residential characteristics, and struggling is not uniform across countries.

The relatively high levels observed in suburban areas in some countries are also noteworthy. In France, Croatia, Austria, Colombia, and the Dominican Republic, the suburban group has higher levels of struggling than the other residential groups. This may indicate that residential patterns are associated with individuals' living conditions. However, such differences cannot be explained by income inequality alone; factors such as transportation, housing costs, employment opportunities, and access to public services may also play a role.

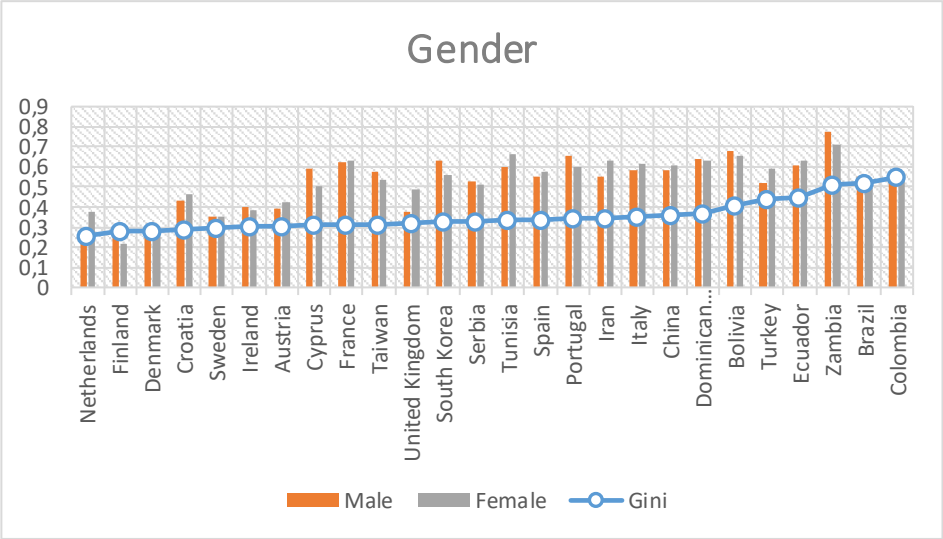
Overall, levels of struggling tend to increase as the Gini coefficient rises across different residential groups. However, the magnitude of this increase and the residential group in which it is most pronounced vary across countries. Therefore, the spatial dimension of the relationship between income inequality and struggling should be evaluated within the specific country context.

In conclusion, differences in struggling can be observed across residential settings, and these differences may vary alongside income inequality. However, because the figures provide descriptive and correlational comparisons, they do not establish that any particular residential setting directly causes higher levels of struggling. A more comprehensive explanation of these differences would require consideration of additional factors such as income levels, living costs, employment structures, and access to public services.

3.5. Comparison of Struggling and the Gini Coefficient by Gender

Individuals were classified by gender, and the levels of struggling among women and men were compared and evaluated alongside the Gini coefficients of the respective countries. This analysis examines not only the relationship between income inequality and the levels of struggling among women and men, but also how gender differences vary across countries and different levels of income inequality.

Figure 12. Comparison of Women's and Men's Levels of Struggling and the Gini Coefficient Across Countries



In Figure 12, countries are ranked from lower to higher Gini coefficients, and the levels of struggling among women and men are presented alongside the Gini coefficient. Overall, as the Gini coefficient increases, both women's and men's levels of struggling tend to increase. However, the magnitude of this increase varies across countries, and the direction of the difference between women and men also varies.

In countries with relatively low Gini coefficients, such as the Netherlands, Finland, Denmark, and Sweden, both women and men generally exhibit lower levels of struggling. However, the values for women and men are not identical in all countries. For example, women in the Netherlands have higher levels of struggling than men, whereas the opposite pattern is observed in Finland. This suggests that lower income inequality does not automatically result in similar levels of struggling among women and men.

In countries with higher Gini coefficients, such as Zambia, Ecuador, Brazil, and Colombia, both women's and men's levels of struggling generally reach higher levels. However, the direction of the gender difference may also vary across these countries. For example, men exhibit higher levels of struggling than women in Zambia and Brazil, whereas women have higher levels than men in Türkiye.

These findings suggest that the Gini coefficient may be associated with the overall level of struggling among both women and men, but that it does not by itself explain the direction or magnitude of gender differences. Therefore, women's and men's levels of struggling need to be examined separately when assessing the gender dimension of the relationship between income inequality and struggling.

To examine the difference between women and men more explicitly, the gender difference was calculated as women's level of struggling minus men's level of struggling. Accordingly, positive values indicate higher levels of struggling among women, while negative values indicate higher levels among men.

Figure 13. Relationship Between the Gini Coefficient and the Gender Difference in Struggling

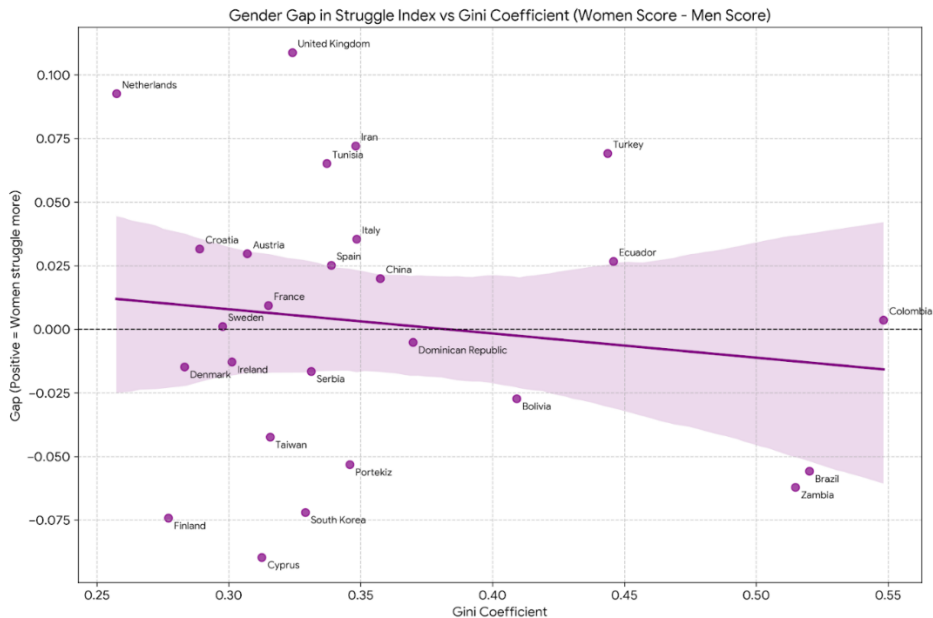


Figure 13 plots the Gini coefficient on the horizontal axis and the gender difference in struggling—calculated as women’s level of struggling minus men’s level of struggling—on the vertical axis. The zero line represents the reference point at which women and men have equal levels of struggling. Positive values indicate higher levels among women, whereas negative values indicate higher levels among men.

The fact that observations are distributed both above and below the zero line indicates that the gender difference in struggling varies considerably across countries. In the United Kingdom, the Netherlands, Iran, Tunisia, and Türkiye, women have higher levels of struggling than men, whereas men have higher levels in Finland, Portugal, South Korea, Brazil, and Zambia. The United Kingdom and the Netherlands stand out among the countries with more pronounced differences in which women report higher levels of struggling, while the pattern is reversed in Finland, Brazil, and Zambia.

The negative slope of the regression line suggests that, on average, the difference between women’s and men’s levels of struggling may decrease as the Gini coefficient increases. Thus, some of the differences favoring higher levels among women at lower levels of income inequality may become smaller as inequality rises, or may reverse in favor of higher levels among men in some countries. However, the substantial dispersion of observations around the regression line indicates considerable cross-country variation in this relationship.

Overall, the gender difference in struggling cannot be explained by income inequality alone. Factors such as patterns of labor force participation, wage

structures, working conditions, the distribution of caregiving responsibilities, and gender norms may also contribute to these differences.

CONCLUSION

Income inequality is not only a measure of how economic resources are distributed within a society but also an important social indicator that may be associated with individuals' economic security, living conditions, and evaluations of their future. This study examined the relationship between income inequality and individuals' levels of struggling using the Gini coefficient and the *Struggling* indicator derived from the Gallup World Poll, while considering socio-demographic characteristics such as age, employment status, difficulty in making ends meet, place of residence, and gender. Comparisons of countries based on their Gini coefficients revealed a generally positive association between income inequality and struggling. Countries with relatively low Gini coefficients, such as the Netherlands, Finland, and Denmark, generally exhibited lower levels of struggling, whereas higher values were observed in countries with relatively higher levels of inequality, such as Colombia, Brazil, and Zambia.

The findings by age group indicate that the association between income inequality and struggling varies across age groups. The correlation coefficient of $r = 0.63$ for individuals aged 15–24 was the highest among the age groups, indicating that the tendency for levels of struggling among young people to vary together with cross-country differences in income inequality was particularly pronounced in this group. The corresponding correlations were $r = 0.60$ for the 25–34 and 35–44 age groups, $r = 0.48$ for the 45–64 age group, and $r = 0.15$ for individuals aged 65 and over. This pattern indicates that the strength of the association may vary across stages of the life course. Young people's transition into the labor market and higher unemployment risk may be among the possible explanations for the stronger association observed among younger age groups, while the weaker association among older individuals may be related to factors such as retirement income and social protection. However, these factors were not directly tested in the present analysis.

Regarding employment status, unemployed individuals generally exhibited higher levels of struggling. At the same time, in some countries with high levels of income inequality, full-time employees and those not in the labor force also exhibited high levels of struggling. The fact that full-time employees in some countries had higher levels of struggling than the unemployed suggests that employment alone may not be a sufficient indicator of economic well-being. Accordingly, working conditions, earnings from employment, and job security should also be taken into consideration.

In terms of difficulty in making ends meet, individuals who reported having difficulty making ends meet generally exhibited higher levels of struggling across almost all countries. This finding suggests that assessments of financial difficulty should take into account not only income inequality but also factors such as

overall income levels, purchasing power, living costs, inflation, and social protection.

The findings concerning place of residence indicate that the relationship between income inequality and struggling may also vary spatially. Levels of struggling among individuals living in large cities, suburbs, and small towns or villages differ across countries. In some countries, rural populations exhibit higher levels of struggling, whereas in others, residents of suburban areas stand out with higher values. At the same time, countries with higher Gini coefficients generally tend to exhibit higher levels of struggling across residential groups. These differences may also be associated with factors such as transportation, housing costs, employment opportunities, and access to public services.

With respect to gender, the findings indicate that differences in struggling between women and men vary across countries. Although both women and men generally exhibit higher levels of struggling in countries with higher Gini coefficients, the direction of the gender difference varies across countries, with either women or men showing higher levels. Thus, income inequality alone does not explain gender differences in struggling. Factors such as patterns of labor force participation, wage structures, working conditions, and the distribution of caregiving responsibilities should also be considered when evaluating these differences.

Overall, the findings indicate a positive association between income inequality and struggling, while the strength and pattern of this association vary across socio-demographic groups and countries. Young people, unemployed individuals, and those who have difficulty making ends meet stand out with particularly high levels of struggling. At the same time, the differences observed across these groups cannot be explained by income inequality alone. The findings suggest that individuals' living conditions are associated not only with their absolute income levels but also with the broader economic, social, and spatial environments in which they live.

From a policy perspective, efforts to reduce income inequality should address not only income distribution but also the economic and social vulnerabilities faced by different population groups. Facilitating young people's transition into the labor market, strengthening the economic security of older adults, improving workers' incomes and working conditions, supporting households experiencing financial hardship, reducing regional disparities in opportunities, and promoting women's equal participation in economic life represent important policy areas. However, these recommendations refer to policy areas suggested by the findings rather than interventions directly tested in the present study.

Finally, it should be emphasized that this study provides a descriptive and correlational analysis based on comparisons between countries' Gini coefficients and levels of struggling across different socio-demographic groups. Therefore, the findings do not establish that income inequality directly causes higher levels of struggling. Likewise, the economic, social, and institutional mechanisms underlying the observed associations cannot be determined conclusively from the

available data. Future research using individual-level microdata, broader country and time coverage, panel-data or multilevel models, and additional variables such as income, education, unemployment, social security, health, living costs, and access to public services could provide a more detailed understanding of the relationship between income inequality and struggling.

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CHAPTER 6

**Artificial Intelligence Adoption
Occupational Exposure and
Macroeconomic Transmission Channels**

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1 Introduction

Technological progress is one of the principal sources of long-run economic growth. General-purpose technologies such as steam power, electricity, and information and communication technologies have not merely lowered costs in particular industries; they have also transformed the organization of production, the emergence of new products, and the demand for skills. Artificial intelligence, particularly through large language models and generative AI applications, is now regarded as the latest stage in this historical trajectory because it can predict, classify, generate text and code, support decisions, and partially automate knowledge-intensive tasks.

A key feature distinguishing AI from earlier waves of automation is its capacity to affect cognitive and communicative tasks as well as routine physical activities. Technological feasibility, however, is not equivalent to economic adoption. The fact that a task can technically be automated does not imply that it will be automated quickly or that the associated occupation will disappear. Cost, error risk, legal liability, data quality, regulation, customer preferences, and organizational complementarities determine the actual pace of adoption. Without this distinction, exposure indices may be incorrectly interpreted as realized employment losses.

The study addresses three research questions. First, through which channels are AI-driven innovations transmitted from firm-level task productivity to aggregate total factor productivity? Second, under what conditions do labor-substituting or labor-complementing effects dominate employment, wage distribution, and the labor share? Third, how do differences in infrastructure, skills, and institutional capacity between advanced and developing economies shape these outcomes?

The study makes three contributions. First, it calculates the change in AI use in Türkiye between 2021 and 2025 by enterprise size. Second, it compares the 2025 AI adoption gap between Türkiye and the European Union at the aggregate level, across enterprise-size classes, and in the information and communication sector. Third, it uses quantitative evidence to demonstrate that firm adoption and occupational exposure indicators do not measure the same economic phenomenon. Given the short observation period, simultaneity, and differences in measurement, observed facts, scenarios, and causal effects are kept analytically separate.

2 Conceptual Scope and Key Distinctions

2.1 What constitutes an artificial intelligence shock

In macroeconomic analysis, an "AI shock" is not a single observable variable. At least four distinct developments may be described by this term: an exogenous improvement in model capabilities, a decline in computing costs, an increase in

firms' adoption of AI, and an increase in occupations' exposure to AI. These indicators do not measure the same concept. Patents and scientific publications represent knowledge production; enterprise surveys capture actual use; job advertisements indicate skill demand; and occupational exposure indices measure technical applicability. A credible empirical design must specify in advance which mechanism the selected indicator measures and which outcome it can plausibly explain.

2.2 The distinction between exposure adoption and impact

Exposure refers to the potential for tasks within an occupation to be supported or automated by AI. Adoption means that the technology has actually been incorporated into production. Impact denotes the subsequent change in outcomes such as productivity, employment, wages, or quality. Considerable attrition may occur between these stages. High exposure may produce little adoption because of data-security concerns, verification costs, or regulatory constraints. Likewise, even extensive adoption may generate limited productivity growth if organizational processes are not redesigned.

Table 1. Concepts measured by artificial intelligence indicators

Indicator	Dimension measured	Main advantage	Main limitation
Occupational AI exposure index	Technical task exposure	Comparison across occupations and industries	Does not measure actual use or job loss
Enterprise AI adoption rate	Actual adoption	Close to observed economic behavior	Self-reporting, coverage, and definitions may vary
AI patents and publications	Knowledge production and innovation capacity	Long-run and cross-country comparison	Does not directly measure commercialization or diffusion
Job postings requiring AI skills	Direction of labor demand	High-frequency and detailed	Subject to platform and posting-selection bias
Robot or ICT capital	Tangible technology investment	Linked to productive capital	May not adequately capture generative AI

Source: Author's compilation based on Acemoglu and Restrepo (2018, 2019), Felten et al. (2021), and OECD (2023).

3 Theoretical Framework

3.1 Growth theory and the general-purpose technology approach

In the neoclassical growth model, long-run growth in income per capita depends on exogenous technological progress. Endogenous growth models bring technology into the model through research and development, human capital, and knowledge spillovers (Romer, 1990; Aghion & Howitt, 1992). AI may be treated in both frameworks as an input that improves the quality of capital. Its character as an "invention of a method of invention," however, makes it a potentially stronger mechanism because it can also affect the knowledge-production function (Cockburn et al., 2019). Faster research, coding, and experimental design may influence not only current output but also the rate at which new ideas are produced.

The macroeconomic effects of general-purpose technologies often emerge with a delay. Measured returns may remain low until appropriate data infrastructure, software, process design, management practices, and workforce skills are developed. The modern productivity paradox discussed by Brynjolfsson et al. (2019) explains the gap between high expectations and the limited productivity growth observed in national accounts through such delays in complementary investment. High AI investment accompanied by modest short-run TFP growth is therefore not necessarily contradictory.

Aggregate output also depends on reallocation. The expansion of productive firms, the contraction of less productive firms, and the movement of resources across industries can raise aggregate productivity. Market power, data concentration, and switching costs, however, may delay the movement of resources toward more productive uses. The private return to technology may consequently differ from its social return.

3.2 The task-based approach

In the task-based approach, production consists of a set of tasks that can be performed by labor or capital (Acemoglu & Restrepo, 2018, 2019). AI affects particular tasks within an occupation rather than necessarily replacing the occupation as a whole. Four channels should be distinguished:

- Displacement effect: Tasks previously performed by labor are carried out by capital or software, reducing labor demand and wage pressure in the affected tasks.
- Productivity effect: Lower unit costs can expand demand and production, thereby generating labor demand in tasks that have not been automated.

- New-task effect: New activities such as model supervision, data governance, security, adaptation, and human-machine coordination can expand labor's comparative advantage.
- Capital-accumulation and reallocation effect: Higher expected returns may stimulate investment, but concentration of gains among high-technology firms may increase within-industry inequality.

The net employment effect is the sum of these channels and cannot be determined a priori. The same technology may substitute for a worker in one workplace while increasing another worker's productivity elsewhere. Generalizations such as "AI reduces employment" or "AI creates jobs" are therefore scientifically inadequate unless the unit of analysis, time horizon, and outcome variable are clearly defined.

3.3 Skill-biased and task-biased technological change

The skill-biased technological change framework argues that technology increases the skill premium by complementing highly educated labor (Goldin & Katz, 2008). The routine-task approach instead shows that automation depends more on a task's codifiability than on formal education (Autor et al., 2003). Because generative AI can also affect writing, coding, and knowledge synthesis, the two approaches need to be considered together. Early experiments indicate that productivity gains are larger for less-experienced workers in some settings. This does not imply that wage inequality will necessarily decline in the long run: unequal access to technology, complementary skills, ownership, and bargaining power may reverse the outcome.

4 Macroeconomic Transmission Mechanisms

4.1 From firm productivity to total factor productivity

At least five intermediate stages separate faster completion of a particular task by one worker from an economy-wide increase in TFP: diffusion across firms, conversion of time savings into additional output, deduction of error and verification costs, complementary investment, and reallocation of resources toward more productive firms. Translating percentage changes from micro-level experiments directly into national TFP estimates ignores these stages. Macroeconomic assessment must account for adoption rates, the share of affected tasks, and general-equilibrium responses.

4.2 Employment unemployment and wages

In the short run, the reorganization of tasks within firms, the composition of recruitment, and work intensity may respond faster than aggregate employment. Demand for some skills may decline in job advertisements while demand for AI-complementary skills rises. In the medium run, the wage effect depends on how productivity gains are shared with workers, how labor supply adjusts, and how

bargaining institutions operate. When displaced workers require a long time to move to another industry, substantial welfare losses can arise even if long-run aggregate employment is unchanged. Analysis should therefore track wages, working time, contract type, and occupational transitions as well as employment counts.

4.3 Labor share and market concentration

If ownership of AI capital is concentrated among a small group of firms, productivity gains may not be fully transmitted to wages. Economies of scale, data advantages, and high fixed costs of model development may strengthen market power. Changes in the labor share reflect not only the technical elasticity of substitution but also pricing power, firm entry and exit, unionization, and the tax system. Sectoral composition and market concentration should therefore be controlled for in analyses of the labor share.

4.4 Inflation aggregate demand and fiscal channels

Productivity growth may reduce unit costs and become disinflationary over the medium term. Rapid growth in demand for data centers, energy, semiconductors, and specialized labor may nevertheless create short-run price pressures in particular inputs. If worsening income distribution lowers the income of groups with high marginal propensities to consume, aggregate demand may weaken. A shift in the tax base from labor toward capital income may also place pressure on social-security financing. These channels show why an AI shock cannot be treated solely as a supply shock in monetary and fiscal analysis.

5 Method Data Sources and Evidence Assessment Strategy

5.1 Critical evidence assessment and descriptive analysis

The study follows a two-stage analytical strategy. The first stage compares experiments, firm and job-posting data, occupational exposure studies, and macro-sectoral research through a critical narrative assessment of the evidence. This assessment is not presented as a systematic review or meta-analysis; it evaluates selected studies in terms of identification strategy, outcome variable, and limits to external validity. The second stage descriptively compares published statistics from the TurkStat Survey on Information and Communication Technology Usage in Enterprises, Eurostat's ICT Usage in Enterprises dataset, and the ILO's 2025 occupational exposure index. Percentage-point gaps, relative levels, and changes over time are calculated directly from published values. The design is a bounded description of adoption and exposure patterns rather than a causal impact estimate.

The evidence is classified at four levels: controlled task or field experiments, firm and job-posting data, occupational exposure research, and macroeconomic or sectoral analysis. For each finding, the type of measurement, identification

strategy, outcome variable, and boundary of external validity are considered jointly. This approach recognizes the strong internal validity of experimental evidence while preventing its automatic generalization across industries, countries, and long time horizons.

5.2 Principal threats to causal inference

Table 2. Principal sources of bias and potential solutions in empirical analysis

Risk	Source of the problem	Suggested response
Reverse causality	More productive firms may adopt AI earlier	Predetermined exposure, an instrumental variable, a natural experiment, or a staggered-adoption design
Concurrent common shocks	The pandemic, interest rates, demand, or digitalization affect outcomes simultaneously	Year and industry-country fixed effects, trends, and event studies
Measurement error	Exposure does not represent actual use	Multiple indicators, validation with adoption surveys, and sensitivity analysis
Selection bias	Voluntary users or selected platforms may not be representative	Weighting, transparent sample boundaries, and alternative data sources
Spurious correlation	Nonstationary macroeconomic series share common trends	Unit-root and cointegration tests, differencing, or error-correction methods
Multiple testing	Reporting only significant findings from many outcomes	A preregistered analysis plan, primary-outcome definition, and adjusted p-values

Source: Author's compilation based on Acemoglu et al. (2022) and Georgieff and Hye (2022).

6 Critical Assessment of Empirical Evidence

6.1 Task and field experiments

Controlled experiments provide the strongest evidence for identifying the causal effects of generative AI on specific tasks. Noy and Zhang (2023) show that access to the technology reduced completion time and improved average quality in professional writing tasks. The field study by Brynjolfsson et al. (2023) in a customer-service setting reports that AI-supported recommendations increased the number of issues resolved per hour, with larger gains among less-experienced workers. Peng et al. (2023) find that participants given access to a coding assistant completed a software-development task more quickly.

The common finding is that AI can improve speed and quality in relatively standardized tasks with rapid feedback. The results do not imply that all tasks will be affected to the same extent. Performance may decline when a task lies outside the technology's capability frontier and users rely on incorrect outputs. Experimental samples, short-duration tasks, and intensive tool support differ from long-run organizational settings. Whether productivity gains lead to workforce reductions, additional output, or shorter working hours depends on firm demand and management decisions.

6.2 Job postings firm behavior and skill demand

Using online job postings in the United States, Acemoglu et al. (2022) show that organizations with greater AI exposure changed their skill demand, while the early effects on aggregate employment and wages remained more limited. This finding supports the view that technological change may initially proceed through job content rather than the number of jobs. Job postings provide high-frequency information, but because they cover only vacancies and selected platforms, they do not fully capture the transformation of tasks performed by existing employees.

6.3 Distinguishing exposure studies from realized outcomes

Eloundou et al. (2023) assess the potential impact of large language models on occupational tasks in the United States, while ILO and IMF studies adapt similar exposure measures to the structure of the global workforce. A common finding is that generative-AI exposure is relatively high in knowledge-intensive and clerical occupations and lower in physical and field-based work. Exposure rates, however, are not forecasts of job losses. Some studies reduce this risk of misinterpretation by separately classifying the potential for automation and task augmentation.

6.4 Aggregate productivity and the productivity paradox

Macroeconomic evidence remains more uncertain. The period following the widespread diffusion of generative AI is short, national adoption measures are limited, and concurrent shocks are substantial. Acemoglu (2024) emphasizes that only a subset of technically feasible tasks will be economically profitable to automate and consequently offers cautious estimates of short-run macroeconomic gains. More optimistic scenarios assume rapid expansion of the task frontier, complementary investment, and faster innovation. These projections are assumption-sensitive scenarios rather than realized outcomes.

Table 3. Methodological assessment of selected empirical evidence

Study	Data and method	Main finding	Interpretive limitation
Noy and Zhang (2023)	453 professionals; randomized writing tasks	Lower completion time and higher quality	Short task; does not measure long-run employment
Brynjolfsson et al. (2023)	5,179 customer-service workers; staggered field implementation	Average productivity increased; gains were larger for novice workers	One firm and a specific task environment
Peng et al. (2023)	Software task; randomized tool access	Task completion time declined	Cannot be generalized to the entire occupation
Acemoglu et al. (2022)	US online job postings and AI exposure	Skill demand changed; aggregate early effects were limited	Posting data exclude incumbent workers
Eloundou et al. (2023)	Occupation-task exposure classification	High potential exposure in knowledge-intensive occupations	Potential exposure is not realized job loss
Gmyrek et al. (2023)	Global occupational data and GPT exposure	High exposure in clerical tasks; augmentation is important	Domestic adoption and prices are excluded
Cazzaniga et al. (2024)	Global exposure and complementarity index	Exposure is higher in advanced economies	Scenario and index; not a causal estimate
Acemoglu (2024)	Task shares and macroeconomic calibration	Short-run gains are highly assumption-sensitive	Calibration is not a realized outcome

Source: Author's compilation based on Acemoglu (2024), Acemoglu et al. (2022), Brynjolfsson et al. (2023), Cazzaniga et al. (2024), Eloundou et al. (2023), Gmyrek et al. (2023), Noy and Zhang (2023), and Peng et al. (2023).

As Table 3 shows, the most credible short-run findings in the literature concern task-level productivity. The evidence is less conclusive for employment and aggregate productivity outcomes. Preserving this evidence hierarchy is essential for communicating the appropriate degree of certainty in policy discussions.

7 Differences Between Advanced and Developing Economies

7.1 Infrastructure and complementary capital

Advanced economies may adopt AI more rapidly because of their cloud-computing capacity, data centers, broadband infrastructure, research and development, and management capabilities. Developing economies can benefit from technology transfer, but may face foreign-currency costs for software and hardware, energy-security constraints, and inadequate data infrastructure. Lower exposure may therefore indicate not only lower risk but also fewer opportunities for productivity gains.

7.2 Human capital and language

Educational attainment alone is insufficient. Domain knowledge, data literacy, verification, and problem-definition skills are also essential. The stronger performance of global models in high-resource languages may produce quality gaps in local languages and contexts. Without local datasets and evaluation standards, dependence on imported technology may restrict productivity gains.

7.3 Informality and social protection

In economies with high informal employment, job losses and task transformation may appear in administrative data only with a delay. Limited unemployment-insurance coverage increases transition costs. Weak links between reskilling programs and employer demand may also widen the gap between training and successful job placement.

7.4 Implications for Türkiye

For Türkiye, the principal opportunity lies in a young workforce, a large service sector, and a digitizing manufacturing base that is receptive to AI-assisted process improvement. The main risks include skill mismatch, limited financial and data capacity among small and medium-sized enterprises, imported-technology costs, and regional digital divides. Empirical research on Türkiye should link occupational exposure indices to actual firm adoption and explicitly model informality, sector size, and regional heterogeneity. Applying an international exposure index directly to Turkish employment may be misleading if local task content and adoption capacity are ignored.

8 Descriptive Findings from Official Data

The empirical assessment is based on secondary analysis of published official statistics. Data for Türkiye are drawn from TurkStat's Artificial Intelligence Statistics 2025 bulletin; the EU comparison uses Eurostat's ICT Usage in Enterprises dataset (isoc_eb_ai); and occupational exposure indicators come from the ILO's 2025 Refined Global Index of Occupational Exposure. In the enterprise data, the unit of analysis is the share of enterprises reporting the use of at least one AI technology. In the ILO indicators, it is the share of employment in occupations assigned to particular exposure gradients. Because these indicators have different units of analysis, they are neither combined in a single table nor treated as substitutes. The calculated differences are descriptive and do not identify causal effects on productivity, wages, or employment.

Comparability rests on both sources reporting the share of enterprises using AI within the framework of ICT-use surveys. Nevertheless, differences in sectoral coverage, national survey implementation, questionnaires, and response behavior cannot be eliminated completely. The Türkiye-EU gaps should therefore be interpreted as harmonized directional indicators of adoption rather than as definitive performance rankings. The ILO exposure rates are global or income-group estimates and do not represent employment outcomes realized specifically in Türkiye.

8.1 Observed trends in artificial intelligence adoption in Türkiye

According to TurkStat, the share of enterprises reporting the use of at least one AI technology rose from 2.7% in 2021 to 7.5% in 2025. This corresponds to an increase of 4.8 percentage points, a relative increase of approximately 177.8%, and a compound annual growth rate of approximately 29.1% over four years. Although these figures indicate faster adoption, the relative growth rate should not be interpreted as the magnitude of the macroeconomic impact because the initial level was low.

Table 4. Share of enterprises using artificial intelligence in Türkiye by enterprise size

Group	2021 (%)	2025 (%)	Change (percentage points)	Relative change (%)
All enterprises	2.7	7.5	+4.8	+177.8
10-49 employees	2.3	6.6	+4.3	+187.0
50-249 employees	3.6	9.6	+6.0	+166.7
250+ employees	9.6	24.1	+14.5	+151.0

Source: TurkStat (2025). Relative changes are the author's calculations.

Table 4 reveals a strong association between enterprise size and adoption. In 2025, the 24.1% adoption rate among large enterprises was approximately 3.7 times the 6.6% rate among small enterprises. The central empirical fact for Türkiye is therefore not only the low aggregate adoption rate, but also a pronounced scale gap consistent with differences in complementary capital, expertise, and financing capacity.

8.2 The Türkiye EU comparison and the adoption gap

According to Eurostat's harmonized enterprise survey, 20.0% of enterprises in the EU used at least one AI technology in 2025, compared with 7.5% in Türkiye. The resulting gap was 12.5 percentage points, and Türkiye's rate corresponded to approximately 37.5% of the EU average. Between 2024 and 2025, the rate increased from 4.5% to 7.5% in Türkiye, a gain of 3.0 percentage points, and from 13.5% to 20.0% in the EU, a gain of 6.5 percentage points. Adoption accelerated in both areas, but the absolute gap remained wide in 2025.

Table 5. Artificial intelligence use in 2025 A comparison of Türkiye and the European Union

Indicator	Türkiye (%)	EU (%)	Türkiye-EU gap (pp)	Türkiye / EU (%)
All enterprises	7.5	20.0	-12.5	37.5
Small (10-49)	6.6	17.0	-10.4	38.8
Medium (50-249)	9.6	30.4	-20.8	31.6
Large (250+)	24.1	55.0	-30.9	43.8
Information and communication	47.1	62.5	-15.4	75.4

Source: TurkStat (2025) and Eurostat (2025). Differences and ratios are the author's calculations.

Both data sources display the same scale gradient: AI use increases with firm size. The absolute gap between Türkiye and the EU is nevertheless wider among medium-sized and large enterprises. This pattern is consistent with the chapter's emphasis on complementary intangible capital and organizational capacity, although the table alone does not identify the causal effects of financing, skills, or management capability.

8.3 Occupational exposure Distinguishing use from potential impact

The ILO's 2025 update remeasures exposure to generative AI using a task-based classification covering approximately 29,753 tasks together with human and expert validation. Globally, approximately 25% of workers are employed in occupations with some degree of GenAI exposure, while 3.3% of employment is in the highest exposure gradient. Total exposure is estimated at 34% in high-income countries and 11% in low-income countries. In the highest exposure category, the corresponding shares are 4.7% for women's employment and 2.4%

for men's employment. These indicators measure the technical potential for task transformation, not realized job loss.

Table 6. ILO 2025 indicators of occupational exposure to generative artificial intelligence

Group or indicator	Share (%)	Interpretation
World - any exposure	Approximately 25	Share of global employment in exposed occupations
World - highest exposure	3.3	Highest exposure gradient
High-income countries - any exposure	34	Total exposure for the income group
Low-income countries - any exposure	11	Total exposure for the income group
Women - highest exposure	4.7	Within global female employment
Men - highest exposure	2.4	Within global male employment

Source: International Labour Organization (2025) and Gmyrek et al. (2025).

8.4 Statistical interpretation and limitations of the findings

The official data support three robust descriptive findings. First, AI adoption in Türkiye increased markedly between 2021 and 2025. Second, in 2025 Türkiye remained below the EU average overall and in every enterprise-size category, while adoption was concentrated among large enterprises. Third, global occupational exposure indicates a much broader potential field of transformation than actual enterprise-use rates. Taken together, these findings show why each stage in the chain from technical exposure to actual adoption and then to economic outcomes must be measured separately.

The short observation period and the simultaneous determination of adoption with digitalization, capital intensity, workforce skills, and demand conditions make simple country-time correlations unsuitable for causal interpretation. The tables therefore report only observed levels of use and exposure. Identifying productivity and employment effects would require firm- or industry-level panels, exposure determined prior to adoption, a credible comparison group, and an event-study or difference-in-differences design.

8.5 Reproducibility and data sources

All figures in Tables 4-6 are taken from publicly available institutional publications or derived arithmetically from the reported values. TurkStat Artificial Intelligence Statistics 2025 is used for Türkiye, Eurostat dataset isoc_eb_ai for the EU comparison, and ILO Working Paper 140 for global occupational exposure. Reproduction uses the formulas A minus B for percentage-point differences, A divided by B times 100 for relative levels, and the final value divided by the initial value minus one, multiplied by 100, for

relative change over time. These transparent calculation rules allow third parties to verify the results.

9 Policy Framework

9.1 Productivity-oriented adoption policy

Public policy should target measurable gains in productivity and quality rather than merely increasing the number of AI users. For SMEs, shared data infrastructure, secure cloud services, industry-specific testing centers, and management consulting may provide a more complementary package than software subsidies alone. Support programs should incorporate evaluation designs that monitor use, output, error rates, energy costs, and effects on workers.

9.2 Skills and transition security

Reskilling programs should not be limited to general digital literacy; they should integrate workplace problem definition, verification of model outputs, data security, and domain knowledge. Skill acquisition and sustainable job placement should be monitored rather than payments to training providers. Unemployment insurance, portable entitlements, and instruments such as wage insurance may reduce the costs of transitions across industries.

9.3 Competition data governance and labor standards

The concentration of data and computing capacity among a small number of firms may restrict the diffusion of innovation. Policies supporting interoperability, data portability, competitive procurement, and access to research infrastructure are important. Minimum standards for algorithmic management in the workplace should include worker notification, human oversight, an appeals mechanism, and personal-data protection. Instruments such as an automation tax risk penalizing technology too broadly and imprecisely and should therefore be compared with more neutral designs that directly address externalities and tax-base erosion.

Table 7. Matching policy objectives instruments and monitoring indicators

Objective	Instrument	Monitoring indicator
SME productivity	Shared infrastructure, technical advice, and secure cloud services	Value added, error rates, and energy intensity alongside adoption
Skill alignment	Employer-linked modular training	Verified skills and sustained job placement rather than course completion
Transition security	Unemployment insurance, portable rights, and active labor-market policy	Transition time, wages, and job quality in the new position

Objective	Instrument	Monitoring indicator
Competition	Interoperability, data portability, and supplier diversity	Concentration, entry rates, and switching costs
Responsible use	Impact assessment, human oversight, and the right to appeal	Errors, discrimination, security incidents, and remediation time

Source: Author's compilation based on OECD (2023), World Bank (2019), and Cazzaniga et al. (2024).

10 Discussion

Official data for 2025 illustrate the theoretical framework's emphasis on adoption capacity: 7.5% of enterprises in Türkiye used AI, compared with an EU average of 20.0%; among large enterprises, the corresponding rates were 24.1% and 55.0%. This observed adoption gap shows that technological feasibility does not translate automatically into actual use. Cross-sectional differences alone, however, cannot reveal the cause: enterprise size, sectoral composition, skills, financing, and digital infrastructure may all contribute.

A joint reading of the literature reconciles two apparently conflicting results. Task and field experiments indicate substantial productivity gains, whereas aggregate data have yet to reveal an increase of comparable magnitude. The difference reflects distinct levels of analysis rather than evidence that one set of findings is necessarily incorrect. Experiments capture particular users, tasks, and short-run conditions; macroeconomic indicators also incorporate diffusion, general-equilibrium responses, sectoral composition, and measurement problems.

Automation and augmentation are not mutually exclusive outcomes in the labor market. A worker may delegate some tasks to AI and become more productive in the remaining tasks. Employment may be preserved if a firm uses this gain to expand production, but headcount may fall if the firm uses it to reduce costs. The elasticity of product demand, competition, the creation of new tasks, and worker mobility determine the net effect.

Time is the most important limitation of the current evidence. The observation period for generative AI is too short to assess adjustment in the capital stock and education system. Moreover, rapidly changing capabilities and prices mean that measured exposure is not fixed. Scenarios with explicit assumptions and regularly updated measurements should therefore be preferred to definitive long-run projections.

The study has four principal limitations. First, the critical evidence assessment is not a systematic review or meta-analysis and does not claim to cover the entire publication universe. Second, enterprise adoption rates are self-reported and do

not measure intensity of use or economic returns. Third, the ILO exposure indicators have not been reweighted to Türkiye's specific occupational and task structure. Fourth, the observation period for generative AI is too short to assess adjustment in the capital stock, education system, and institutions. These limitations require the findings to be interpreted as descriptive patterns rather than causal effects.

11 Conclusion

Recent official data reinforce the chapter's central distinction. The share of enterprises using AI in Türkiye rose from 2.7% in 2021 to 7.5% in 2025, but the EU average was 20.0% in 2025. In the same year, adoption among large enterprises was 24.1% in Türkiye and 55.0% in the EU. According to the ILO's 2025 index, approximately one quarter of global employment is located in occupations with some GenAI exposure. There is therefore a substantial gap between the prevalence of exposure and actual adoption, and the two indicators should not be used interchangeably when assessing macroeconomic outcomes.

The macroeconomic consequences of AI and innovation shocks are not determined solely by the technology's technical capability. The magnitude of productivity gains depends on adoption costs, complementary intangible capital, organizational redesign, workforce skills, and the reallocation of resources across firms. AI should therefore be understood not as a homogeneous one-time shock added to the production function, but as a general-purpose technology whose effects vary across time and institutional settings.

Empirical evidence strongly supports improvements in speed and quality for particular cognitive tasks. The long-run effects on aggregate employment, wage inequality, the labor share, and TFP remain more uncertain. Exposure indicators should not be interpreted as job-loss estimates; micro-level productivity rates should not be translated directly into aggregate growth forecasts; and calibration results should not be presented as realized outcomes.

For developing economies, the main policy dilemma is not limited to the risk of job loss. Unequal access to technology, computing capacity, and complementary skills may also widen international productivity gaps. Policy in Türkiye should jointly address SMEs' adoption capacity, local-language and data infrastructure, labor-market transition security, and a competitive technology ecosystem.

Future research should use country-industry or firm-level panel designs that distinguish predetermined task exposure from actual adoption. Event studies, parallel-trends tests, alternative exposure measures, and transparent replication files are minimum requirements for credible inference in this rapidly changing field.

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CHAPTER 7

Trade Policy Uncertainty: A Bibliometric Analysis of the 2019–2026 Period

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1. Introduction

Trade policy uncertainty refers to the difficulty what firms and investors cannot know in advance about future tariffs, trade agreements, and import rules. Governments do not always signal clearly where trade policy is heading, or when it will change. Faced with that ambiguity, companies tend to hold back on large, hard-to-reverse investments they plan. They also think twice before entering new export markets, and they re-examine the risks running through their global supply chains and value chains.

So TPU matters well beyond the volume of cross-border trade. It reaches into firm productivity, corporate performance, and financial markets. Again and again, research points to the same conclusion; when policy is ambiguous or uncertain, firms may change how they operate internationally.

New economic policy uncertainty indexes gave researchers superior tools for measuring TPU (Baker et al., 2016; Handley & Limão, 2015, 2017; Caldara et al., 2020). Early studies concentrated mainly on tariffs. Since then the field has grown quickly, and it now asks how sudden policy shifts shape growth, risk, and financial stability.

Of course, a literature growing this fast cannot be understood by counting publications alone. Bibliometric methods let us ask sharper questions. Which journals publish most actively? Which countries contribute most? Which concepts tend to appear together? And which studies form the field's intellectual foundation? Therefore TPU literature has emerged as a critical field of inquiry, identifying trade policy uncertainty as a distinct driver of economic volatility that influences global investment and trade flows.

This chapter maps TPU research published between 2019 and 2026, drawing on a clearly defined Web of Science dataset. We look at the field's production structure, its main themes, and its intellectual roots. Publication counts are descriptive, so we read them with care. We also report the network analyses alongside the rules we used to clean the data.

2. Dataset and Methodology

2.1. Construction of the Final Data Corpus

We searched English-language academic publications in the Web of Science from 2019 to 2026. The search covered titles, abstracts, and both keyword fields, using exact phrases such as “trade policy uncertainty” and “trade policy uncertainty index.” It returned 402 records. After excluding four items that WoS tagged as both “Article” and “Proceedings Paper,” the final dataset contained 398 records. We also confirmed that it included no standalone book chapters, retraction notices, or publications in languages other than English.

We based exclusions on WoS's official document-type tags. Some proceedings papers with both tags may also have appeared as full journal articles, but we excluded them to keep the selection rule consistent. All results reported here therefore reflect the 398 records in the final dataset. Using different inclusion criteria would mean rebuilding the dataset and recalculating the results. Since we collected the data in October 2026, the figures for that year cover only part of the year.

2.2. Bibliometric Approach and Data Processing

Following established bibliometric guidelines (Donthu et al., 2021), we traced changes in publication output, author productivity, and country affiliations over time. We extracted country information from the WoS C1 address fields. When a scholarly paper included authors from three countries, each country received credit; country shares can therefore sum to more than 100%. We also standardized author names and corrected basic keyword formatting, including capitalization and spacing. And, we deliberately avoided merging similar terms too broadly, since small wording differences may reflect distinct concepts or misleading.

We employed Bradford's (1934) law of scattering to divide journals into three zones according to publication volume. This provides a practical distinction between the small group of core journals and the longer tail of less active sources. Because article counts are discrete, the zones need not contain exactly equal totals. We also constructed a keyword network to identify terms that occur together within papers. Following the co-word framework of Callon et al. (1983), we used a Python-based community-detection tool to group the 150 most frequent keywords into the thematic clusters. The map's centrality and density measures are custom calculations for this network rather than direct outputs from software such as Bibliometrix.

To get the co-citation analysis, we counted how often two earlier references were cited together in the corpus. We matched references through DOIs and basic bibliographic information, chiefly author and year. WoS records sometimes contain typographical errors or more than one DOI for the same paper. To reduce that kind of false links, we carefully moved ambiguous matches to a separate audit file. Then, the metadata remain imperfect, however, so the resulting links should still be interpreted with great caution.

Table 1. Core bibliometric indicators of the final 398-record corpus

Indicator	Value
Final analytical records	398
Unique WoS UT identifiers	398
Publication year range	2019–2026 (2026 is partial)
Publication sources	169
Normalized author names	1055
Author appearances (gross)	1198
Single-authored publications	52
Multi-authored publications	346
Mean authors per document	3.01
Normalized keywords	1644
Normalized cited references	14119

3. Fundamental Bibliometric Findings

3.1. Annual Scientific Production

Table 2 documents and explicitly shows a sharp rise in scholarly interest to the field. Annual output increased from 4 papers in 2019 to 91 in 2025, while the available portion of 2026 already contains 129 papers. The annual growth rate reached 75% in 2025. The apparent 41.76% increase in 2026 should not be treated as a final annual rate because the year is incomplete. Even so, the broader upward trend is clear, although the latest surge may partly reflect indexing lags or the timing of data extraction.

Table 2. Scientific production by year

Year	Publication Count	Annual Change	Data Scope
2019	4	—	Full Year
2020	10	150.0%	Full Year
2021	27	170.0%	Full Year
2022	37	37.04%	Full Year
2023	48	29.73%	Full Year
2024	52	8.33%	Full Year
2025	91	75.0%	Full Year
2026	129	41.76%	Partial Year

3.2. Author Productivity

When we review, Chen, Xiaoping, and Zhao, Xiaotao are the most productive authors, with six publications each. Gocer, Ismet; Lee, Chien-Chiang; and Ongan, Serdar follow with five papers apiece. Yet even the leading authors account for only a small share of the corpus. TPU research is therefore distributed across many teams rather than concentrated within a narrow group of scholars.

Table 3. Top 15 most productive authors

Rank	Author	Publications	Corpus Share (%)
1	Chen, Xiaoping	6	1.51
2	Zhao, Xiaotao	6	1.51

3	Gocer, Ismet	5	1.26
4	Lee, Chien-Chiang	5	1.26
5	Ongan, Serdar	5	1.26
6	Suwanprasert, Wisarut	4	1.01
7	Yilmazkuday, Hakan	4	1.01
8	Yu, Linhui	4	1.01
9	Zhou, Kexuan	4	1.01
10	Borojo, Dinkneh Gebre	3	0.75
11	Cepni, Oguzhan	3	0.75
12	Dang, Buu Kiem	3	0.75
13	Gozgor, Giray	3	0.75
14	Hu, Nan	3	0.75
15	Kumar, Sanjay	3	0.75

3.3. National Production and Geographical Distribution

China leads the geographical distribution by a wide margin: So Chinese institutions appear in about 61% of the papers. After that dominance, The United States ranks second with 69 publications. Türkiye and the United Kingdom share third place with 29 papers each, followed by France, Pakistan, and India. Because one paper may include affiliations from several countries, naturally these percentages may overlap.

Table 4. Top 15 most productive countries/regions

Rank	Country/Region	Publications	Corpus Share (%)
1	China	241	60.55
2	United States	69	17.34
3	Türkiye	29	7.29
4	United Kingdom	29	7.29
5	France	18	4.52
6	Pakistan	16	4.02
7	India	14	3.52
8	Canada	12	3.02
9	Australia	11	2.76
10	Germany	9	2.26
11	Vietnam	9	2.26
12	Italy	8	2.01
13	South Korea	8	2.01
14	Azerbaijan	7	1.76
15	Bangladesh	7	1.76

3.4. Publication Sources and Bradford's Law

We see that *Finance Research Letters* is the leading outlet, with 33 papers (8.29%). This may be considered a surprising result because of the official scope of the journal. *Emerging Markets Finance and Trade* and the *Journal of International Economics* share second place. The inclusion of journals such as *Energy Economics* and the *International Review of Economics & Finance* also shows that TPU research now extends beyond traditional trade journals into finance and energy economics.

Table 5. Top 15 most productive publication sources

Rank	Publication Source	Publications	Corpus Share (%)
1	Finance Research Letters	33	8.29
2	Emerging Markets Finance and Trade	14	3.52
3	Journal of International Economics	14	3.52
4	International Review of Economics & Finance	13	3.27
5	Energy Economics	11	2.76
6	Applied Economics	10	2.51
7	Sustainability	10	2.51
8	Applied Economics Letters	8	2.01
9	Resources Policy	8	2.01
10	World Economy	8	2.01
11	European Economic Review	7	1.76
12	China Economic Review	6	1.51

13	Economic Analysis and Policy	6	1.51
14	Economics Letters	6	1.51
15	Pacific-Basin Finance Journal	6	1.51

The Bradford distribution reinforces this core–periphery pattern. Only 11 journals form the core zone, yet they published about 34% of the corpus. By contrast, Zone 3 required 121 sources to produce a comparable share.

Table 6. Distribution of Bradford zones

Zone	Number of Sources	Publication Count	Share (%)
Zone 1	11	136	34.17
Zone 2	37	130	32.66
Zone 3	121	132	33.17

4. Keyword Frequency and Co-Occurrence Analysis

As expected, “trade policy uncertainty” is the most frequent keyword and appears in 60% of the records. “Impact,” “investment,” and “China” follow. The prominence of “risk,” “volatility,” and “economic policy uncertainty” is equally revealing: researchers generally treat TPU as a systemic source of risk that can shape productivity, innovation, and wider economic performance, not merely as a question of tariff rates.

Table 7. Top 20 most frequently used normalized keywords

Rank	Keyword	Document Count	Corpus Share (%)
1	trade policy uncertainty	239	60.05
2	impact	106	26.63
3	investment	74	18.59
4	china	66	16.58
5	risk	36	9.05
6	volatility	36	9.05
7	economic policy uncertainty	34	8.54
8	policy uncertainty	31	7.79
9	liberalization	29	7.29
10	productivity	29	7.29
11	uncertainty	28	7.04
12	growth	27	6.78
13	shocks	27	6.78
14	exports	25	6.28
15	innovation	24	6.03
16	performance	24	6.03

Table 8. Fundamental characteristics of thematic clusters

Cluster	Prominent Core Terms	Term Count	Term Sum	Freq.	Centrality*	Density*
1	trade policy uncertainty; China; trade; economic growth; tariffs	54	686		11050	1016.67
2	impact; volatility; economic policy uncertainty; policy uncertainty; shocks	41	509		8540	1275.61
3	investment; liberalization; productivity; uncertainty; growth	39	503		9250	1476.92
4	risk; determinants; causality; model; political uncertainty	14	126		2560	335.71
5	India	1	4		0	0
6	Japan	1	4		0	0

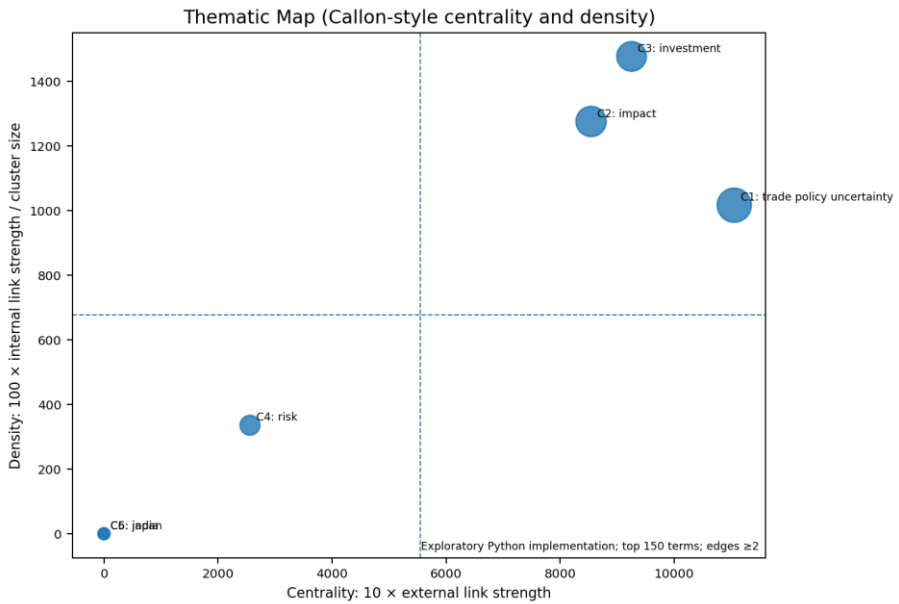


Figure 2. Network-based thematic map of TPU literature

**Note: Centrality and density are operational Callon-style metrics calculated within the co-occurrence network of the top 150 terms.*

6. Co-citation Analysis

The co-citation analysis identifies the foundational studies on which TPU research relies. Baker et al. (2016), which introduced the economic policy uncertainty index, is the strongest anchor and is cited by 185 records in the corpus. The studies by Handley and Limão (2014, 2015, 2017) on trade, welfare, and investment form another central strand. Caldara et al. (2020) received 135 citations for isolating the economic effects of TPU, confirming its position as a key reference.

Table 9. Top 20 most frequently co-cited references within the corpus

Rank	Reference	Intra-Corpus Citations	Cluster
1	Baker SR (2016)	185	1
2	Handley K (2017)	161	2
3	Caldara D (2020)	135	1
4	Handley K (2015)	128	2

5	Handley K (2014)	112	2
6	Feng L (2017)	102	2
7	Pierce JR (2016)	92	2
8	Crowley M (2018)	81	2
9	Liu Q (2020)	65	2
10	Bloom N (2009)	62	1
11	Gulen H (2016)	52	1
12	BERNANKE BS (1983)	47	1
13	Handley K (2022)	43	1
14	Melitz MJ (2003)	41	2
15	Imbruno M (2019)	39	2
16	Huang Y (2020)	37	1
17	Bianconi M (2021)	35	1
18	Steinberg JB (2019)	35	1
19	Benguria F (2022)	34	2
20	Caldara D (2022)	33	1

Table 10. Co-citation clusters of the top 50 references

Cluster	Labeling Reference	Ref. Count	Citation Sum	Example References
1	Baker SR (2016)	29	1077	Baker SR (2016); Caldara D (2020); Bloom N (2009)
2	Handley K (2017)	19	1046	Handley K (2017); Handley K (2015); Handley K (2014)
3	Amiti M (2019)	2	48	Amiti M (2019); Fajgelbaum PD (2020)
	Total	50		

7. Holistic Evaluation of Findings

Taken together, the analyses point to three broad themes. The first is measurement. The central position of Baker et al. (2016) shows how strongly the field depends on credible ways to quantify policy uncertainty. The prominence of Caldara et al. (2020) likewise reflects sustained demand for established models that identify TPU’s economic effects.

The second theme concerns business strategy. Frequent references to “investment,” “productivity,” and “exports” echo the influential work of Handley and Limão on firm decision-making. Tariff levels matter, but they are only part of the mechanism. Expectations about future trade rules can alter decisions that firms make today.

The third theme is financial risk. The frequent appearance of “risk” and “shocks,” together with the prominence of outlets such as *Finance Research Letters* and *Energy Economics*, indicates that TPU reaches well beyond customs and border policy. It also matters for financial markets and energy sectors. Bibliometric evidence, however, shows patterns of discussion and association; it does not establish causal relationships between the underlying variables.

8. Limitations and Future Research Agenda

This study has several limitations. We searched only the Web of Science database, so adding Scopus or other platforms could introduce different journals and change the rankings. Comparisons involving 2026 also require caution because the year is incomplete. Finally, excluding dual-tagged proceedings affected the corpus size directly; a different document-type rule would require the dataset to be rebuilt.

We used automated procedures to extract country affiliations and standardize keywords. These procedures may overlook subtle distinctions, and multi-country papers are necessarily assigned to more than one nation, so manual validation remains useful. In addition, inconsistencies in WoS reference metadata may leave small gaps in the co-citation maps despite our effort to separate ambiguous DOIs. The thematic map was generated with a custom Python script and should not be interpreted as a standard, ready-made Bibliometrix output.

Future research can proceed in several directions. One priority is to estimate how TPU affects particular industries and firms of different sizes. Researchers could also examine tariff uncertainty alongside geopolitical risk and non-tariff barriers, then trace how policy shocks move through global supply chains. More advanced text-mining methods, including AI-assisted approaches, may also support uncertainty indicators that are more precise than current news-based measures.

9. Conclusion

This chapter maps the rapid expansion of trade policy uncertainty research between 2019 and 2026. Using 398 Web of Science records, we show that publication activity rose sharply, although the 2026 observations cover only part of the year. The corpus spans 169 journals and more than 1,000 authors. *Finance Research Letters* is the leading outlet, while a core group of 11 journals accounts for roughly one-third of all publications.

China contributes the largest geographical share, followed by the United States; Türkiye and the United Kingdom also make substantial contributions. The keyword and thematic maps show that scholars do not treat TPU as a narrow trade issue. Instead, they connect it closely with corporate investment, economic growth, and market volatility. The most frequently co-cited studies concentrate on measuring uncertainty and explaining its effects on firm behavior.

Overall, the literature presents trade policy uncertainty as a systemic issue. Its effects range from investment decisions at individual factories to movements in financial markets. This chapter contributes by bringing that structure into view through a single, consistently cleaned dataset. The conclusions nevertheless remain conditional on the selected WoS corpus and the bibliographic rules applied.

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CHAPTER 8

**Keeping Pace? Sustainability
Performance and Economic
Development in Türkiye**

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1. Introduction

Sustainable development requires economic progress to be considered alongside environmental protection, social well-being, and the institutional capacity needed to sustain these outcomes over time. Economic development alone therefore provides an incomplete picture of a country's development trajectory, as countries with comparable levels of economic wealth may differ substantially in their environmental, social, and governance conditions. This has increased interest in country-level environmental, social, and governance (ESG) indicators as multidimensional measures of sovereign sustainability performance, referring to ESG performance assessed at the national rather than the corporate level. Unlike assessments based exclusively on economic outcomes, sovereign ESG frameworks make it possible to examine how environmental conditions, social development, and governance quality evolve both individually and collectively at the national level. In this context, sovereign ESG has gained prominence since the late 2010s, driven by increasing demands from asset owners and policymakers for more socially and environmentally conscious investment practices (Gratcheva & Gurhy, 2024).

The relationship between economic development and sovereign ESG performance is particularly important because improvements in economic and sustainability outcomes need not proceed uniformly. Existing cross-country evidence points to a close but heterogeneous relationship between the two, with the strength and nature of the association varying across countries, economic conditions, and ESG dimensions (Bayram & Feridun, 2026; Leung et al., 2025; Wang et al., 2023). Taken together, this literature suggests that economic and sustainability performance are closely interconnected but that their relationship is neither automatic nor uniform across countries or ESG dimensions.

A related measurement issue concerns the strong association between sovereign ESG scores and countries' levels of economic development. Gratcheva and Gurhy (2024) show that higher sovereign ESG scores remain closely associated with higher income levels and identify this relationship as a persistent income bias in sovereign ESG assessment. This close association with income complicates the interpretation and comparison of sovereign ESG performance across countries at different levels of economic development. A development-adjusted perspective therefore complements conventional ESG scores by asking not only how a country performs, but how that performance compares with the level associated with its economic development. This distinction provides the conceptual basis for the Sustainable GDP framework used in the present study, which evaluates sovereign ESG performance relative to economic development rather than relying exclusively on standardized ESG scores.

This distinction is particularly relevant for Türkiye, where assessing sustainability progress requires considering not only changes in sovereign ESG scores but also whether environmental, social, and governance performance has evolved in line with the country's economic development. Existing research involving Türkiye has examined the relationship between ESG performance and

economic growth, including recent comparative evidence for Türkiye and selected Turkic economies (Nazlıoğlu, 2026). However, the question addressed here is different. Rather than estimating the effect of ESG performance on economic growth or identifying the determinants of ESG performance, this study adopts a descriptive, development-adjusted perspective and examines how Türkiye's sovereign sustainability performance has evolved relative to its level of economic development over time. It further distinguishes among the environmental, social, and governance dimensions, since an aggregate ESG measure may conceal substantially different trajectories across the three pillars.

Against this background, the study examines Türkiye's sovereign ESG performance over the 2000–2023 period using data from the London Stock Exchange Group (LSEG). The analysis first evaluates the levels and temporal trajectories of the Environmental, Social, Governance, and Global ESG Scores and then uses LSEG's Sustainable GDP framework to assess sustainability performance relative to economic development. The Global Sustainable GDP gap is examined alongside its environmental, social, and governance components, and their temporal and cross-dimensional patterns are subsequently evaluated. Accordingly, the study addresses two research questions:

(RQ1) How did Türkiye's sovereign environmental, social, governance, and overall ESG performance evolve over the 2000–2023 period?

(RQ2) To what extent did Türkiye's sustainability performance keep pace² with its level of economic development, and how did this development-adjusted performance differ across the environmental, social, and governance dimensions over time?

By distinguishing changes in standardized ESG scores from development-adjusted sustainability gaps, the study provides a longitudinal assessment of whether improvements in Türkiye's sovereign ESG performance were accompanied by sustainability outcomes consistent with its level of economic development and whether this relationship evolved uniformly across the three ESG dimensions.

2. Conceptual Background and Related Literature

This section develops the conceptual background of the study from three complementary perspectives. It first considers sovereign ESG as a multidimensional framework for assessing sustainability performance, then examines the relationship between ESG performance and economic development, and finally discusses the rationale for evaluating sustainability performance relative to a country's level of economic development.

² In this study, “keeping pace” does not refer to equal growth rates in ESG scores and GDP. Rather, it refers to whether Türkiye's sustainability performance is consistent with, above, or below the level associated with its economic development within the LSEG Sustainable GDP framework.

Sovereign ESG assessment provides a multidimensional perspective on sustainability by extending the environmental, social, and governance framework to the country level. Although it draws on the broader ESG concept, its application to sovereigns differs fundamentally from corporate ESG because governments operate at a different scale and influence a wider range of economic, social, environmental, and institutional outcomes. Gratcheva, Emery, and Wang (2020) therefore caution against directly transferring corporate ESG concepts and empirical relationships to the sovereign context, where sustainability issues and their transmission mechanisms are considerably more complex. From this perspective, country-level ESG assessment brings together distinct dimensions of national sustainability rather than treating sustainability performance as a single underlying characteristic. Kong (2026), for example, characterizes country-level ESG performance in terms of environmental stewardship, social resilience, and institutional quality, while Jiang, Feng, and Yang (2022) similarly demonstrate the value of considering environmental, social, and governance dimensions in assessments of sovereign sustainability. At the same time, aggregation does not eliminate the analytical importance of the underlying dimensions. Recent evidence illustrates that aggregate ESG performance may coexist with substantially different configurations across its components. Although focusing on subnational rather than sovereign units, Polukhina, Napolskikh, Sheresheva, and Lezhnin (2026), in their analysis of 85 Russian regions, show that ESG profiles can differ substantially in their internal composition and that higher overall ESG performance tends to be associated with a more balanced distribution across environmental, social, and governance dimensions. Their findings highlight internal balance across ESG components as an important feature of sustainability profiles, reinforcing the value of examining not only aggregate ESG performance but also its underlying dimensional configuration. This dimensional distinction should also be accompanied by conceptual clarity regarding what ESG indicators represent. ESG-related measures may refer to different constructs and should not be treated interchangeably. Oprean-Stan, Vasiiu, Bratu, and Stan (2026) for example, distinguish ESG performance from sustainability-related uncertainty: whereas ESG performance captures an assessed sustainability profile, sustainability-related uncertainty reflects ambiguity in the ESG information environment rather than the level of sustainability quality itself. The present study focuses on observed sustainability performance and its environmental, social, and governance composition rather than on uncertainty surrounding ESG-related information.

A second consideration is the close relationship between sovereign ESG performance and economic development. Cross-country evidence indicates that the two are strongly interconnected, although the nature and strength of this relationship vary across countries and economic conditions. Hübel (2022) reports a strong correlation between country ESG ratings and GDP per capita and emphasizes the importance of distinguishing ESG-related effects from those

associated with economic development. Jiang et al. (2022) likewise document differences in ESG development across country income groups, indicating that the economic context is relevant to observed sustainability performance. Evidence examining the ESG–growth nexus also points to substantial heterogeneity. Wang et al. (2023) find a positive relationship between improvements in country-level ESG performance and economic growth, driven primarily by environmental and governance performance, while showing that this relationship differs according to income level, greenhouse gas emissions, and natural-resource dependence. Bayram and Feridun (2026) similarly report that socioeconomic development is positively associated with country-level ESG performance and that the relationships between ESG performance and its determinants vary across the ESG performance distribution. The relevance of economic conditions is also evident during periods of economic distress: Leung et al. (2025) find that economic crises are associated with deterioration in national ESG performance, with stronger effects in developing economies and declines across all three ESG dimensions. In the context of Türkiye, Nazlıoğlu (2026) provides recent evidence on the relationship between ESG performance and economic growth in Türkiye and selected Turkic economies. Taken together, this literature indicates that sovereign ESG performance is closely intertwined with the broader economic context, while the relationship remains heterogeneous across countries, economic conditions, and ESG dimensions.

The close association between economic development and sovereign ESG performance also raises an important measurement issue. Comparing sovereign ESG scores across major providers, Gratcheva et al. (2020) document a strong relationship between ESG ratings and national income and characterize the excessive representation of income in sovereign ESG assessment as an “ingrained income bias.” More recent evidence indicates that this issue remains relevant. Gratcheva and Gurhy (2024) show that higher sovereign ESG scores continue to be closely associated with higher income levels, highlighting the persistent influence of economic development on conventional sovereign ESG assessment. This implies that standardized ESG scores and development-adjusted sustainability performance address related but conceptually different questions: the former describe observed ESG performance on a standardized scale, whereas the latter evaluates that performance relative to a country's level of economic development. The need to account for countries' differing economic circumstances has also motivated alternative approaches to comparative ESG assessment. Shih, Hsu, Chen, Shih, and Shih (2026), for example, argue that comparisons based solely on observed ESG levels may be misleading when countries differ in resource endowments and structural constraints, and propose an efficiency-based framework that evaluates ESG outcomes relative to available economic capacity. Although conceptually distinct from this efficiency-based approach, the Sustainable GDP framework developed by LSEG (2025) reflects the broader principle that sustainability performance should be interpreted in relation to economic development. It operationalizes this principle by assessing

environmental, social, and governance performance relative to the levels associated with a country's economic development.

Taken together, these perspectives provide the conceptual foundation for the empirical strategy adopted in this study. Sovereign ESG is multidimensional, making it important to examine environmental, social, and governance performance alongside aggregate ESG performance; observed ESG outcomes are closely intertwined with economic development, making the economic context relevant to their interpretation; and development-adjusted measures provide a complementary perspective by evaluating sustainability performance relative to the level associated with a country's economic development. Accordingly, the analysis combines standardized sovereign ESG scores with aggregate and pillar-specific Sustainable GDP gaps to examine both the evolution and the dimensional configuration of Türkiye's sustainability performance.

3. Data and Methodology

This section describes the data and analytical framework used to assess Türkiye's sovereign sustainability performance over the 2000–2023 period. It first introduces the LSEG Sovereign ESG indicators used in the analysis, followed by the Sustainable GDP framework employed to evaluate sustainability performance relative to economic development. The final subsection outlines the descriptive analytical strategy used to examine temporal, dimensional, and cross-dimensional patterns in the data.

3.1. Data and Sovereign ESG Indicators

The analysis is based on sovereign-level environmental, social, and governance data for Türkiye obtained from the LSEG Sovereign ESG dataset. The study covers the period 2000–2023, providing 24 annual observations for each indicator. The LSEG framework organizes sovereign sustainability performance into three broad pillars, environmental, social, and governance, which encompass multiple underlying themes and indicators. The resulting ESG scores are standardized on a scale from 0 to 100, with higher values indicating stronger performance in the respective dimension (LSEG, 2025).

The environmental pillar captures themes related to areas such as natural resources, climate, biodiversity, and environmental pressures, while the social pillar covers dimensions associated with human development and social conditions, including health, education, employment, and inequality. The governance pillar reflects institutional and governance-related aspects, including political effectiveness, political stability, corruption, democratic life, business rights, security, and rent dependency (LSEG, 2025). Taken together, these thematic components provide a multidimensional representation of sovereign sustainability performance rather than relying solely on economic indicators.

Four ESG measures are used in the empirical analysis: the Environmental Score, Social Score, Governance Score, and Global ESG Score. The first three represent Türkiye's performance in the respective ESG pillars, while the Global ESG Score provides an aggregate measure of overall sovereign ESG

performance. These scores are first used to examine the level and evolution of Türkiye's sustainability performance over the sample period. The analysis then moves beyond these standardized ESG scores to assess sustainability performance relative to the country's level of economic development through the Sustainable GDP framework, which is described in the following section.

3.2. Sustainable GDP and Sustainability Gaps

While sovereign ESG scores provide information on the level of environmental, social, and governance performance, they do not by themselves indicate whether this performance is high or low relative to a country's level of economic development. To incorporate this development-adjusted perspective, the analysis draws on LSEG's Sustainable GDP framework. LSEG defines Sustainable GDP as the theoretical level of GDP consistent with the environmental, social, or governance performance achieved by a country. Accordingly, countries at similar levels of economic wealth may exhibit different levels of sustainability performance, and Sustainable GDP provides a common basis for relating these differences to economic development (LSEG, 2025).

The framework is constructed from more than 210 environmental, social, and governance indicators grouped into 31 themes. The contribution of individual indicators varies according to a country's income group, with indicator weights estimated through Partial Least Squares (PLS) regression models specific to five income groups. These weights reflect the extent to which individual indicators differentiate countries at comparable levels of economic development and explain cross-country differences in GDP per capita at purchasing power parity. For each indicator, an expected value is estimated conditional on the country's level of wealth using locally weighted smoothing (LOESS). This expected value can be interpreted as the level of the indicator expected for a country at that level of wealth, or equivalently as a benchmark based on countries with similar levels of economic development. Indicator-level performance is then determined by comparing the observed value with this expected value (LSEG, 2025).

These indicator-level performances are aggregated within the environmental, social, and governance pillars using income-group-specific weights to derive pillar-level performance and the corresponding Sustainable E, S, and G GDP measures. LSEG also provides an aggregate Sustainable GDP measure combining the three pillars; in the agnostic specification, this measure is calculated as the simple average of the three component Sustainable GDPs. The resulting framework therefore provides both pillar-specific and aggregate measures with which observed economic development can be compared (LSEG, 2025).

The sustainability-gap measures provided by LSEG capture the relative difference between Sustainable GDP and real GDP for each dimension and for the aggregate ESG measure. In the LSEG framework, a positive gap indicates that Sustainable GDP exceeds real GDP and therefore that the country's sustainability performance is above the level associated with its economic development and comparable peers. Conversely, a negative gap indicates that

Sustainable GDP falls below real GDP, implying performance below the corresponding development-adjusted benchmark. A value of zero indicates consistency between the two (LSEG, 2025). Importantly, these gaps should therefore be interpreted as relative, development-adjusted measures of sustainability performance rather than as absolute assessments of whether a country is sustainable or unsustainable.

Accordingly, four sustainability-gap measures are examined for Türkiye over 2000–2023: the Global Sustainable GDP gap and the environmental, social, and governance Sustainable GDP gaps. The Global gap provides an aggregate assessment of sustainability performance relative to economic development, whereas the three pillar-specific gaps allow the composition of this aggregate performance to be examined separately. This distinction is particularly important because a positive aggregate gap does not necessarily imply that environmental, social, and governance performance are simultaneously above their respective development-adjusted benchmarks.

3.3. Analytical Strategy

The empirical analysis follows a descriptive and sequential approach designed to evaluate both the evolution of Türkiye's sovereign ESG scores and its sustainability performance relative to the level of economic development. First, descriptive statistics are calculated for the Environmental, Social, Governance, and Global ESG Scores over the 2000–2023 period, and their annual trajectories are examined to identify broad changes in the level and composition of sovereign ESG performance. This initial analysis provides an overview of how Türkiye's sustainability performance evolved across the three ESG pillars before economic development is explicitly taken into account.

The analysis then turns to the Sustainable GDP gaps described in Section 3.2. The Global Sustainable GDP gap is examined first to assess Türkiye's aggregate sustainability performance relative to its level of economic development. This aggregate perspective is subsequently disaggregated into environmental, social, and governance gaps to determine whether the overall pattern is shared across the three dimensions. For each pillar-specific gap, descriptive statistics and the frequency of positive and negative annual observations are reported, together with their annual trajectories over the sample period.

To examine broader changes over time without defining subperiods on the basis of observed turning points in the data, the 24-year sample is divided into three equal eight-year intervals: 2000–2007, 2008–2015, and 2016–2023. Average environmental, social, governance, and Global Sustainable GDP gaps are calculated for each subperiod. This comparison is used to assess how the relative position of the three sustainability dimensions changed across broader phases of the sample, while avoiding the interpretation of these intervals as statistically identified structural breaks or regimes.

Finally, the analysis considers the cross-dimensional alignment of the environmental, social, and governance gaps. For the purposes of this study,

sustainability alignment is assessed descriptively according to the simultaneous position of the three pillar-specific gaps relative to zero. Particular attention is given to simultaneous positive alignment, defined as years in which the environmental, social, and governance gaps all exceed zero. Such a configuration indicates that performance in all three dimensions is simultaneously above the corresponding development-adjusted benchmarks. The concept concerns the direction of the gaps rather than similarity in their magnitudes and should therefore not be interpreted as a measure of convergence among the ESG dimensions.

Annual alignment patterns are visualized using a heatmap of the environmental, social, and governance sustainability gaps centered on zero. Contrasting colors distinguish negative from positive gaps, while color intensity represents their magnitude. The heatmap therefore complements the subperiod averages by retaining year-to-year information and allowing the direction, magnitude, persistence, and simultaneity of the three-dimensional gaps to be assessed jointly.

4. Results

This section presents the empirical findings in four stages. It first examines the evolution of Türkiye's sovereign ESG scores and then evaluates sustainability performance relative to the country's level of economic development using the Global Sustainable GDP gap. The analysis subsequently considers environmental, social, and governance gaps separately before examining broader changes in their cross-dimensional alignment over time.

4.1. Evolution of Sovereign ESG Performance

As a starting point, Türkiye's sovereign ESG performance is examined through the environmental, social, and governance scores over the 2000–2023 period. This initial assessment provides an overview of the three sustainability dimensions before considering their performance relative to Türkiye's level of economic development. Table 1 reports descriptive statistics for the three pillar scores and the aggregate ESG score, while Figure 1 illustrates their annual trajectories over the sample period.

Table 1. Descriptive Statistics of Türkiye's Sovereign ESG Scores, 2000–2023

Indicator	Mean	Std. Dev.	Min	Max	2000	2023	Change
Environmental	64.95	4.44	58.90	73.70	61.10	73.70	+12.60
Social	64.14	4.98	56.60	72.30	58.90	72.30	+13.40
Governance	66.90	3.74	60.70	74.50	62.10	74.50	+12.40
Global ESG	65.34	4.31	58.70	73.60	60.40	73.60	+13.20

Note: Change is calculated as the 2023 score minus the 2000 score; positive (negative) values indicate an increase (decrease) over the period.

As shown in Table 1, all four ESG scores increased between 2000 and 2023. Among the three dimensions, governance recorded the highest average score (66.90), followed by environmental (64.95) and social (64.14) performance. The

social dimension exhibited the greatest variability over the sample period, with a standard deviation of 4.98, while governance showed the lowest variability (3.74). In terms of the overall change between the beginning and end of the period, the social score registered the largest increase, rising by 13.40 points, followed by the environmental (12.60 points) and governance (12.40 points) scores. The aggregate ESG score also increased by 13.20 points, from 60.40 in 2000 to 73.60 in 2023. Overall, these descriptive statistics indicate a broad improvement across all three dimensions of Türkiye's sovereign ESG performance over the sample period.

While Table 1 summarizes the overall levels and changes in ESG performance, it does not capture how these developments unfolded over time. Figure 1 therefore presents the annual trajectories of the environmental, social, and governance scores, allowing differences in their temporal patterns to be examined more closely.

Figure 1. Evolution of Environmental, Social and Governance Scores in Türkiye, 2000–2023

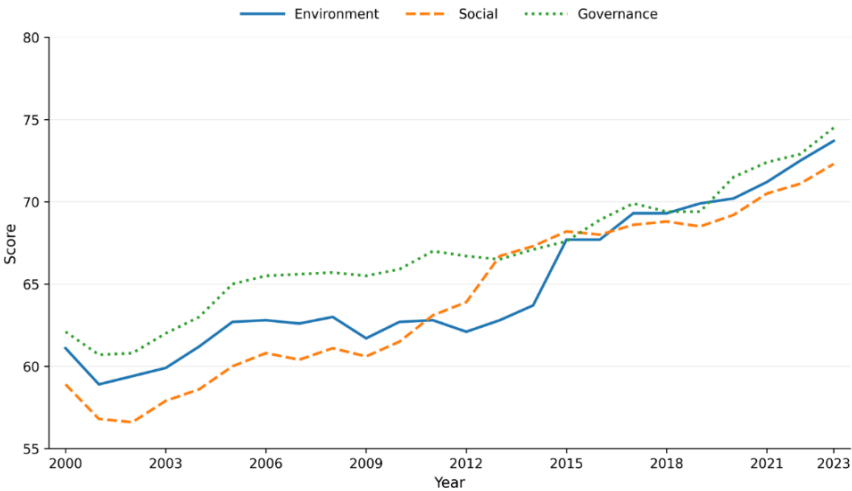


Figure 1 reveals that the overall improvement identified in Table 1 did not follow a uniform pattern across either time or ESG dimensions. All three scores declined at the beginning of the period, reaching relatively low levels in 2001–2002, before generally recovering thereafter. Governance remained above the environmental and social scores throughout most of the first half of the sample period and followed a relatively gradual upward trajectory. In contrast, the social dimension, which initially recorded the lowest scores, improved more rapidly from the early 2010s and temporarily exceeded both other dimensions in 2013–2015. Environmental performance followed a more moderate path until 2014, before showing a marked increase between 2014 and 2015. From the mid-2010s

onward, the three scores moved within a narrower range, with only relatively small differences between their scores toward the end of the sample period. Despite some short-term fluctuations, all three dimensions subsequently followed a broadly upward trajectory and reached their highest observed values in 2023.

Taken together, the descriptive statistics and temporal patterns indicate broad improvements in Türkiye's environmental, social, and governance scores between 2000 and 2023, accompanied by a narrowing of the differences among the three dimensions in the latter part of the period. However, higher ESG scores do not by themselves indicate whether sustainability performance has kept pace with Türkiye's level of economic development. The next section therefore examines sustainability performance relative to Türkiye's level of economic development using the Sustainable GDP gap.

4.2. Sustainability Performance Relative to Economic Development

To assess sustainability performance in relation to economic development, the Global Sustainable GDP gap is examined over the 2000–2023 period. This indicator represents the relative gap between the Sustainable GDP associated with the country's overall ESG performance and its real GDP, thereby providing a development-adjusted measure of sustainability performance. A positive gap indicates that Sustainable GDP exceeds real GDP, whereas a negative gap indicates the opposite. Figure 2 presents the evolution of this gap for Türkiye over the sample period.

Figure 2. Global Sustainable GDP Gap in Türkiye, 2000–2023

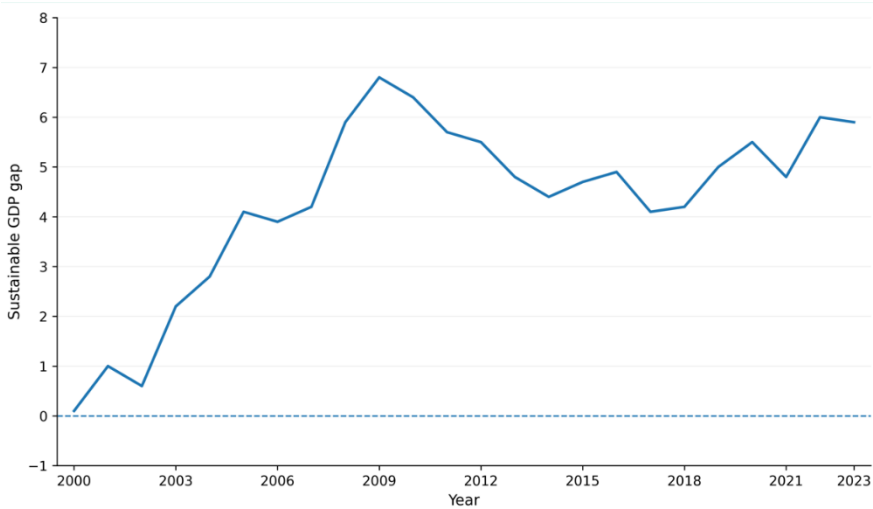


Figure 2 shows that Türkiye's Global Sustainable GDP gap remained positive throughout the entire 2000–2023 period, although its magnitude varied considerably over time. The gap increased from only 0.10 in 2000 to a peak of

6.80 in 2009, indicating a widening positive gap during the first decade of the sample. Following this peak, the gap generally narrowed, reaching 4.10 in 2017, although the decline was not continuous. In the subsequent years, it remained positive but fluctuated, ranging between 4.20 and 6.00 before ending at 5.90 in 2023. Across the full sample, the gap averaged approximately 4.31 and did not fall below zero in any year.

The persistence of a positive gap indicates that Türkiye's overall sustainability performance, as measured within the LSEG framework, remained above its development-adjusted benchmark throughout the sample period. However, the variation in the size of the gap shows that the extent of this relative sustainability performance was not constant over time. In particular, the strong widening observed during the first decade was followed by a period of narrowing and subsequent fluctuations rather than a continuous improvement.

While the consistently positive global gap provides an aggregate picture, it does not reveal whether environmental, social, and governance performance contributed equally to this outcome. The next section therefore disaggregates the overall pattern into its three ESG dimensions.

4.3. Environmental, Social and Governance Sustainability Gaps

To examine the dimensional differences underlying the aggregate sustainability performance, the Global Sustainable GDP gap is disaggregated into its environmental, social, and governance components. Table 2 presents descriptive statistics for the three sustainability gaps over the 2000–2023 period, together with the number of years in which each dimension recorded positive and negative values.

Table 2. Descriptive Statistics of Türkiye's Sustainability Gaps, 2000–2023

Indicator	Mean	Std. Dev.	Min	Max	Positive Years	Negative Years
Environmental	3.17	2.19	−1.60	6.10	20	4
Social	−1.08	4.45	−10.60	3.50	14	10
Governance	10.85	3.08	6.40	15.40	24	0

Note: Positive (negative) years indicate years in which Sustainable GDP was above (below) real GDP for the respective ESG dimension.

Table 2 reveals substantial differences in relative performance across the three ESG dimensions. Governance recorded by far the highest average gap (10.85) and remained positive in all 24 years of the sample period. Environmental performance also exhibited a positive average gap (3.17), with positive values in 20 of the 24 years. In contrast, the social dimension recorded a negative average gap (−1.08) and exhibited positive values in only 14 years, compared with 10 years of negative values. The social dimension also showed the greatest variability, with a standard deviation of 4.45, compared with 3.08 for governance

and 2.19 for environmental performance. The range of observed values further highlights these differences. Governance remained well above zero, with gaps ranging from 6.40 to 15.40, whereas environmental performance ranged from -1.60 to 6.10. Social performance displayed the widest spread, ranging from -10.60 to 3.50, consistent with its higher variability over the sample period.

Overall, the descriptive evidence indicates that the consistently positive global sustainability gap identified in the previous section does not reflect a uniform pattern across the three ESG dimensions. In particular, the aggregate pattern coexists with persistent positive governance performance, predominantly positive environmental performance, and a more mixed social performance profile.

While Table 2 summarizes the overall distribution of the three sustainability gaps, it does not show when the positive and negative values occurred or how the differences among the ESG dimensions evolved over time. Figure 3 therefore presents the annual trajectories of the environmental, social, and governance sustainability gaps.

Figure 3. Environmental, Social and Governance Sustainability Gaps in Türkiye, 2000–2023

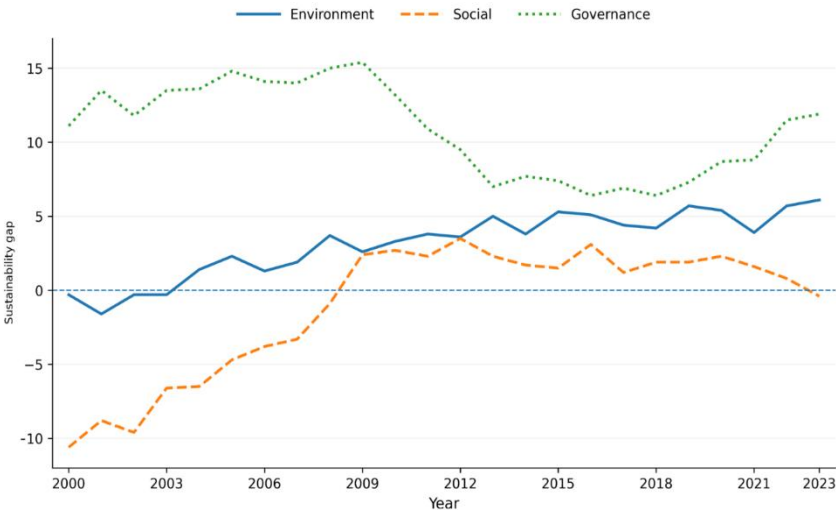


Figure 3 further demonstrates that the three ESG dimensions followed markedly different trajectories over the sample period. The environmental gap was negative during 2000–2003 but turned positive in 2004 and remained above zero thereafter. Despite some year-to-year fluctuations, the environmental gap generally widened over the remainder of the period, reaching its highest observed value of 6.10 in 2023. The social dimension displayed a more pronounced transition. Starting from a substantially negative gap of -10.60 in 2000, the social gap gradually narrowed during the 2000s and turned positive in 2009. It remained

positive through 2022, before declining slightly below zero (−0.40) in 2023. Governance followed a distinctly different pattern. Its sustainability gap remained positive throughout the entire period and reached a peak of 15.40 in 2009. This was followed by a pronounced narrowing, with the gap declining to 6.40 in 2016 and again in 2018. From 2019 onward, however, the positive governance gap widened again, rising to 11.90 by 2023. Thus, the consistently positive governance gap identified in Table 2 was accompanied by considerable variation in its magnitude over time.

Taken together, Figure 3 shows that the positive aggregate sustainability performance documented in Section 4.2 was underpinned by markedly different developments across the ESG dimensions. In the early years, positive governance performance coexisted with negative environmental and particularly pronounced negative social gaps. Environmental performance moved into positive territory earlier, while the social dimension followed later, resulting in all three gaps being simultaneously positive from 2009 to 2022. The slight return of the social gap to negative territory in 2023 further indicates that positive aggregate sustainability performance does not necessarily imply uniform performance across all three dimensions.

4.4. Changing Patterns of Sustainability Gaps and Alignment

The preceding analysis revealed substantial differences in the trajectories of environmental, social, and governance sustainability gaps. To provide a more systematic view of how these relative positions changed over time, the sample period is divided into three equal eight-year subperiods: 2000–2007, 2008–2015, and 2016–2023. Table 3 reports the average environmental, social, governance, and global sustainability gaps for each subperiod, allowing changes in the relative performance of the three ESG dimensions to be compared across broader phases of the sample period.

Table 3. Average Sustainability Gaps across Subperiods in Türkiye

Period	Environmental	Social	Governance	Global
2000–2007	0.55	−6.74	13.30	2.36
2008–2015	3.89	1.94	10.76	5.53
2016–2023	5.06	1.55	8.49	5.05

Table 3 reveals a marked change in the relative configuration of sustainability performance across the three subperiods. During 2000–2007, governance displayed a substantially positive average gap (13.30), while the social dimension recorded a pronounced negative average gap (−6.74). Environmental performance, by contrast, remained close to the benchmark on average, with a relatively small positive gap of 0.55. This pattern changed considerably in 2008–2015: the average environmental gap increased to 3.89 and the social gap turned

positive (1.94), while the governance gap, although still the largest among the three dimensions, declined to 10.76. Over the same period, the average global gap increased from 2.36 to 5.53. In 2016-2023, the environmental gap increased further to an average of 5.06, whereas the governance gap narrowed to 8.49. The social gap remained positive on average (1.55), although slightly below its 2008-2015 level. The global gap also remained strongly positive, averaging 5.05. Taken together, the subperiod averages indicate a substantial reduction in the pronounced cross-dimensional differences observed during the early years of the sample. This change was driven primarily by the movement of social performance from a strongly negative to a positive average gap, the strengthening of the environmental gap, and the simultaneous narrowing of the initially large positive governance gap.

While the subperiod averages summarize broader changes in the magnitude of the sustainability gaps, they may conceal year-to-year differences within each period. Examining the annual environmental, social, and governance gaps therefore provides a complementary perspective on the evolution of sustainability alignment. Figure 4 presents a heatmap of the three-dimensional sustainability gaps over the 2000–2023 period. The color scale is centered on zero, with negative and positive values represented by contrasting colors and greater color intensity indicating larger gap magnitudes. This visualization allows both the direction and magnitude of the gaps to be assessed simultaneously, while making their persistence and cross-dimensional patterns over time more readily visible.

Figure 4. ESG Sustainability Alignment in Türkiye, 2000–2023

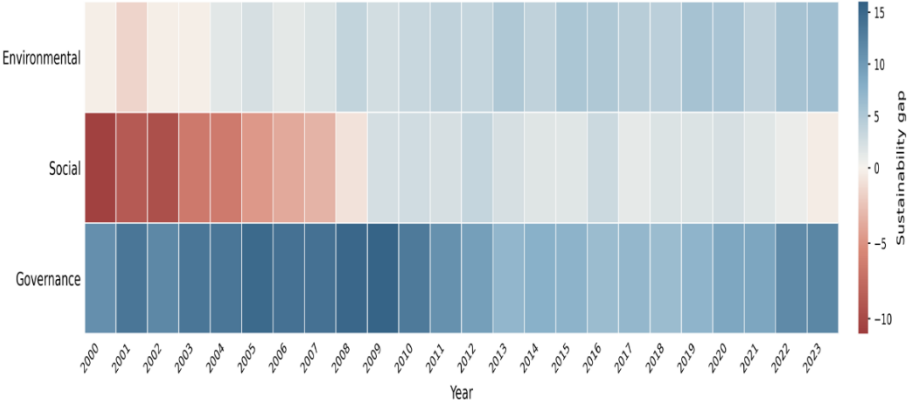


Figure 4 highlights a clear change in the cross-dimensional pattern of Türkiye's sustainability gaps over time. In the early years of the sample, the three dimensions were markedly differentiated: governance displayed consistently positive and relatively large gaps, while social performance was strongly negative and environmental performance remained slightly negative or

close to the benchmark. This cross-dimensional contrast gradually diminished as the environmental gap moved into positive territory from 2004 onward and the initially pronounced negative social gap progressively narrowed. From 2009 to 2022, all three dimensions simultaneously recorded positive gaps, indicating an extended period in which environmental, social, and governance performance were all above their respective development-adjusted benchmarks.

The heatmap also shows that this broader positive alignment did not result from uniform changes across the three dimensions. The initially large positive governance gap became less pronounced during the middle and later parts of the sample, while environmental performance shifted toward increasingly positive gaps. Social performance underwent the most visible change, moving from strongly negative gaps in the early 2000s to predominantly positive values from 2009 onward. In 2023, however, the social gap moved slightly below zero (-0.40), interrupting the simultaneous positive pattern observed since 2009. Given the small magnitude of this gap and its occurrence in a single year, this observation is interpreted cautiously rather than as evidence of a persistent shift.

Taken together, the subperiod averages and annual heatmap patterns indicate a substantial change in the composition of Türkiye's relative sustainability performance over the sample period. The pronounced cross-dimensional differences observed in the early years gradually diminished as the environmental gap became increasingly positive, the initially large negative social gap narrowed and subsequently turned positive, and the positive governance gap became less pronounced. These developments resulted in a broader sustainability configuration in which positive relative performance was no longer concentrated primarily in governance but extended across all three ESG dimensions for much of the latter part of the sample.

5. Discussion

This section discusses the main findings in relation to the study's research questions and the broader literature. It first considers Türkiye's sustainability performance in relation to economic development and then examines the changing composition and alignment of environmental, social, and governance performance over time.

5.1. Sustainability Performance and Economic Development in Türkiye

The findings reveal two complementary aspects of Türkiye's sustainability trajectory over the 2000–2023 period. From the perspective of standardized sovereign ESG scores, environmental, social, governance, and overall ESG performance all improved over the sample period, although their trajectories differed over time. This broad upward movement indicates that Türkiye ended

the period with stronger observed ESG performance than at its beginning. At the same time, the narrowing differences among the three ESG scores in the latter part of the sample suggest that the dimensions became more similar in their observed performance levels over time. These findings address the first research question by showing that Türkiye's sovereign ESG performance improved overall, but that the process was neither temporally nor dimensionally uniform.

A different but complementary picture emerges when sustainability performance is evaluated relative to economic development. The Global Sustainable GDP gap remained positive throughout the entire sample period, indicating that, within the LSEG framework, Türkiye's aggregate sustainability performance consistently remained above the level associated with its economic development. This finding is important because it shows that the improvement observed in standardized ESG scores was accompanied by positive development-adjusted sustainability performance at the aggregate level. However, the magnitude of the Global Sustainable GDP gap did not increase continuously. Its widening during the first decade was followed by narrowing and subsequent fluctuations, even as standardized ESG scores generally continued to improve. The two measures therefore provide related but distinct information: rising standardized ESG scores indicate improvement in observed sustainability performance, whereas changes in the Sustainable GDP gap indicate whether that performance strengthened or weakened relative to the benchmark associated with Türkiye's economic development.

This distinction is particularly relevant in light of the broader literature on the close relationship between sovereign ESG performance and economic development. Previous cross-country studies show that ESG performance and economic outcomes are interconnected, but that this relationship varies across income levels, country characteristics, economic conditions, and ESG dimensions (Bayram & Feridun, 2026; Leung et al., 2025; Wang et al., 2023). Evidence involving Türkiye likewise documents a relationship between ESG performance and economic growth (Nazlıoğlu, 2026). The present findings complement rather than directly test this literature, since the analysis does not estimate the effect of ESG performance on economic growth or the reverse. Instead, it shows descriptively how Türkiye's sustainability performance evolved once economic development is incorporated into the benchmark against which ESG outcomes are evaluated. In this respect, the results also illustrate the relevance of concerns raised in the sovereign ESG literature regarding the close association between conventional ESG scores and income levels (Gratcheva et al., 2020; Gratcheva & Gurhy, 2024). Evaluating standardized ESG scores alongside development-adjusted sustainability gaps makes it possible to

distinguish improvement in observed ESG performance from changes in sustainability performance relative to economic development.

Importantly, the consistently positive Global Sustainable GDP gap should not be interpreted as evidence that Türkiye performed uniformly strongly across all areas of sustainability. The aggregate measure summarizes environmental, social, and governance performance and can therefore coexist with substantially different positions across the underlying dimensions. Indeed, the disaggregated results show that this was the case for Türkiye: the positive aggregate position was supported by markedly different environmental, social, and governance trajectories. This distinction shifts the interpretation from the question of whether aggregate sustainability performance kept pace with economic development to the question of how that relative performance was distributed across the three ESG dimensions over time, which is considered in the following section.

5.2. Uneven ESG Progress and Sustainability Alignment

The aggregate perspective discussed above conceals important differences in the composition of Türkiye's development-adjusted sustainability performance. The pillar-specific results reveal a pronounced asymmetry across environmental, social, and governance dimensions, particularly during the earlier years of the sample. Governance consistently remained above its development-adjusted benchmark, whereas environmental performance began closer to the benchmark and initially fell below it, and social performance started from a substantially weaker relative position. This pattern indicates that Türkiye's positive aggregate sustainability performance was initially supported disproportionately by governance rather than by uniformly positive performance across all three dimensions. The distinction is important because it demonstrates that a favorable aggregate sustainability position does not necessarily imply a similarly favorable configuration at the pillar level.

The dimensional composition of this relative performance nevertheless changed substantially over time. Environmental performance moved above its development-adjusted benchmark from 2004 onward, while the initially large negative social gap progressively narrowed and became positive in 2009. At the same time, the exceptionally large positive governance gap observed during the earlier part of the sample became less pronounced. The subperiod evidence reinforces this interpretation: the pronounced differences characterizing 2000–2007 diminished in the subsequent periods as environmental performance strengthened, social performance moved from a strongly negative to a positive average position, and governance remained positive despite a narrowing of its relative advantage. Türkiye's sustainability trajectory can therefore be characterized not simply as an improvement in aggregate performance, but as a change in its composition, from an initially governance-dominated configuration

toward a broader distribution of positive development-adjusted performance across the three ESG dimensions.

This finding is consistent with the broader argument that aggregate ESG measures may coexist with substantial differences across their underlying components. Polukhina et al. (2026), although examining Russian regions rather than sovereign countries and employing a different composite ESG framework, identify structural asymmetries across environmental, social, and governance performance and emphasize the importance of internal balance among ESG components. Türkiye's experience provides a related longitudinal perspective: dimensional differences were pronounced in the early part of the sample but became less marked as environmental and particularly social performance improved relative to their development-adjusted benchmarks. The comparison should not be interpreted as evidence of identical ESG dynamics across the two settings; rather, it reinforces the analytical value of looking beneath aggregate ESG measures to identify how individual sustainability dimensions contribute to the overall performance profile.

The changing dimensional configuration is particularly evident in the emergence of simultaneous positive sustainability alignment. From 2009 to 2022, all three pillar-specific gaps were positive, indicating that environmental, social, and governance performance were simultaneously above their respective development-adjusted benchmarks. This extended period represents a broader distribution of positive relative sustainability performance than that observed during the early years of the sample. Importantly, however, positive alignment should not be interpreted as convergence among the three ESG dimensions. As defined in this study, alignment concerns the simultaneous direction of the pillar-specific gaps relative to zero rather than similarity in their magnitudes. The emergence of positive alignment therefore indicates a broadening of development-adjusted sustainability performance across dimensions, not the elimination of differences among them. Similarly, the slight movement of the social gap below zero in 2023 should be interpreted cautiously. Given its small magnitude and occurrence in a single year, it does not by itself establish a persistent reversal of the broader pattern observed since 2009.

These findings have an important implication for the assessment of sovereign sustainability performance. Aggregate indicators provide a useful summary of overall ESG performance, but they may obscure substantial differences in the relative position and evolution of the underlying dimensions. In Türkiye's case, the Global Sustainable GDP gap remained positive throughout the sample even when individual pillars, most notably the social dimension in the early years, were below their development-adjusted benchmarks. Assessing aggregate and pillar-specific development-adjusted measures jointly therefore provides a more informative account of sustainability progress, distinguishing between an overall

favorable relative position and the extent to which that position is shared across environmental, social, and governance dimensions. For policymakers and analysts, this suggests that monitoring sovereign sustainability performance at the aggregate level should be complemented by attention to its dimensional composition, particularly when the objective is to identify areas in which sustainability performance may be lagging relative to economic development.

6. Conclusion

This study examined the evolution of Türkiye's sovereign sustainability performance over the 2000–2023 period, with particular attention to whether this performance kept pace with the country's level of economic development. To address this question, the analysis combined two complementary perspectives: standardized sovereign ESG scores, which capture observed environmental, social, governance, and overall ESG performance, and LSEG's Sustainable GDP gaps, which evaluate sustainability performance relative to development-adjusted benchmarks. This combined approach made it possible to distinguish changes in observed ESG performance from changes in Türkiye's sustainability position relative to its economic development.

The findings provide clear answers to the study's two research questions. First, Türkiye's environmental, social, governance, and overall ESG scores all improved between 2000 and 2023, although their trajectories differed over time. Second, Türkiye's aggregate sustainability performance remained above its development-adjusted benchmark throughout the sample period, as indicated by the consistently positive Global Sustainable GDP gap. However, this aggregate result was neither temporally constant nor uniform across the underlying ESG dimensions. Governance remained above its development-adjusted benchmark throughout the period, environmental performance moved from an initially weaker position to persistently positive gaps from 2004 onward, and social performance underwent the most substantial transition, moving from pronounced negative gaps in the early years to predominantly positive performance from 2009 onward. Consequently, Türkiye's relative sustainability profile shifted from an initially governance-dominated configuration toward a broader distribution of positive performance across the three ESG dimensions, with simultaneous positive alignment observed from 2009 to 2022.

These findings highlight the analytical value of complementing conventional sovereign ESG scores with development-adjusted measures. Rising ESG scores alone do not reveal whether sustainability performance is keeping pace with economic development, just as a favorable aggregate development-adjusted position does not necessarily imply similarly favorable performance across all ESG dimensions. The Türkiye case demonstrates that the two perspectives can provide distinct but complementary information: standardized scores capture the evolution of observed ESG performance, while Sustainable GDP gaps reveal how

that performance compares with the level associated with economic development. Examining the environmental, social, and governance gaps separately further reveals changes in the composition of aggregate sustainability performance that would otherwise remain obscured. Accordingly, assessments of sovereign sustainability progress may benefit from considering both aggregate and pillar-specific development-adjusted indicators alongside conventional ESG scores.

The findings should nevertheless be interpreted in light of several limitations. First, the analysis focuses exclusively on Türkiye and therefore does not establish whether the patterns identified here extend to countries with different economic and institutional characteristics. Second, the study is descriptive and does not identify the causal mechanisms underlying changes in environmental, social, or governance performance. Third, the development-adjusted results depend on the construction and methodological choices of the LSEG Sustainable GDP framework, including its underlying indicators, weighting procedures, and development-based benchmarks. Finally, the analysis is limited to the 2000–2023 period for which the relevant data are available. Future research could extend the analysis through cross-country comparisons, examine the robustness of the findings using alternative development-adjusted sustainability measures, and investigate the economic and institutional factors associated with changes in individual ESG dimensions. Such extensions would help determine whether the changing sustainability configuration observed for Türkiye reflects a country-specific trajectory or a broader pattern in the relationship between economic development and sovereign sustainability performance.

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CHAPTER 9

**Does Capacity Utilization Drive
Economic Growth? Evidence from
Türkiye on Short- and Long-Run Dynamics**

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1. Introduction

What drives economic growth is a question macroeconomists keep returning to, and one variable that surfaces repeatedly in that conversation is the capacity utilization rate. By measuring how much of a country's existing production capacity is actually put to use, it doubles as a barometer for demand pressure, production intensity, and where an economy sits within the business cycle. Firms respond to demand signals by adjusting how much of their installed capacity they put to work: when aggregate demand strengthens, a larger share of that capacity is drawn into use and output rises with it, whereas weakening demand leads firms to scale back production and utilization to fall. This responsiveness is precisely what makes the indicator such a widely used gauge of where an economy stands in the cycle.

A number of empirical studies go further, treating movements in capacity utilization as a proxy for how intensively the capital stock is actually being deployed — not merely a snapshot of short-run fluctuations, but a window into production efficiency and how effectively existing resources are being used. The mechanism is arguably sharper still in emerging markets, where structural rigidities and demand-led growth patterns can magnify how much capacity utilization matters for overall performance. Türkiye is a case in point: swings in industrial production and demand conditions there produce sizeable movements in capacity utilization that plausibly feed back into growth outcomes. Yet the long-run side of this relationship has received comparatively little direct attention in the Turkish context — most existing work leans on short-term indicators or industrial production data, leaving the longer time-series dynamics underexplored. That gap is the starting point for this paper.

Three contributions follow from this. New long-run evidence on the capacity utilization–growth link in Türkiye is produced using the ARDL bounds testing approach; short-run dynamics and long-run equilibrium are estimated jointly within one framework rather than treated separately; and by incorporating inflation alongside a level-shift dummy capturing the structural change from 2022Q1 onward, the analysis situates the relationship within the broader macroeconomic environment, including recent structural changes in the Turkish economy.

Working with quarterly data from 2014Q2 to 2025Q2, the estimates point to a positive, statistically significant effect of capacity utilization on growth and to a stable long-run equilibrium linking the three variables. The evidence further suggests that this link is carried mainly by long-term adjustment rather than by short-run causal interaction.

The paper proceeds as follows. Section 2 reviews the relevant literature; Section 3 presents the econometric methodology; Section 4 describes the data and reports the empirical results; and Section 5 concludes the study with a discussion of the main findings and their implications.

2. Literature Review

The idea that capacity utilization tracks the pulse of an economy is not new. As a measure of how much of the installed production base is actually being run, it has repeatedly been tied in the macroeconomic literature to swings in aggregate demand, investment behavior, and the business cycle more broadly.

Some of the earliest contributions to this literature treat capacity utilization primarily as a cyclical signal. Shapiro (1989) ties its variation to how firms adjust production in response to demand shocks, and Bernanke and Parkinson (1991) similarly find that movements in capacity utilization carry useful information about short-run swings in production and activity. A separate strand links capacity utilization more directly to growth outcomes. Corrado and Matthey (1997) trace it back to firms' own production decisions and connect it closely to output dynamics, while Burnside, Eichenbaum, and Rebelo (1995) interpret it as a proxy for effective capital services that feeds through into output.

More recent evidence suggests the utilization–growth relationship is not uniform across horizons. Gahn and González (2022), for example, find a positive short-run association that weakens and becomes ambiguous over the long run, and Erdoğan and Telek (2023) reach a broadly similar conclusion for Türkiye, where short-run effects are positive but long-run effects fail to reach significance.

Beyond growth, a substantial body of work looks at how capacity utilization interacts with inflation, typically finding that fuller utilization coincides with greater price pressure as production costs and demand conditions tighten. Finn (1996) shows that this relationship depends heavily on the nature of the underlying shock — technological change and energy price swings, for instance, pull it in different directions — while Dotsey and Stark (2005) caution that the link is not particularly stable over time. Ahmed and Cassou (2017) add a causal dimension, finding that inflation can move capacity utilization in the short run even though the reverse channel is weaker.

Turkish evidence tells a broadly consistent story. Külünk (2023) and Bayar et al. (2024) both document a positive link between industrial indicators and growth, while Abdioğlu (2013) and Arabacı and Arabacı (2008) find capacity utilization to be a meaningful driver of inflation dynamics domestically. The size and even the sign of these effects, however, tend to shift depending on the sample period and methodology adopted, underscoring how sensitive this relationship can be to modeling choices. What is comparatively rare, across this otherwise sizeable literature, is a study that considers capacity utilization, growth, and inflation together rather than two at a time; most work still isolates pairwise relationships.

This paper is positioned to fill that gap, using the ARDL bounds testing method to trace how capacity utilization, growth, and inflation move together in Türkiye and, in doing so, to build a fuller picture of how production capacity dynamics feed into overall macroeconomic performance. What sets it apart from prior work, in short, is treating all three variables jointly within a single time-series framework rather than in isolation.

Econometric Methodology

To examine the short- and long-run relationships among the variables, this study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al. (2001). The ARDL framework enables the testing of cointegration relationships among variables while simultaneously allowing the estimation of both short- and long-run coefficients. Pesaran et al. (2001) developed the F-bounds test, which is based on the joint significance of the lagged level terms included in the ARDL specification. The same study also proposed the t-bounds test, which focuses on the lagged level of the dependent variable. The t-bounds test is particularly useful in cases where the p-value associated with the conventional t-statistic does not conform fully to the standard asymptotic distribution, thereby providing more reliable inference (Varol, Torun, & Sönmezler, 2024). Within the error correction framework, this test also provides evidence on whether the error correction term (ECT) is negative and statistically significant, thereby indicating the speed at which the system converges toward its long-run equilibrium following a short-run disturbance.

One of the main advantages of the ARDL approach is that it remains applicable when the variables are integrated of order zero, $I(0)$, or order one, $I(1)$, provided that none of the variables is integrated of order two, $I(2)$. In addition, by specifying an Unrestricted Error Correction Model (UECM), short-run dynamics and long-run relationships can be analyzed jointly within a single framework (Narayan & Smyth, 2006).

In this study, GDPG, representing real GDP growth, is employed as the dependent variable, while the manufacturing capacity utilization rate (CU) and consumer price index inflation rate (INF) are included as explanatory variables. The theoretical relationship among these variables can be expressed in the following functional form:

$$GDPG_t = f(CU_t, INF_t) \quad (1)$$

The linear form of this relationship can be expressed as:

$$GDPG_t = \beta_0 + \beta_1 CU_t + \beta_2 INF_t + \varepsilon_t \quad (2)$$

where β_0 denotes the constant term, β_1 and β_2 represent the coefficients associated with the explanatory variables, and ε_t denotes the error term.

The Unrestricted Error Correction Model (UECM) underlying the ARDL bounds testing approach is specified as follows:

$$\Delta GDPG_t = \beta_0 + \sum_{i=1}^m \beta_{1i} \Delta GDPG_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta CU_{t-i} + \sum_{i=0}^p \beta_{3i} \Delta INF_{t-i} + \phi_1 GDPG_{t-1} + \phi_2 CU_{t-1} + \phi_3 INF_{t-1} + \varepsilon_t \quad (3)$$

In Equation (3), Δ denotes the first-difference operator, the β coefficients capture the short-run dynamics, while the ϕ coefficients associated with the lagged level terms represent the long-run relationship among the variables (Narayan, 2005).

The hypotheses employed to test for the existence of a long-run relationship are specified as follows:

$$H_0: \phi_1 = \phi_2 = \phi_3 = 0$$

$$H_1: \phi_1 \neq \phi_2 \neq \phi_3 \neq 0$$

The null hypothesis states that there is no long-run cointegration relationship among the variables. This hypothesis is tested using the Wald test-based F-statistic. If the calculated F-statistic is lower than the lower critical bound, the null hypothesis of no cointegration cannot be rejected. If the F-statistic lies between the lower and upper critical bounds, the result is inconclusive. If the F-statistic exceeds the upper critical bound, the null hypothesis is rejected, indicating the existence of a long-run cointegration relationship among the variables.

Once cointegration is established, the long-run coefficients are estimated through the following ARDL model:

$$GDPG_t = \alpha_0 + \sum_{i=1}^m \alpha_{1i} GDPG_{t-i} + \sum_{i=0}^n \alpha_{2i} CU_{t-i} + \sum_{i=0}^p \alpha_{3i} INF_{t-i} + \varepsilon_t \quad (4)$$

After identifying the long-run relationship, an Error Correction Model (ECM) is estimated to analyze the short-run dynamics:

$$\Delta GDPG_t = \alpha_0 + \sum_{i=1}^m \delta_{1i} \Delta GDPG_{t-i} + \sum_{i=0}^n \delta_{2i} \Delta CU_{t-i} + \sum_{i=0}^p \delta_{3i} \Delta INF_{t-i} + \lambda ECT_{t-1} + \varepsilon_t \quad (5)$$

where ECT_{t-1} denotes the lagged error correction term. The coefficient λ measures the speed at which short-run deviations from equilibrium are corrected toward the long-run equilibrium. A negative and statistically significant error correction coefficient indicates that the system converges back to its long-run equilibrium following a short-run disturbance.

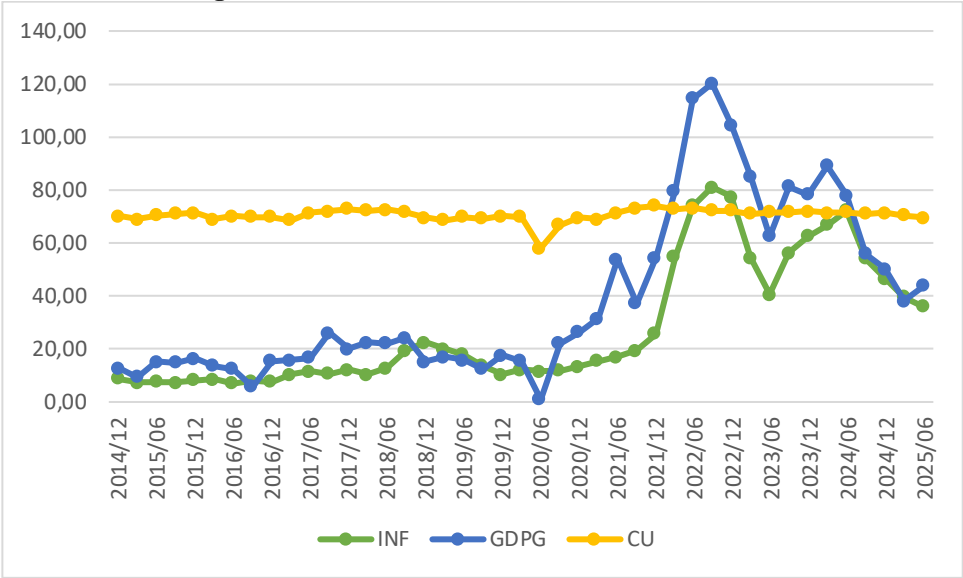
Data Set and Empirical Results

This study analyzes the relationship between economic growth and selected macroeconomic indicators in the Turkish economy. The dataset consists of quarterly observations covering the period from 2014Q2 to 2025Q2. Gross Domestic Product (GDPG) is used as the dependent variable to represent economic growth. Two key explanatory variables that may affect economic growth are included in the model. The first is the inflation rate (INF), which captures changes in the general price level in the economy. The second is the manufacturing capacity utilization rate (CU), which indicates the extent to which existing production capacity in the industrial sector is utilized.

The GDPG and INF series used in the study were obtained from the database published by the Turkish Statistical Institute (TurkStat), while the CU series was retrieved from the Electronic Data Delivery System of the Central Bank of the Republic of Türkiye (CBRT). Since the variables are measured at a quarterly frequency, the series were seasonally adjusted prior to the analysis.

To provide a clearer view of the behavior of the series over the sample period, the corresponding time-series plots are presented below.

Figure 1. Time-Series Plots of the Variables



The graphical inspection reveals cyclical fluctuations and indications of structural changes in the series over the sample period. In particular, both GDPG and CU exhibit a pronounced decline around 2020, suggesting a temporary structural disruption in the series. Following 2021, both GDPG and CU display a strong upward tendency, accompanied by considerable volatility and fluctuations over time. During the same period, the inflation rate (INF) also shows a marked increase.

Following the graphical analysis, descriptive statistics were calculated to summarize the main statistical characteristics of the variables. The results are presented and briefly evaluated in Table 1.

Table 1. Descriptive Statistics of the Variables

	Mean	Median	Max	Min	Std.Dev.	Skewness	Kurtosis	JB	Prob.
INF	27.538	15.391	82.142	6.772	23.486	1.010	2.552	7.678	0.021
GDPG	38.723	24.066	120.196	-0.839	32.022	1.052	2.939	7.935	0.019
CU	70.536	70.904	73.678	57.877	2.437	-3.275	18.116	486.319	0.000

Note: Number of observations=43

The mean values of the series indicate that INF, GDPG, and CU have average values of 27.53, 38.72, and 70.53, respectively. The minimum and maximum values show that INF ranges from 6.77 to 82.14, GDPG from -0.83 to 120.19, and CU from 57.87 to 73.67. The standard deviations reveal relatively high volatility in INF (23.48) and GDPG (32.02), whereas CU (2.43) follows a comparatively more stable pattern. The skewness coefficients indicate positive skewness for INF and GDPG, while CU exhibits negative skewness. Overall, the

descriptive statistics suggest that the general price level and economic growth were characterized by greater fluctuations over the sample period, whereas the manufacturing capacity utilization rate displayed comparatively limited variation.

Following the descriptive analysis, unit root tests were conducted to determine the stationarity properties of the series. Given the possibility of structural breaks in the variables, the Zivot–Andrews (1992) unit root test, which endogenously determines a single structural break, was employed instead of relying solely on conventional unit root tests. The results are reported in Table 2.

Table 2. Results of the Zivot–Andrews Unit Root Test with a Structural Break

Variable	Break Date	Test Statistic
$INF_{(1)}^A$	03/01/2022	-6.835*
$INF_{(1)}^B$	12/01/2019	-3.338
$INF_{(1)}^C$	03/01/2022	-7.985*
$GDPG_{(0)}^A$	03/01/2021	-2.589
$GDPG_{(0)}^B$	12/01/2023	-2.257
$GDPG_{(0)}^C$	03/01/2022	-4.621
$CU_{(0)}^A$	06/01/2021	-4.974**
$CU_{(0)}^B$	09/01/2020	-3.986
$CU_{(0)}^C$	06/01/2021	-4.864***
$\Delta GDPG_{(0)}^A$	12/2022	-7.025*
$\Delta GDPG_{(0)}^B$	06/2022	-6.051*
$\Delta GDPG_{(0)}^C$	12/2022	-6.858*

Note 1: Superscripts A, B, and C denote Model A, Model B, and Model C, respectively, while subscripts (0) and (1) indicate the corresponding lag lengths. For stationary series, *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Note 2: The critical values for Model A are -5.34, -4.93, and -4.58 at the 1%, 5%, and 10% significance levels, respectively. For Model B, the corresponding critical values are -4.80, -4.42, and -4.11, while for Model C they are -5.57, -5.08, and -4.82, respectively.

In the preceding stage of the analysis, the graphical inspection revealed pronounced fluctuations in the series and suggested the presence of structural breaks, particularly after 2020. Accordingly, the Zivot–Andrews unit root test, which allows for an endogenously determined structural break, was applied. The Zivot–Andrews test is estimated under three alternative specifications. Model A allows for a break in the intercept only, Model B allows for a break in the trend only, and Model C allows for simultaneous breaks in both the intercept and the trend. As can be observed from Figure 1, the INF series appears to exhibit a structural break in both its level and trend. Therefore, Model C is considered the most appropriate specification for INF. The GDPG series contains a unit root under all three model specifications. For the CU series, no pronounced change in

trend is observed. Hence, Model A, which allows for a break in the intercept only, is considered more appropriate for CU.

Accordingly, the results indicate that the stationarity properties of the series vary across model specifications. For INF, the test statistics obtained under Models A and C are lower than the corresponding critical values, indicating that the series is stationary in the presence of a structural break. By contrast, under Model B, the test statistic remains above the critical values, suggesting that the series contains a unit root. Moreover, the concentration of the estimated break dates around 2022 points to a significant structural change in the inflation series during this period.

For GDPG, the test statistics under Models A, B, and C are all above the relevant critical values. This indicates that the GDPG series contains a unit root in levels and is therefore non-stationary. However, the results for the first-differenced series show that the test statistics are lower than the critical values under all three specifications, demonstrating that GDPG becomes stationary after first differencing.

The results for CU also vary depending on the model specification. The series is found to be stationary at the 5% significance level under Model A and at the 10% significance level under Model C, whereas it contains a unit root under Model B. In addition, the estimated break dates for CU are concentrated around the 2020–2021 period, suggesting that a structural change in the utilization of manufacturing capacity occurred during this interval.

Overall, the results indicate that the series exhibit structural breaks and differ in their orders of integration. In particular, the finding that GDPG becomes stationary after first differencing, while the remaining variables are stationary in levels under the relevant structural-break specifications, indicates that the variables are integrated of order $I(0)$ and $I(1)$. This mixed order of integration supports the suitability of the ARDL bounds testing approach for the empirical analysis. The corresponding ARDL bounds test results are reported in Table 3.

Table 3. ARDL Model Results				
	Coefficient	Std. Error	t-Statistic	p-value
ΔGDPG_{t-1}	0.4589	0.1503	3.054*	0.0043
CU	0.1117	0.0428	2.614**	0.0131
INF	0.0114	0.0058	1.963***	0.0576
DUMMY	0.0794	0.2451	0.324	0.7478
C	-6.4305	2.8527	-2.254**	0.0305
R^2				0.8896
$\bar{R}^2$				0.8770

*, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. DUMMY denotes a level-shift dummy taking the value 1 from 2022Q1 onward and 0 otherwise.

The ARDL(1,0,0) model, selected on the basis of the Akaike Information Criterion (AIC), was estimated with the logarithm of GDPG as the dependent variable. According to the estimation results, the one-period lagged value of the dependent variable is positive and statistically significant at the 1% level, with a coefficient of 0.4589. This finding indicates that economic growth is influenced by its past values and exhibits a dynamic adjustment process.

The coefficient of CU is 0.1117 and is statistically significant at the 5% level. Since the dependent variable is expressed in logarithmic form, this result implies that a one-unit increase in CU is associated with an approximately 0.11% increase in GDPG, *ceteris paribus*. This finding suggests that a more intensive utilization of existing production capacity contributes positively to economic growth. The coefficient of INF is 0.0114 and is statistically significant at the 10% level. Accordingly, a one-unit increase in INF is associated with an approximately 0.01% increase in GDPG, *ceteris paribus*. However, given that this effect is significant only at the 10% level, the evidence for the positive impact of inflation on economic growth is relatively weak compared with that of CU.

The time-series plots reveal a pronounced break or divergence, particularly around the second quarter of 2022. To control for the potential effect of this period, a dummy variable was introduced into the model. The time-series plots and the structural-break analysis indicate a pronounced change around the beginning of 2022. To account for this structural shift, a level-shift dummy variable was included in the model. The dummy variable takes the value of 1 from 2022Q1 onward and 0 for the preceding periods, thereby capturing a potential persistent change in the level of the underlying macroeconomic relationship.

The level-shift dummy is statistically insignificant, indicating that, after controlling for CU and INF and the dynamic structure of the model, the post-2022Q1 shift does not exert an additional statistically significant effect on GDPG. Nevertheless, the dummy is retained as a deterministic control to account for the structural change identified in the preliminary analysis.

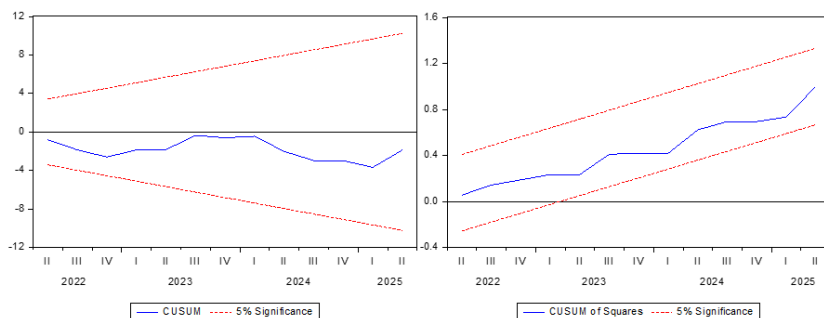
Regarding the overall explanatory performance of the model, the R^2 and $\bar{R}^2$ values are relatively high. This suggests that the explanatory variables included in the model account for a substantial proportion of the variation in GDPG.

Overall, the results indicate that the capacity utilization rate (CU) has a positive and statistically significant effect on economic growth, while inflation (INF) exhibits a weaker but positive relationship with growth. Following the estimation of the ARDL model, diagnostic tests were conducted to assess whether the model satisfies the relevant econometric assumptions. The results are presented in Table 4.

Table 4. Diagnostic Tests for the ARDL Model

Test	Statistic	p-value
Jarque-Bera	2.916	0.233
Breusch-Godfrey LM	1.757	0.780
Breusch-Pagan-Godfrey	5.025	0.285
Ramsey RESET	0.191	0.665

First, the results of the Jarque–Bera normality test indicate that the residuals are normally distributed. Since the corresponding p-value is greater than 0.05, the null hypothesis of normality cannot be rejected, suggesting that the residuals do not violate the normality assumption. To examine whether the model suffers from serial correlation, the Breusch–Godfrey LM test was applied. The reported p-value are greater than 0.05, indicating that there is no evidence of autocorrelation in the model residuals. The presence of heteroskedasticity was assessed using the Breusch–Pagan–Godfrey test. The p-value associated with the reported test statistics are all greater than 0.05. These findings suggest that the null hypothesis of homoskedasticity cannot be rejected and that the constant variance assumption is satisfied. Finally, the Ramsey RESET test was employed to assess whether the functional form of the model is correctly specified. The p-value corresponding to the F-statistic exceed 0.05. This result indicates that there is no evidence of model misspecification arising from an incorrect functional form or omitted nonlinear terms.

Figure 2. CUSUM and CUSUMSQ Stability Plots

The CUSUM and CUSUMSQ stability test results show that both statistics remain within the corresponding confidence bounds throughout the sample period. This indicates that the estimated model coefficients are stable over time and that there is no evidence of parameter instability. Accordingly, the model can be regarded as stable over the period under consideration. Overall, these findings suggest that the estimated model produces statistically reliable and consistent results.

Table 5. Short- and Long-Run Coefficients of the ARDL(1,0,0) Model

Short Run				
	Coefficient	Std.Error	t-statistic	p-value
<i>ECT</i>	-0.5410	0.1503	-3.955	0.001
<i>CU</i>	0.1117	0.0428	2.614	0.013
<i>INF</i>	0.0114	0.0058	1.963	0.058
<i>DUMMY</i>	0.0794	0.2451	0.324	0.748
<i>C</i>	-6.4305	2.8527	-2.254	0.031
Long Run				
	Coefficient	Std.Error	t-statistic	p-value
<i>CU</i>	0.2065	0.0753	2.741	0.0096
<i>INF</i>	0.0211	0.0093	2.266	0.0298

According to the ARDL(1,0,0) model reported in the table, the error correction coefficient is -0.541 and statistically significant. This finding indicates that approximately 54% of the short-run disequilibrium is corrected within one period. In other words, deviations from the long-run equilibrium are adjusted at a relatively rapid pace.

Regarding the short-run effects, both *CU* and *INF* have positive and statistically significant coefficients. The coefficient of *CU* is 0.1117 and is statistically significant, while the coefficient of *INF* is 0.0114 and is significant at the 10% level. The *DUMMY* variable, however, is statistically insignificant in the short run, indicating that the the post-2022Q1 level shift does not exert a statistically significant effect on GDPG.

The long-run estimates show that the coefficients of *CU* and *INF* are 0.2065 and 0.0211, respectively. Both coefficients are positive and statistically significant, indicating that capacity utilization and inflation are positively associated with GDPG in the long run.

Overall, the ARDL model reveals statistically significant relationships in both the short and long run. Moreover, the negative and statistically significant error correction term confirms the existence of a stable adjustment mechanism through which short-run deviations are corrected and the system converges toward its long-run equilibrium.

Table 6. F-Bounds t-Bounds Test Results

F-Bounds Test			
Significance	I(0)	I(1)	Conclusion
10%	3.373	4.377	✓
5%	4.133	5.260	✓
1%	5.893	7.337	—
<i>F-statistic: 4.931</i>			
t-Bounds Test			
Significance	I(0)	I(1)	Conclusion
%10	-2.57	-3.21	✓
%5	-2.86	-3.53	—
%1	-3.43	-4.10	—
<i>t-statistic: -3.600</i>			

Note 1: The ✓ symbol indicates the presence of cointegration.

The F-bounds and t-bounds test results support the existence of a long-run relationship among the variables. At the 10% significance level, the F-bounds statistic exceeds both the I(0) lower bound and the I(1) upper bound. At the 5% significance level, it exceeds the I(0) lower bound but remains below the I(1) upper bound, yielding an inconclusive result at that level. The t-bounds test, however, confirms the existence of cointegration, as the calculated t-statistic is more negative than the I(1) critical value at the 5% significance level. Therefore, taken together, the bounds test results provide evidence in favor of a long-run equilibrium relationship. The short- and long-run estimates further indicate that the economic variables included in the model have statistically significant effects on GDPG and that the system adjusts toward its long-run equilibrium.

Table 7. Granger Causality Test Results

Null Hypothesis	F-Statistic	Prob.
GDPG does not Granger-cause CU	0.422	0.659
CU does not Granger-cause GDPG	1.319	0.281
INF does not Granger-cause CU	0.248	0.782
CU does not Granger-cause INF	1.259	0.296
INF does not Granger-cause GDPG	1.757	0.188
GDPG does not Granger-cause INF	6.187	0.0052***

Note: *** indicates rejection of the null hypothesis at the 1% significance level.

The pairwise Granger causality results provide further evidence on the short-run predictive relationships among the variables. No statistically significant Granger causality is detected between CU and GDPG in either direction, as the null hypotheses that GDPG does not Granger-cause CU and that CU does not Granger-cause GDPG cannot be rejected ($p = 0.659$ and $p = 0.281$, respectively). This finding suggests that the relationship between capacity utilization and economic growth is not primarily driven by short-run predictive interactions. Rather, when considered together with the ARDL and error correction results, it points to a relationship that operates predominantly through the long-run equilibrium mechanism identified in the preceding analysis.

Similarly, no evidence of Granger causality is found between CU and INF. The null hypotheses that INF does not Granger-cause CU and that CU does not Granger-cause INF cannot be rejected, with p -values of 0.782 and 0.296, respectively. Thus, neither variable appears to contain significant short-run predictive information for the other over the sample period.

A different pattern emerges for the relationship between economic growth and inflation. The null hypothesis that GDPG does not Granger-cause INF is rejected at the 1% significance level ($F = 6.187$, $p = 0.0052$), whereas the null hypothesis that INF does not Granger-cause GDPG cannot be rejected ($p = 0.188$). These results indicate unidirectional Granger causality running from economic growth to inflation. In predictive terms, past values of GDP growth contain statistically significant information for explaining subsequent movements in inflation, while past inflation does not provide comparable predictive information for GDP

growth. Economically, this pattern is consistent with the possibility that stronger economic activity is followed by increased price pressures; however, the Granger causality results should be interpreted as evidence of predictive precedence rather than structural causation.

Taken together, the causality findings complement the ARDL and error correction results. While CU is significantly associated with economic growth within the estimated short- and long-run ARDL framework, the absence of Granger causality between CU and GDPG suggests that their dynamic relationship is more strongly reflected in the long-run equilibrium adjustment than in short-run predictive causality. By contrast, GDPG exhibits significant short-run predictive content for INF, indicating a one-way dynamic running from economic growth to inflation.

Discussion and Conclusion

This paper set out to trace how capacity utilization, inflation, and economic growth interact in Türkiye over 2014Q2–2025Q2, using the ARDL bounds testing approach to do so. The central finding is a positive, statistically significant relationship between capacity utilization and growth: higher utilization goes hand in hand with stronger growth, underscoring that fuller use of existing productive capacity is a meaningful driver of activity, and pointing more broadly to how much production-side dynamics and demand conditions shape growth outcomes in the Turkish economy. Inflation, too, is positively linked to growth, though the effect is modest in size — plausibly a byproduct of demand-driven expansions that carry rising prices along with them. The relationship should not be over-interpreted, but it does sit comfortably alongside patterns documented elsewhere in emerging markets. Taken together, the bounds test and error correction results confirm a stable long-run equilibrium among the three variables, with an estimated error correction term of -0.541 implying that roughly 54% of any short-run disequilibrium closes within a quarter. Short-term shocks to growth, on this evidence, are largely transitory rather than persistent.

The Granger causality tests add an important qualification: capacity utilization and growth show no short-run predictive link, so their relationship appears to be a long-run one rather than something driven by quarter-to-quarter dynamics. Growth and inflation, by contrast, are connected by a one-way causal channel running from growth to inflation, suggesting that stronger economic activity can itself generate inflationary pressure. For policy, the implication is that measures to lift capacity utilization and production efficiency can meaningfully support growth — cutting idle capacity, raising industrial productivity, and keeping demand conditions stable all stand out as levers likely to pay off in more sustainable growth.

The study is not without limitations: the sample period is relatively short and the set of macroeconomic variables deliberately narrow. Extending the analysis to include indicators such as industrial production, investment, or labor market variables, or testing the robustness of these results under alternative econometric methods, would be natural directions for future work. More broadly, this study

contributes integrated evidence on how capacity utilization, inflation, and growth move together in Türkiye, reinforcing the case that supply-side, production-capacity conditions deserve a central place in understanding the country's macroeconomic performance.

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CHAPTER 10

**The Relationship Between Stock Market,
Inflation, Exchange Rate, and Oil Prices in
China: Evidence from SVAR Analysis**

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Introduction

The stability in the stock market is important for the functioning of the entire economy (Hong et al., 2024). Stock prices are known as the present values of future cash flows of firms (Zhao, 2010), and are affected by many variables such as oil prices, inflation, exchange rates, interest rates, etc. The impact of oil shocks on the macroeconomic variables occurs through supply, demand, and trade channels (Schneider, 2004). First, the increasing oil prices after the oil shock provide a redistribution of income between oil exporting and importing countries (Brown & Yücel, 2002) and thus reduce demand. Second, since increasing oil prices reduce the total demand of firms, total supply also decreases. As a result, there is a decrease in capital and labor productivity and therefore a decrease in potential output (Cunado & Perez, 2005). Unforeseen developments such as risk and uncertainty expected after this process may cause supply and demand to fluctuate and the effects of this process to continue for a long time (Schneider, 2004). Therefore, the macroeconomic implications of energy price shocks are significant. The transmission mechanism from oil prices to the stock market works as follows: rising oil prices increase production costs. These costs are passed through consumers and lead to an increase in inflation expectations. In this case, the Central Bank increases short-term interest rates to reduce inflation. Thus, firms' short-term borrowing costs increase, which means lower cash flows. Consequently, stock prices lose value due to increased discount rates and/or lower cash flows (Degiannakis et al., 2018). On the other hand, oil price increases mean higher production costs and lower consumption for oil importing economies. This situation is reflected to companies with low cash flows and low stock prices (Antonakakis et al., 2017). In summary, increases in oil prices closely affect economic activity, inflation, corporate earnings and monetary policy. This process also affects stock and financial markets.

Flow-oriented exchange rate models (Dornbusch & Fischer, 1980) and stock-oriented models (Frankel (1983); Branson (1983)) have been developed to explain the linkage between stock markets and exchange rates. While flow-oriented exchange rate models focus on the effect of exchange rate changes on stock markets, equity-oriented models argue that innovations in stock markets affect exchange rates (Ajayi et al., 1998). When domestic stock prices rise, the local currency appreciates as global investors buy more local assets (Rai & Garg, 2022). According to macroeconomic theory, exchange rates and stock prices are positively correlated. A fall in the exchange rate of a country's currency encourages exports and increases the revenue of industries that compete with exports and imports, thereby raising the average level of stock prices (Wu, 2000). However, under inflationary conditions, the linkage between the exchange rate and stock price is likely to be negative. This is because when inflation increases, the exchange rate rises as a result of the depreciation of the local currency, and the increase in inflation expectations requires a higher risk premium and hence a

higher rate of return. This process has a depressing effect on stock prices (Wu, 2000).

The Chinese stock market reflects China's regulatory and supervisory power, economic targets, and significant role in global markets. The Chinese stock market has evolved rapidly over recent decades, becoming a significant force in both domestic and global finance. The Chinese stock market has become a central part of the global financial system, with increasing price informativeness, unique risk-return dynamics, and significant diversification potential (Zhao et al., 2016). However, it is still immature compared to the stock markets of Europe and the United States due to reasons such as lack of professional investment information, sensitivity to external shocks, and volatility risk (Xiao et al., 2024).

The fluctuations in oil prices have significant effects on inflation and the stock market in China, where oil consumption is largely dependent on imports (Zhao et al., 2016; Audi et al., 2025). Volatility in oil prices affects production costs and inflation. In addition to this direct effect, it can also create indirect effects such as a decrease in economic growth and consumer confidence and the devaluation of the Chinese currency (Aladwani, 2025). Therefore, the fluctuations in oil prices can impact on the stock market through exchange rates. China has long been an important driver of global oil demand, but oil demand has slowed since 2024. During the 2000-2023 period, China was responsible for 50% of the increase in world oil demand, recording an average increase of 518,000 barrels per day (bpd) (Downs & Rajendran, 2024). According to Moody's Investors Service research, China's crude oil demand is expected to peak in the coming years and India is expected to lead in oil demand due to slowing growth in recent years, a decreasing population, increasing sales of new energy vehicles, and rapid transition towards energy diversification (Kennedy, 2025). Depending on these developments, the effects of oil prices on exchange rates, inflation, and stock markets will continue in the coming years, albeit at a slower pace.

Figure 1

Time series of the variables from 2000m1 to 2024m12

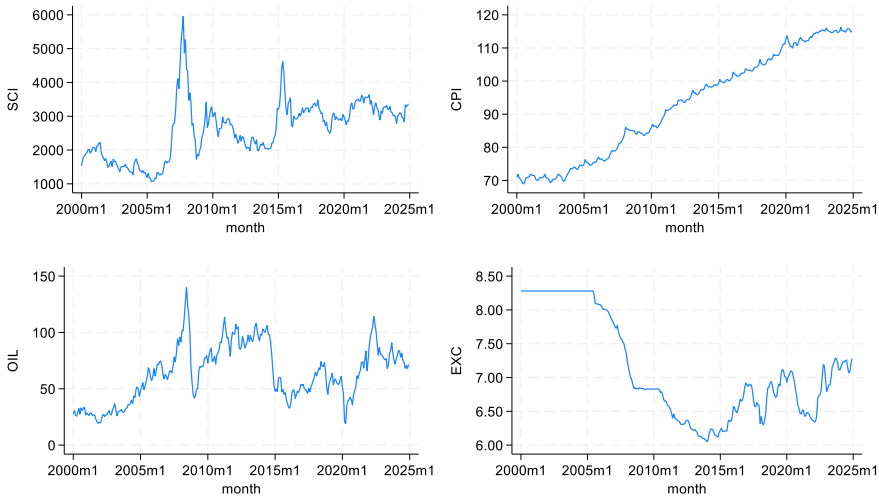


Figure 1 shows the trend of the variables over time. Accordingly, the Chinese stock market has been significantly affected by major events such as the 2008 crisis, the Russia-Ukraine war, the 2018 US-China trade war, and the 2020 pandemic. In this context, the stock market has followed a volatile trend over the years, but it has maintained an upward trend. Oil prices are also affected by external shocks and fluctuate cyclically. During the pandemic, insufficient aggregate demand and production restrictions brought oil prices to minimum levels. The global recovery following the pandemic has also reflected to oil prices. The CPI index, calculated as 2015=100, reflects the inflationary developments experienced after 2015. China continues its tendency to keep the Yuan low against the dollar to gain a significant advantage in global competition. China, which kept the Yuan/Dollar exchange rate stable for a long time, began to gradually lower it from mid-2006 onwards. China does not allow the yuan to float completely freely, it keeps the currency under control through a "managed floating exchange rate" regime.

The number of studies in the literature that explain stock markets, oil prices, inflation, and exchange rate together is quite limited. Furthermore, there are no studies that analyze these variables together for China using Structural Vector Autoregressive (SVAR) Approach. In this context, identifying the relationships between variables in the long term makes a significant contribution to policy design. Therefore, it is believed that this study will contribute to the literature.

The rest of the paper is organized as follows: Section 2 includes a literature review on the interaction between variables in China and other countries. Section

3 covers the data, and methodology. Section 4 includes the findings of the study. Section 5 contains conclusions, policy implications, and suggestions for the future studies.

Literature Review

Inflation and Stock Price

In the 1930s, pro-cyclical movements in money, inflation, and stock prices led to positive or insignificant relations (Kaul, 1987). Therefore, until the mid-1970s, many economists believed in a positive relationship between real stock returns and inflation, based on Fisher's (1930) hypothesis (Khil & Lee, 2000). After this period, Fama (1981) pointed to a negative correlation between the stock returns and inflation based on the positive relationship between stock market and real activity and the negative relationship between inflation and real activity. Some authors have thought that inflation rates affect stock market volatility and risk. Many countries have experienced stock market declines during periods of high inflation, as stocks and other financial assets were unable to keep up with increases in commodity prices. In addition, there is extreme volatility in stock market returns during these periods (Geetha et al., 2011).

Most studies have found a negative relationship between inflation and stock prices. Stock market returns can be negatively affected by inflation, as inflation reduces the present value of companies' expected future profits and therefore their stock prices (Geetha et al., 2011). Some of these studies are as follows: Fama & Schwert (1977); Fama (1981); Kaul (1987); Zhao (1999); Khil & Lee (2000); Spyrou (2001); Ioannides et al. (2005); Khumalo (2013); Qamri et al. (2015), etc. The negative correlation between inflation and stock prices is strengthened when the source of inflation is nonmonetary, that is, related to real factors (Danthine & Donaldson, 1986; Stulz, 1986; Marshall, 1992).

There are some studies that find a long-term positive inflation effect. Jaffe & Mandelker (1976) reported a negative relation between inflation and the stock market in the short term but a positive relation over the long period 1875-1970. Boudoukh & Richardson (1993) find a long-run positive relationship between stock returns and inflation in the United States and the United Kingdom during 1802-1990. Anari & Kolari (2001) found evidence for the existence of the Fisher effect in the long run by examining monthly stock price indices and commodity price indices for six industrialized countries using cointegration methods for the years 1953-1998. In the short run, it was revealed that stock prices in all six countries initially responded negatively to the inflation shock. Geetha et al. (2011) found a long-run relationship between expected and unexpected inflation and stock market returns in Malaysia, the US, and China.

Oil Price Shocks on the Stock Price

From the oil shocks of the 1970s to the present, many researchers have investigated the connection between oil prices and various macroeconomic indicators (Wei & Guo, 2017). The linkage between oil prices and the stock market has been the subject of many studies, as oil is a major driver of modern economic activity and stock markets are perceived to respond to oil price shocks (Nandha & Faff, 2008). The magnitude, duration, and even direction of a country's stock market response to oil price shocks depend on whether the country is an oil exporter or importer, and whether oil price changes are driven by supply or demand (Wang et al., 2013).

Some studies have highlighted the negative effects of oil price shocks on the stock market. For example, Sadorsky (1999); Nandha and Faff (2008); Park & Ratti (2008); Qutb and AbdelKhalik (2024) etc. Some studies have shown that an increase in oil prices rises stock market returns (Sadorsky, 2001; Foroni et al., 2017). However, Narayan & Sharma (2011) have proven that increases in oil prices can have negative or positive effects on sectors. Some studies have pointed out heterogeneous effects and stated that oil prices can have an impact on the stock market depending on whether countries export or import oil (Wang et al., 2013; Boldanov et al., 2016; Antonakakis et al., 2017). There are also studies that show the increase in oil prices does not affect the stock market or this effect is weak. Wei (2003) argued that the decline in US stock prices in 1974 was not related to the oil price increase in 1973-1974. Cong et al. (2008) found that oil price shocks do not affect stock returns much except for the manufacturing index and some oil companies. Also, the increase in oil volatility may increase stock returns due to speculations in the mining index and petrochemical index.

Exchange Rate and Stock Price

There are different results in the literature regarding the effect of exchange rates on the stock prices. Some studies have not found any long-term relationship between these variables. Bahmani-Oskooee & Sohrabian (1992) for S&P 500 index; Nieh & Lee (2001) for G7 countries; Zhao (2010) for China; Suriani et al. (2015) for Pakistan found no long-run relationship. However, Soenen & Hennigar (1988) for India; Wu (2000) for Singapore; Chiang & Yang (2003) for nine Asian markets; Yau & Nieh (2009) for Japanese and Taiwanese have found a long-term positive linkage between stock prices and exchange rates. However, Rai & Garg (2022) proved that there are significant negative dynamic correlations and volatility spillovers between equity and stock market returns in most of the BRIICS economies during the Covid-19 period. According to the study, the decline in equity returns led to capital outflows and hence an increase in exchange rates.

Exchange Rate and Inflation

Studies examining the relationship between inflation and exchange rates particularly indicate that there may be a pass-through effect from the exchange rate to prices. Edwards (2006) showed that the pass-through effect is reduced in countries that implementing inflation targeting. Arslaner et al. (2014), found an exchange rate pass-through effect that influences inflation in Türkiye for the period 1986-2013. There are also studies indicating that the effect of the exchange rate on inflation is negative. Hooper and Lowery (1979) stated that a 10% depreciation of the dollar would lead to a long-term increase of 0.8% to 1.5% in the US consumer price index. Kim (1998), in the study based on a cointegration analysis covering the period 1973-1995 in the US, showed that the dollar exchange rate had a significant negative effect on inflation as measured by the producer price index.

SVAR Approach in China Stock Market and Relevant Variables

Weiguo et al. (2010) investigated the long-term relationship between the RMB exchange rate, stock market, interest rate, consumption, general real money balance, and their dynamics in China between 2000 and 2009 using Johanson and SVAR methods. They concluded that the exchange rate and stock market have significant effects on long-term money demand. Jiang and Kim (2013) estimated the impact of exchange rate changes on prices in China using the SVAR method. According to findings, the exchange rate pass-through to the Producer Price Index (PPI) and the Retail Price Index (RPI) is generally incomplete. However, the exchange rate pass-through to the PPI is higher than that to the RPI. According to the SVAR findings, exchange rate stability plays a significant role in price stability in China. Hu et al. (2018) used the SVAR approach and the nonlinear ARDL (NARDL) method to determine the effects of oil price shocks on the Chinese stock market. They found that demand-side shocks from oil prices have a significant impact on the Chinese stock market in both the short and long term. Furthermore, the aggregate demand shock has an asymmetric effect in the short term.

Data and Methodology

This paper employs monthly values of stock market, inflation, oil price, and exchange rate for China. The frequency of the data is monthly and the period covered is between January 2000 and December 2024. Data information is as follows: SCI (China Shanghai Composite Stock Market Index), CPI (Consumer Price Index, 2015=100). OIL (Crude oil price), and EXC (Exchange rate, USD/CNY). OIL and EXC variables obtained from <https://www.macrotrends.net/>, CPI variable obtained from FRED, SCI variable obtained from <https://www.tradingview.com/> websites.

Table 1 presents descriptive statistics for the variables. All variables in logarithmic form. The logarithmic transformation is performed to normalize the data and thus the statistical analysis results more valid. The Jarque-Bera (JB) test is used to evaluate whether a data set is normally distributed. According to the JB test, the variables except for lnEXC are not normally distributed. Table 2 shows that there is no multicollinearity between variables.

Table 1
Descriptive Statistics

	Variables			
	lnSCI	lnCPI	lnOIL	lnEXC
Mean	7.808	4.514	4.067	1.956
Std. dev.	0.347	0.173	0.445	0.113
Min	6.966	4.234	2.956	1.488
Max	8.692	4.756	4.941	2.114
Variance	0.121	0.030	0.198	0.013
Skewness	-0.428	-0.184	-0.535	-0.169
Kurtosis	2.520	1.603	2.400	3.387
JB test	12.020	26.080	18.800	3.301
p-value	0.003	0.000	0.000	0.192
Obs	300	300	300	300

Table 2
VIF Statistics

Dependent Variable	lnSCI		lnCPI		lnEXC		lnOIL	
Variable	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
lnSCI			1.54	1.6496	1.95	0.5139	1.98	0.5061
lnCPI	2.19	0.4559			2.12	0.4707	2.82	0.3548
lnOIL	1.68	0.5962	1.68	0.5954	1.32	0.7574		
lnEXC	2.82	0.3549	2.16	0.4631			2.25	0.4440
Mean VIF	2.23		1.79		1.80		2.35	

Vector Autoregressive (VAR) models are a common approach for modeling multivariate time series. However, these models cannot reveal the simultaneous effects of a shock to the economy. This problem is attempted to be overcome with orthogonal impulse responses obtained from Cholesky decomposition. As an alternative to this approach, SVAR models have been developed that directly address the relationship between simultaneous variables (Mohr, 2020).

In this study, the SVAR approach developed by Sims (1980) and Shapiro and Watson (1988) is applied. The SVAR method captures the interactions between variables in response to external shocks (Sunde, 2025). In this respect, the SVAR model is constructed to determine the temporal relationship among stock market, inflation, oil price, and exchange rate. The standard VAR model is expressed as follows (Ünlü, 2024).

$$Y_t = B * X'_t + u'_t \quad (1)$$

In Eq. (1), Y_t is the vector of endogenous variables (stock market, inflation, oil price, and exchange rate). X'_t represents the lag of the endogenous variables. u'_t represents the residuals of the vectors (4×1). B refers to (4×4) concurrent matrix.

$$BY_t = \Gamma_0 + \sum_{i=1}^n \Gamma_i \gamma_{t-i} + \varepsilon_t \quad (2)$$

In Eq. (2) Γ_0 and Γ_i are the constant term of the vector and (4×4) is the autoregressive coefficient matrix, respectively. n is the optimal lag length, and ε_t is the structural shock matrix.

The matrix form of the SVAR model is given in Eq. (3):

$$e_t = \begin{bmatrix} e_t^{lnSCI} \\ e_t^{lnCPI} \\ e_t^{lnOIL} \\ e_t^{lnEXC} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} x \begin{bmatrix} e_t^{lnSCI Shock} \\ e_t^{lnCPI Shock} \\ e_t^{lnOIL Shock} \\ e_t^{lnEXC Shock} \end{bmatrix} \quad (3)$$

In standard VAR models, error terms only reflect correlations and cannot directly explain causality. SVAR analysis decomposes these error terms using constraints based on economic theory to arrive at pure "structural shocks" (Mohr, 2020).

Empirical Results

The unit root tests were performed to test the stationarity of the series in the model. The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests calculated for the levels and first differences of the variables are given in Table 3. Accordingly, the variables are stationary at the I(1) level.

Table 3
Unit Root Test Results

Variables	ADF		PP	
	Constant	Constant and Trend	Constant	Constant and Trend
lnSCI	-1.958	-2.426	-2.446	-3.164
lnCPI	-0.938	-2.277	-0.600	-1.808
lnOIL	-2.671*	-2.837	-2.424	-2.513
lnEXC	-1.672	-1.168	-2.220	-2.627
Δ lnSCI	-15.934***	-15.906***	-16.271***	-16.248***
Δ lnCPI	-3.137**	-3.182*	-13.545***	-13.517***
Δ lnOIL	-14.891***	-14.871***	-14.879***	-14.864***
Δ lnEXC	-10.856***	-10.926***	-22.071***	-23.838***

Note: *, **, and *** denote the significance at 10%, 5%, and 1%, respectively.

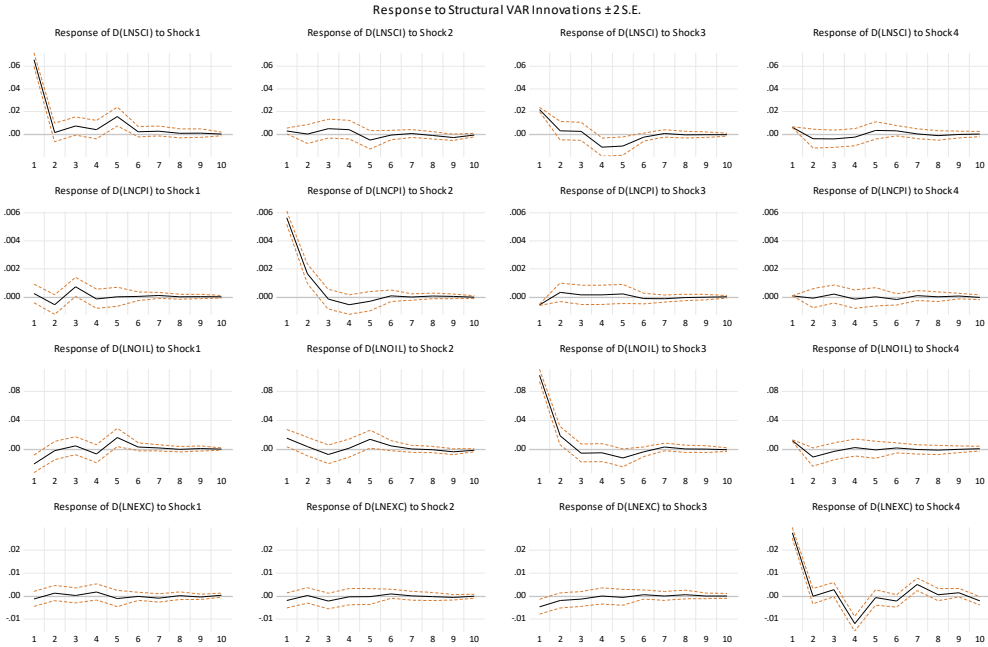
Table A1 shows that there is no autocorrelation among the error terms for the 1st, 2nd, 4th, and 5th lag selected. In this study, a lag length of 4 was selected using FPE (Final Prediction Error) and AIC (Akaike Information Criterion). Figure A1 shows that the VAR model has a stable structure because all the roots are located inside the unit circle and the modulus of all roots is less than one. The results of the long-term structural VAR analysis are presented in Table 4. The coefficients in the multiplier matrix are not interpretable; however, the signs and statistical significance levels of the coefficients provide preliminary information for impulse-response approach (Ünlü, 2024: 70). Accordingly, stock market is positively correlated with its own shocks in the long term. In addition, inflation, exchange rates, and oil prices are positively affected by shocks related to them. Inflation responds positively to oil price shocks and negatively to exchange rate shocks.

Table 4
The Model for Long-run SVAR Matrix

	lnSCI	lnCPI	lnOIL	lnEXC
lnSCI	C(1)	0	0	0
lnCPI	C(2)	C(5)	0	0
lnOIL	C(3)	C(6)	C(8)	0
lnEXC	C(4)	C(7)	C(9)	C(10)
	lnSCI	lnCPI	lnOIL	lnEXC
lnSCI	0.098***	0.000	0.000	0.000
lnCPI	0.001	0.006***	0.000	0.000
lnOIL	-0.002	0.027***	0.097***	0.000
lnEXC	-0.001	-0.004***	-0.007***	0.020***

Note: *** denotes the significance at 1%.

Figure 3
Impulse Response Functions in the Long-run



The Structural Impulse-Response Function (IRF) describes how the current and future values of variables dynamically respond to a one-unit change in a given structural shock, under the assumption that all other shocks are zero (Mahajan and Sah, 2025). The graphical representation of the IRF of the stock market, inflation, oil price and exchange rate due to shocks in stock market, inflation, oil price and exchange rate for 10 periods is given in Figure 3. In this figure, lnSCI (shock 1), lnCPI (shock 2), lnOIL (shock 3), and lnEXC (shock 4) are represented. Accordingly, the own shock of the stock market, which starts positively in the first period, sharply diminishes and disappears in the second period. Then it becomes positive again and gradually decreases from the 6th period. Inflation's response to its own shock is initially positive, then it begins to decrease, turning negative after the third period and disappearing after the sixth period. The exchange rate is not significantly affected by shocks from other variables; it can only be associated with exchange rate shocks. In response to an exchange rate shock, it exhibits a highly volatile trend. This effect, which is positive until the third period, turns negative in the fourth period, then positive, and gradually decreases.

Table 5
Variance Decomposition Results

d.lnSCI					
Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	0.069662	89.46345	0.151339	9.636760	0.748447
2	0.069861	88.98893	0.150586	9.759684	1.100800
3	0.070542	88.28562	0.591149	9.684868	1.438361
4	0.071753	85.61458	0.854071	11.99200	1.539350
5	0.074434	83.89157	1.290699	13.19508	1.622657
6	0.074573	83.65180	1.301462	13.28575	1.760989
7	0.074619	83.66349	1.303560	13.27325	1.759697
8	0.074648	83.60679	1.329787	13.27087	1.792553
9	0.074719	83.46129	1.494985	13.25110	1.792624
10	0.074727	83.44269	1.510366	13.25465	1.792290
d.lnCPI					
Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	0.005687	0.191161	98.81637	0.972342	0.020122
2	0.005957	1.020229	97.74041	1.199305	0.040058
3	0.006009	2.453618	96.15580	1.238495	0.152091
4	0.006039	2.478157	96.01410	1.291944	0.215797
5	0.006050	2.469116	95.90452	1.411169	0.215199
6	0.006054	2.471522	95.78579	1.444245	0.298439
7	0.006057	2.500352	95.69444	1.483867	0.321344
8	0.006058	2.500657	95.69039	1.487125	0.321827
9	0.006058	2.503165	95.67715	1.487514	0.332172
10	0.006058	2.503468	95.67392	1.487645	0.334971
d.lnOIL					
Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	0.106236	3.690335	2.080596	92.97718	1.251893
2	0.108470	3.571654	2.104243	92.10818	2.215922
3	0.108994	3.722168	2.532901	91.47284	2.272092
4	0.109331	4.051648	2.534903	91.11409	2.299360
5	0.112046	5.962948	3.928161	87.91372	2.195168
6	0.112262	6.020156	4.093415	87.67632	2.210110
7	0.112318	6.035828	4.090578	87.66425	2.209341
8	0.112328	6.035075	4.092471	87.65216	2.220297
9	0.112392	6.033375	4.196296	87.55219	2.218139
10	0.112405	6.031992	4.213715	87.53439	2.219906
d.lnEXC					
Period	S.E.	Shock1	Shock2	Shock3	Shock4

1	0.028091	0.207626	0.464103	2.769347	96.55892
2	0.028187	0.418881	0.469095	3.210007	95.90202
3	0.028444	0.421809	1.061513	3.365833	95.15084
4	0.030932	0.683387	0.907291	2.846205	95.56312
5	0.030965	0.805228	0.910690	2.876563	95.40752
6	0.031064	0.802145	1.003160	2.900217	95.29448
7	0.031490	0.861542	0.976775	2.822260	95.33942
8	0.031503	0.863614	0.981140	2.859494	95.29575
9	0.031543	0.875353	1.010684	2.852441	95.26152
10	0.031616	0.882601	1.006950	2.839379	95.27107

Structural Forecast Error Variance Decomposition (FEVD) indicates the contribution of structural shocks to the estimation error variance of a particular variable (Mahajan and Sah, 2025). The FEVD results quantitatively reveal the relative importance of each shock (Sunde, 2025). The outcomes of the variance decomposition using SVAR factors are presented in Table 5. Table 5 shows the variance decomposition results related to the SVAR approach. According to the results, 89.46% of the change in lnSCI in the first period is determined by its own shock. This rate gradually decreases and falls to 83% in the last period. In addition, the results show that oil prices may also have an effect on the stock market by approximately 9%-13%. It is observed that the change in inflation was affected by its own shock by 98.8% in the first period and 95.67% in the tenth period, and this rate is quite high. The change in inflation can be correlated with the stock market by an average of 2% throughout the periods. Oil prices are initially correlated with their own shocks by 92.97%, gradually decreasing to 87.53% in the tenth period. However, other variables may have an impact on oil prices ranging from 2% to 6%. The exchange rate is affected by its own shocks by an average of 95% throughout all periods. Oil prices have a 2%-3% impact on the exchange rate.

Conclusion

The stock market has a significant impact on economic development, particularly in developing economies such as China. The stock market plays a crucial role in developing new investment instruments, diversifying risk, reducing investment costs, and allocating capital to productive areas. High-tech and innovative companies support long-term growth and development through the stock market. In this respect, the Chinese Stock Market, a key player in the global market, holds a key position in supporting SMEs, developing innovative technologies, and ensuring sustainable development. More than just an index, the Chinese Stock Market informs investors about the goals and policy strategies of the Chinese economy. It also guides the trends, expectations and policy

preferences of decision-makers. Therefore, the connections between the stock market and the real sector create important results.

The Chinese stock market has become a significant force in the global financial world in recent years, but it also faces various factors such as regulation, volatility and policy risk. In this context, many variables such as oil prices, inflation, exchange rate and interest rate can affect the Chinese stock market. China's oil consumption is largely dependent on imports, so fluctuations in oil prices affect the stock market and inflation. The fluctuations in oil prices can also affect the stock market through exchange rates, as it leads to a decrease in consumer confidence and a depreciation of the Yuan.

This study analyzes the relationship between the stock market, inflation, oil prices, and exchange rates in China using the SVAR approach for the period of 2000m1-2024m12. The results show the equilibrium values of the stock market, inflation, oil prices, and exchange rates are largely explained by their own internal dynamics in the long term. The impulse-response analysis reveals that the effects of the own shocks of these variables show a rapid decrease in approximately two periods, and then follows moderate oscillations. The results are consistent with the studies of Wei (2003) and Cong et al. (2008), who concluded that there is no relationship or that the relationship between the stock market and oil prices is insignificant. As in this study, some studies examining the relationships between the stock market and exchange rates, for example Bahmani-Oskooee & Sohrabian (1992) for the S&P 500 index; Nieh & Lee (2001) for G7 countries; Zhao (2010) for China; and Suriani et al. (2015) for Pakistan, have not found long-term relationships between these variables. Furthermore, the result that the exchange rate may have a negative effect on inflation is consistent with Hooper & Lowery (1979), and Kim (1998).

According to the SVAR coefficients, the exchange rate has a negative but insignificant effect on the stock market. This process is explained by Wu (2000) as follows: when inflation increases, the local currency depreciates and the exchange rate rises. The increase in inflation expectations requires a higher risk premium and therefore a higher rate of return. This process creates a suppressive effect on stock prices. The positive but statistically insignificant relationship found between the stock market and inflation confirms Fisher's (1930) assertion that there is a positive relationship between real stock returns and inflation.

These results highlight the importance of policymakers formulating policies that consider the long-term structures of variables such as the stock market, inflation, oil prices, and exchange rates. In this context, policymakers should take into account that these variables will behave independently of external factors in the long run and the short-term effects of policy designs may be temporary. In conclusion, the Chinese stock market, unlike those of developed countries, has

an unstable and fragile structure and strong regulatory interventions; therefore, these findings provide important implications for decision-making units.

Future studies can be enriched with models that include the heterogeneous structure of the stock market and reveal sectoral differences. Furthermore, it can be developed to investigate stock market volatility and stock returns for different sectors or countries/country groups. Additionally, comparative studies between China and developing countries will also contribute to understanding the structure of stock markets. Recently, it has been understood that geopolitical and climate risks also affect stock markets through indirect channels and have been incorporated into studies. It may be useful to consider these connections when comparing China and emerging economies.

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Appendix

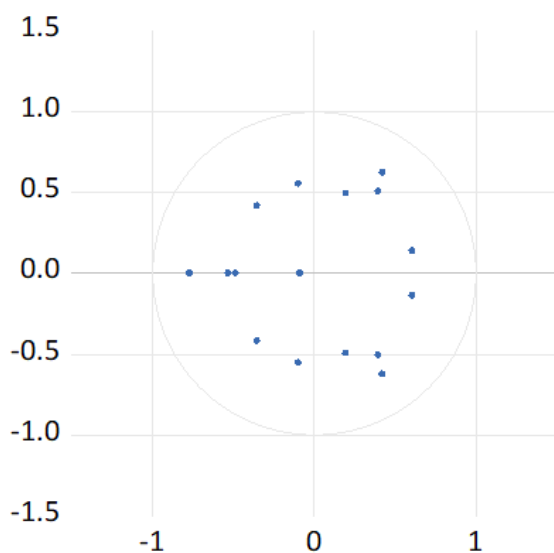
Table A1

Serial Correlation LM Test

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	16.86852	16	0.3942	1.056075	(16, 828.6)	0.3942
2	22.38501	16	0.1312	1.406093	(16, 828.6)	0.1312
3	39.99707	16	0.0008	2.539163	(16, 828.6)	0.0008
4	11.45924	16	0.7803	0.715095	(16, 828.6)	0.7803
5	10.11783	16	0.8604	0.630878	(16, 828.6)	0.8604

Figure A1

Inverse Roots of AR Characteristic Polynomial



CHAPTER 11

Beyond Street Vending: Local Food Systems and Gastronomic Heritage in Kayseri

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1. INTRODUCTION

The rich gastronomic heritage of Turkish cuisine, shaped by diverse geographical conditions, climates, and cultural interactions, is also evident in the street foods embedded in everyday life. As expressions of local dietary practices and urban cultural identities, street foods can contribute to the preservation of gastronomic heritage, the distinctiveness of destinations, and the creation of authentic tourism experiences (Ellis et al., 2018; Richards, 2015; Sims, 2009).

Kayseri, one of Anatolia's long-established settlements, has developed a distinctive culinary identity through its location at the intersection of historical trade routes, its interaction with different civilizations, and its strong production culture. Written records recovered from Kültepe-Kaniş Karum indicate that the region was an important commercial center approximately four thousand years ago. Trade, migration, animal husbandry, grain production, and climatic conditions have collectively shaped Kayseri's gastronomic heritage (Kılıçhan, 2019; Ülker & Kılıçhan, 2021). Although the city is primarily known for mantı (small filled dumplings), pastırma (Turkish dry-cured beef), and sucuk (Turkish fermented sausage), its gastronomic culture also encompasses neighborhood bakeries, butcher shops, traditional meat-processing businesses, vineyard culture, winter food preparations, and local agricultural production (Kılıçhan & Kılıçhan, 2014; Kılıçhan, 2020).

Street food is commonly defined as ready-to-eat foods and beverages prepared and/or sold in streets and similar public spaces (Food and Agriculture Organization of the United Nations [FAO], 1989). This conventional definition, however, does not fully capture the Kayseri context, where everyday food practices have developed mainly around neighborhood bakeries, butcher shops, traditional meat-processing businesses, and small family-run enterprises rather than mobile street vendors. For the purposes of this chapter, street gastronomy is therefore approached through accessibility, everyday consumption, reliance on local ingredients and production knowledge, and the capacity of food to reflect local cultural identity. Çemen ekmek, sucuk ekmek, and gilaburu şerbeti (a traditional beverage made from *Viburnum opulus* L.) are examined as representative products within this framework. This chapter explores their historical and cultural backgrounds, production and consumption characteristics, and contributions to gastronomic heritage and tourism. By focusing on these everyday products, it seeks to broaden Kayseri's predominantly product-centered gastronomic image and highlight the role of street food in the city's living culinary heritage.

2. HISTORICAL AND CULTURAL FOUNDATIONS OF STREET FOOD IN KAYSERİ

The formation of local cuisines cannot be explained solely by geographical conditions and agricultural production. Economic structures, trade relations, migration, cultural interaction, and urban development also influence culinary practices. Food should therefore be examined not only through its ingredients and preparation techniques but also within the historical and socioeconomic

environments in which it is produced and consumed (Bell & Valentine, 1997; Counihan & Van Esterik, 2013).

Kayseri, one of Anatolia's oldest commercial centers, provides a notable example of how a long-standing trading tradition can influence culinary culture. Archaeological evidence from Kültepe-Kaniş Karum dates to the second millennium BCE, when the settlement was one of the principal centers of the Assyrian trade colony network. The cuneiform tablets unearthed at the site provide extensive information about commercial relations, production practices, and everyday life during this period. This historical pattern of mobility and exchange formed part of the broader social and economic context in which Kayseri's culinary heritage developed (Kılıçhan, 2019; Ülker & Kılıçhan, 2021).

The city's location along major trade routes, together with animal husbandry, grain production, and viticulture, diversified the raw materials available and shaped local consumption practices. Its established artisan and bazaar culture also encouraged the development of foods that could be prepared quickly, transported easily, and adapted to the routines of urban working life. The historical foundations of Kayseri's bakery, butchery, and meat-processing traditions can therefore be associated with this interconnected economic and social structure (Kılıçhan, 2020).

Neighborhood bakeries have played a particularly important role in this system. In addition to producing bread and other baked goods, they serve as shared facilities where households have certain foods and dishes baked. By connecting domestic food preparation with artisanal production, these bakeries contribute to the transmission of culinary knowledge and the continuation of neighborhood-based social relations. Similarly, Kayseri's butchery and meat-processing traditions have brought the city's expertise in meat preservation, spice use, pastırma, and sucuk production into everyday consumption. The interaction between bakery culture and meat-processing knowledge has supported the development and continuity of practical products such as çemen ekmek and sucuk ekmek (Kılıçhan, 2020).

Accessibility, affordability, quick preparation, portability, and suitability for everyday consumption are commonly recognized characteristics of street food (Bellia et al., 2022; Sezgin & Şanlier, 2016). In Kayseri, however, these characteristics are expressed primarily through neighborhood bakeries, butcher shops, traditional meat-processing businesses, and small family-run enterprises rather than mobile street vendors. Kayseri's street gastronomy should therefore be evaluated not solely according to the location of sale but as a local food system shaped by production practices, artisan knowledge, neighborhood businesses, and everyday consumption habits. This perspective provides the historical and cultural foundation for examining çemen ekmek, sucuk ekmek, and gilaburu şerbeti as representative products of the city's street gastronomy.

3. REPRESENTATIVE STREET FOODS OF KAYSERİ

Kayseri cuisine has a deep-rooted gastronomic heritage that encompasses numerous products, including mantı, pastırma, sucuk, yağlama, cıvıklı, and nezzine. However, belonging to a local cuisine does not by itself qualify a product as street food. Street foods are generally characterized by their accessibility, availability for immediate consumption, portability, and suitability for consumption in public spaces or through businesses closely integrated into public life (Bellia et al., 2022; FAO, 1989; Sezgin & Şanlıer, 2016). Within the analytical framework adopted in this chapter, dishes such as mantı, yağlama, pöç, and kurşun aşı, which are usually served as complete meals and consumed in a seated setting, correspond less directly to these characteristics. By contrast, çemen ekmek, sucuk ekmek, and gilaburu şerbeti align more closely with the accessibility, practicality, and everyday consumption dimensions of street gastronomy.

These three products illustrate how Kayseri's historical production culture has been adapted to accessible forms of daily consumption. Çemen ekmek and sucuk ekmek connect the city's bakery culture with its expertise in meat processing and spice use, whereas gilaburu şerbeti incorporates a locally cultivated agricultural product into the regional beverage culture. Together, they reflect the interaction of animal husbandry, agricultural production, neighborhood bakeries, artisan knowledge, and local consumption practices (Kılıçhan, 2020; Ülker & Kılıçhan, 2021).

A distinctive feature of Kayseri's street gastronomy is that these products are primarily made available through established neighborhood businesses, including bakeries, butcher shops, traditional meat-processing businesses, and local product retailers, rather than through mobile street vendors. Accordingly, they should be evaluated not only according to where they are sold but also through the production systems, artisan knowledge, consumption practices, and cultural continuity surrounding them. Çemen ekmek, sucuk ekmek, and gilaburu şerbeti were selected not as the only examples of street food in Kayseri but as three complementary products representing the city's bakery culture, meat-processing tradition, and local agricultural production. Their examination provides a framework for understanding how Kayseri's everyday food practices can contribute to the city's gastronomic identity and visitor experience.

3.1. Çemen (Çaman) Ekmek: The Intersection of Kayseri's Bakery and Pastırma Traditions

Çemen ekmek, locally also known as çaman ekmek, is a distinctive product that brings together Kayseri's bakery and pastırma traditions. Its principal component is çemen, the paste traditionally used as the outer coating of Kayseri Pastırması. According to its geographical indication specification, this paste includes fenugreek flour, a vetch-and-wheat flour blend, red pepper, cumin, garlic, and water (Tekinşen & Doğruer, 2000; Turkish Patent and Trademark Office, 2002a). Çemen ekmek is prepared by spreading the paste on bread and

baking it in a neighborhood bakery, resulting in a warm and practical product suitable for immediate consumption.

Figure 1: Çemen Ekmek



Source: Tellioglu Patisserie

No direct historical record documenting the precise emergence of çemen ekmek was identified in the sources reviewed for this chapter. Its development can nevertheless be interpreted as the gradual adaptation of Kayseri's pastırma-production knowledge to its neighborhood bakery culture. Local culinary products frequently emerge through long-term interactions among ingredients, production techniques, artisan knowledge, and changing consumption practices rather than through a single identifiable event (Counihan & Van Esterik, 2013; Kızıldemir et al., 2014). From this perspective, the use of çemen paste on bread represents the transfer of a component associated with pastırma production to a more accessible form of everyday consumption.

Çemen ekmek is not associated with a particular ceremony, season, or special occasion. It may be obtained warm from neighborhood bakeries and consumed at different times of the day as a light meal or snack. Its accessibility, relatively quick preparation, portability, and ability to be consumed without an elaborate service arrangement correspond to widely recognized characteristics of street food (Bellia et al., 2022; Sezgin & Şanlıer, 2016). Although it is generally sold through fixed neighborhood businesses rather than mobile vendors, its close integration with public and everyday life allows it to be conceptualized in this chapter as a “bakery-based street food.”

The gastronomic significance of çemen ekmek extends beyond its practical form. The product embodies Kayseri's knowledge of meat processing, use of

spices, neighborhood baking practices, and local taste preferences (Kılıçhan, 2020). It also demonstrates that gastronomic heritage is not static; traditional ingredients and production knowledge can acquire new meanings as they are incorporated into changing consumption contexts. The continued preparation and consumption of *çemen ekmek* can therefore be considered an example of living gastronomic heritage (Bessière, 1998; Richards, 2015; UNESCO, 2003).

Çemen ekmek also has experiential value for gastronomy tourism. Gastronomic experiences involve not only tasting local products but also encountering their production processes, cultural settings, and roles in everyday life (Ellis et al., 2018; Hall & Sharples, 2003; Richards, 2021). Observing the product being prepared in a neighborhood bakery and consuming it within the setting in which local people encounter it can provide visitors with insight into Kayseri's daily food culture. In this context, the bakery functions not merely as a sales point but also as a social and cultural setting in which artisanal knowledge and neighborhood practices remain visible.

The relationship among *çemen* paste, *pastırma* production, neighborhood bakeries, and everyday consumption gives the product a strong sense of place. Its value derives not only from its taste but also from its connection to local ingredients, production knowledge, and consumption settings. Such connections between food, place of origin, and cultural narratives can strengthen the role of local products in destination identity and tourism experiences (Everett & Slocum, 2013; Sims, 2009).

The sustainability of *çemen ekmek* depends on preserving not only its recipe but also the knowledge, actors, and consumption environments associated with its production. Rather than imposing a single unchanging recipe, its basic characteristics, ingredient variations, baking techniques, and forms of presentation in different neighborhood bakeries should be documented. Recording these practices can support intergenerational knowledge transfer while allowing the product to retain its character as an evolving element of Kayseri's living gastronomic heritage (Timothy, 2016; World Tourism Organization & Basque Culinary Center, 2019).

3.2. Sucuk Ekmek: Kayseri's Street-Style Sucuk Sandwich

Sucuk is one of the long-established fermented meat products of Turkish culinary culture and a major gastronomic symbol of Kayseri. The city's experience in animal husbandry, butchery, meat processing, and spice use has enabled sucuk to function not only as a traditional preserved meat product but also as an ingredient in everyday forms of consumption. Sucuk ekmek is a prominent example of this transformation. When prepared to order in neighborhood bakeries, butcher shops, and traditional meat-processing businesses, it can be served hot as a portable and filling product within Kayseri's street gastronomy.

The production of sucuk involves fermentation, seasoning, drying, and maturation processes that require technical knowledge and artisanal expertise (Ercoskun & Özkal, 2011). According to its geographical indication specification, the dominant aromas of garlic and cumin, pronounced spiciness, and dark red color are among the distinguishing characteristics of Kayseri Sucuğu (Turkish Patent and Trademark Office, 2002b). These characteristics directly influence the sensory identity of sucuk ekmek. Although the type of bread and the cooking method may vary among establishments, the product differs from standardized industrial fast food because its principal ingredient is closely associated with local production knowledge and artisanal practices. The intergenerational transmission of this knowledge is important for maintaining the continuity and distinctiveness of local food products (Counihan & Van Esterik, 2013; Montanari, 2006).

The accessibility, quick preparation, portability, and suitability of sucuk ekmek for immediate consumption correspond to the practical characteristics of street food. However, its significance is not limited to these functional qualities. The product is generally prepared and sold through an established network of butcher shops, neighborhood bakeries, and traditional meat-processing businesses rather than mobile vendors. Sucuk ekmek can therefore be considered a bakery- and butcher-based form of street food that reflects the interaction between Kayseri's meat-processing expertise, artisan culture, and everyday consumption practices. In this form, Kayseri Sucuğu is transformed from a preserved meat product into an accessible component of daily urban life.

Figure 2: Sucuk Ekmek



Source: Kayseri Metropolitan Municipality, Kardanadam

Local foods can contribute to destination identity by conveying the cultural meanings, production traditions, and social settings associated with a place (Ellis et al., 2018; Hall & Gössling, 2016). Sucuk ekmek reflects Kayseri's animal husbandry, meat-processing tradition, use of spices, neighborhood businesses, and artisanal knowledge (Kılıçhan, 2020). These connections can be interpreted through the concepts of sense of place and terroir, which emphasize that the character of a food product is shaped not only by its ingredients but also by its geographical, cultural, and production context (Sims, 2009; Trubek, 2008). Presenting sucuk ekmek together with its production story and artisan culture can therefore enhance the visibility of Kayseri's street gastronomy and provide visitors with a more meaningful understanding of the city's everyday culinary life.

3.3. Gilaburu Şerbeti: From Local Tradition to Street Consumption

Local beverages can reflect the relationship among a region's agricultural production, natural environment, cultural practices, and everyday life (Hall et al., 2003). In Kayseri, gilaburu (*Viburnum opulus* L.), cultivated particularly in the districts of Bünyan and Akkışla, is traditionally stored in water after harvest and then pressed to prepare a local beverage (Kılıçhan, 2020). Research on *Viburnum opulus* has also reported that the fruit contains bioactive compounds and exhibits considerable antioxidant capacity (Rop et al., 2010). These characteristics contribute to the nutritional and gastronomic value attributed to gilaburu.

The connection between gilaburu and its place of origin has been institutionally recognized through geographical indication protection. Bünyan Gilaburusu was registered as a designation of origin in 2018, followed by Akkışla Gilaburusu in 2021 (Turkish Patent and Trademark Office, 2018, 2021). Geographical indications can contribute to protecting local production knowledge, strengthening the relationship between a product and its place of origin, supporting producer organization, and promoting rural development (Belletti & Marecotti, 2011; Bowen, 2010). The patent application for gilaburu şerbeti developed at Kayseri University also illustrates how traditional agricultural knowledge can interact with academic product-development initiatives (Ertürk & Güner, 2024).

Figure 3: Gilaburu Şerbeti



Source: Kayseri University

Gilaburu şerbeti can be served quickly, offered in individual portions, and consumed in public or semi-public settings. Within the framework adopted in this chapter, these characteristics allow it to be considered a locally rooted street beverage. Its reliance on a regional agricultural product and production knowledge transmitted through local practices distinguishes it from standardized industrial beverages. Moreover, visitors' interest in the origins, production stories, and cultural meanings of local foods and beverages indicates that gilaburu şerbeti has the potential to become a meaningful component of Kayseri's gastronomic experiences (Ellis et al., 2018).

The adaptation of gilaburu şerbeti to contemporary presentation and consumption settings should not result in the loss of its production knowledge or cultural context. Preserving the relationship among the fruit, its place of cultivation, traditional processing practices, and local producers is essential for maintaining its character as living gastronomic heritage (Bessière, 1998; UNESCO, 2003; Vandecandelaere et al., 2018). When presented through regional product centers, gastronomy routes, festivals, or university-based application areas, gilaburu şerbeti can communicate the relationship among Kayseri's natural environment, agricultural production, cultural memory, and contemporary knowledge production. In this way, it can contribute to the visibility of the city's street gastronomy while supporting local development and gastronomy entrepreneurship.

4. SUSTAINING KAYSERİ'S STREET GASTRONOMY: LOCAL VALUE CHAINS, HERITAGE, AND TOURISM

Kayseri's street gastronomy can be understood not merely as a collection of foods and beverages but as an interconnected local food system shaped by agricultural resources, meat-processing traditions, neighborhood bakeries,

artisanal knowledge, and everyday consumption practices (Counihan & Van Esterik, 2013; Hall & Gössling, 2016). Within this system, *çemen ekmek* connects the city's bakery and *pastırma* traditions, *sucuk ekmek* reflects its expertise in meat processing, and *gilaburu şerbeti* represents local agricultural production and beverage culture. Because these products remain embedded in the everyday lives of local people, they constitute elements of living gastronomic heritage rather than offerings produced exclusively for tourists (Bessière, 1998).

The long-term continuity of these products depends on the local value chain connecting farmers, livestock enterprises, butcher shops, traditional meat-processing businesses, neighborhood bakeries, local food shops, and small retailers. Short food supply chains can strengthen local production, help maintain the distinctive qualities of products, and retain a greater proportion of value added within the region (Marsden et al., 2000; Renting et al., 2003). Neighborhood businesses also function as social settings in which artisanal knowledge is transmitted and trust is established between producers and consumers. Safeguarding Kayseri's gastronomic heritage therefore involves preserving not only individual products and recipes but also the producers, businesses, skills, and social relationships that sustain them.

From a tourism perspective, *çemen ekmek*, *sucuk ekmek*, and *gilaburu şerbeti* can be presented as complementary components of an integrated visitor experience. A Kayseri Street Gastronomy Route connecting neighborhood bakeries, butcher shops, traditional meat-processing businesses, *gilaburu* producers, and regional product centers could allow visitors to observe production processes, interact with local producers, and encounter the city's everyday food culture. Bringing these elements together would offer a coherent experience extending beyond separate product tastings (Pine & Gilmore, 1999). Local products also become more meaningful when visitors engage with their origins, production processes, and cultural contexts (Ellis et al., 2018; World Tourism Organization & Basque Culinary Center, 2019). Research further indicates that the perceived authenticity and distinctiveness of local cuisine can influence tourists' food preferences, satisfaction, and memorable destination experiences (Björk & Kauppinen-Räsänen, 2016; Çeşmeci et al., 2023; Kim et al., 2009).

The development of such initiatives would benefit from cooperation among universities, local governments, producer organizations, tourism businesses, and local artisans. Universities can contribute through gastronomic inventories, documentation, product-development studies, entrepreneurship training, and applied research. The geographical indication registrations of *Bünyan Gilaburusu* and *Akkışla Gilaburusu* illustrate how the relationship between a product and its place of origin can be formally protected (Bowen, 2010; Turkish Patent and Trademark Office, 2018, 2021). Similarly, the 2024 patent application for

gilaburu şerbeti developed by researchers at Kayseri University -an application rather than a granted patent- provides a contemporary example of university-based product development (Ertürk & Güner, 2024).

Product-centered promotion could be complemented by experience-oriented destination management. Producer-led demonstrations, gilaburu harvesting and beverage-making activities, local festivals, and digital storytelling could increase the visibility of these products while communicating their cultural and production contexts (World Tourism Organization, 2017). Such initiatives should be designed with the participation of local producers and businesses so that tourism development does not separate the products from the communities and practices that give them meaning. By integrating heritage preservation, experience design, and stakeholder collaboration, Kayseri can strengthen the tourism visibility of its street gastronomy while supporting the local production networks on which its continuity depends.

5. CONCLUSIONS, PRACTICAL IMPLICATIONS, AND FUTURE RESEARCH

Street food can contribute to the preservation of gastronomic heritage, the reinforcement of destination identity, and the development of local economies. Nevertheless, a substantial part of the existing literature approaches street food primarily through food safety, hygiene, consumer behavior, and street-vending practices (Bellia et al., 2022; Sezgin & Şanlıer, 2016). This emphasis leaves scope for context-sensitive studies examining street food in Anatolian cities in relation to local production systems, artisanal knowledge, everyday consumption practices, and gastronomic identity.

This chapter responds to this need by examining Kayseri's street gastronomy through çemen ekmek, sucuk ekmek, and gilaburu şerbeti. Rather than treating these products as separate commodities, it conceptualizes them as components of an interconnected local food system involving neighborhood bakeries, butcher shops, traditional meat-processing businesses, agricultural producers, retailers, and artisanal knowledge. Although the Food and Agriculture Organization of the United Nations defines street food mainly as ready-to-eat foods and beverages prepared and/or sold in streets and similar public spaces (FAO, 1989), the Kayseri case indicates that sales location alone may not adequately explain locally embedded forms of street gastronomy. Accessibility, ease of consumption, integration into everyday life, reliance on local production systems, and cultural context should also be considered. This broader interpretation is proposed as a context-sensitive analytical framework rather than as a replacement for the conventional definition of street food.

The three products represent complementary dimensions of Kayseri's gastronomic heritage. Çemen ekmek reflects the interaction between the city's bakery and pastırma traditions; sucuk ekmek transforms its meat-processing

expertise into an accessible form of everyday consumption; and gilaburu şerbeti connects local agricultural production with regional beverage culture. Their continued production and consumption illustrate how gastronomic heritage is sustained through the interaction of products, producers, neighborhood businesses, knowledge, and social practices. Institutional protection and product-development initiatives may support the continuity of this system. The geographical indication registrations of Bünyan Gilaburusu and Akkışla Gilaburusu formally protect the relationship between these products and their geographical origins (Turkish Patent and Trademark Office, 2018, 2021). The patent application for gilaburu şerbeti developed by researchers at Kayseri University also demonstrates how traditional knowledge can inform contemporary product-development activities (Ertürk & Güner, 2024). This initiative should, however, be identified accurately as an application filed on 8 October 2024 rather than as a granted or registered patent.

In practical terms, Kayseri's street gastronomy could be incorporated into experience-oriented destination planning through gastronomy routes, producer-led demonstrations, festivals, regional product centers, and digital storytelling. Cooperation among local governments, universities, producer organizations, artisans, and tourism businesses could support the documentation and intergenerational transmission of production knowledge. Such initiatives may also increase the visibility of neighborhood businesses and enable visitors to engage with Kayseri's everyday food culture. However, tourism-oriented development should preserve the relationship between the products, their producers, and their local consumption settings rather than reducing them to standardized promotional commodities.

This chapter is limited by its conceptual and product-selective approach and its reliance primarily on documentary and secondary sources. It neither provides an exhaustive inventory of Kayseri's street foods nor empirically tests the proposed framework. Future research could identify other products suitable for inclusion in the city's street gastronomy, document variations in production and consumption practices, and collect qualitative and quantitative data from producers, businesses, residents, and visitors. Comparative studies involving other Anatolian cities could also examine how different production systems and urban settings shape locally specific forms of street food. By combining systematic documentation, empirical research, heritage preservation, experience design, and stakeholder collaboration, future initiatives may strengthen the visibility and continuity of Kayseri's street gastronomy within sustainable gastronomy tourism.

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CHAPTER 12

**Economic Policy Uncertainty and
Corporate Capital Structure Decisions:
*Evidence from S&P 1500 Firms***

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1. INTRODUCTION

Globally, the present political and economic environment has resulted in one of the most significant levels of uncertainty in recent years (Pricewaterhouse Coopers, 2019). The world has experienced several critical challenges, such as the financial and economic downturn 2008, the Greek government debt crisis, the US debt ceiling, Brexit, trade wars, and rising protectionism in the last decade (Baker et al., 2016). Consequently, emerging literature highlights the ramifications of uncertainty on macroeconomic and financial variables (Idnani et al., 2023).

The present study examines how corporate innovation (INV) affects the impact of economic policy uncertainty (EPU) on a firm's financial performance (FP). The operational environment influences a firm's choice of strategies and FP (Rodriguez Lopez et al., 2017). Because uncertainty can impact firm decision-making and performance, the continual changes in economic policies can make the operating environment complex and unpredictable (Gulen & Ion, 2015). Therefore, firms should consider operating environmental factors when developing their strategic posture (O'Regan et al., 2020). EPU has increased due to the COVID-19 pandemic, one of the most recent events, making this study more urgently needed than others. Given that EPU may have had a different impact on the performance of innovative and non-innovative firms, policy responses to it have become pertinent and essential. Real-world evidence about the link between EPU and a company's FP when corporate INV is present therefore seems very important. Additionally, since INV has received greater attention from practitioners and scholars, this study also attempts to clarify its advantages. According to the resource-based view (RBV), INV is vital for a firm's competitive advantage and performance (Awan et al., 2018). Previous research, however, shows mixed findings.

Many studies suggest that INV improves the performance of a business by raising its profits, productivity, market value, and competitive edge (Eberhart et al., 2004; Damanpour & Aravind, 2012). Another study, however, found that the uncertain return and high cost of INV could outweigh the benefits and cause the firm to perform worse (Coad et al., 2016). One reason for the conflicting results is the inadequate INV proxies commonly used, such as patents and R&D expenditure (Ranta et al., 2021). Patent numbers face critique when used as a proxy for INV because they cannot capture the extent of INV output, as not all INVs are patentable. Thus, this study fills the gap by adopting a novel market-based INV index constructed from analysing analyst reports from S&P 1500 firms (Bellstam et al., 2021). Unlike other INV proxies, this study's empirical findings support RBV by showing that INV positively impacts a firm's FP, extending earlier work on the connection between EPU and a company's FP (Guo & Wang, 2022).

The present study investigates the correlation between EPU and the firm's FP when corporate environmental INV is present. According to one strand of research, high EPU financing INV lessens the positive effect of corporate environmental INV on firm performance because intangible assets become more expensive and are not efficiently used as loan collateral (Denlertchaikul, Chatjuthamard, Jiraporn, & Phiromswad, 2022). A strategic growth-option view, on the other hand, suggests that EPU raises the possible gain of INV and intangible assets and makes the company run better (Gilchrist et al., 2014). This study fills in the blanks by adding the interaction term between market-based INV and the EPU index to the regression. Drawing on the RBV and real options theory conceptual framework, this study addresses the impact of a company's financial performance on corporate environmental innovation and examines how EPU affects corporate environmental innovation and firm performance.

From an academic standpoint, this work adds to the body of knowledge in two ways. First, the presence of EPU clarifies the relationship between corporate environmental INV and the firm's FP. RBV and earlier studies on INV concentrate on the impact of environmental INV on FP (Guo & Wang, 2022); however, little is known about how EPU affects this relationship. This study addresses this gap, revealing that periods of high EPU significantly reduce the positive impact of corporate INV on a company's FP. This emphasises the importance of the operating environment in affecting corporate INV value and adds to the literature on INV, EPU, RBV, and real options theory (Abdul-Shukor et al., 2008; Borghesi & Chang, 2020; Gulen & Ion, 2015). Second, prior studies on INV often face limitations when drawing causal inferences between INV and firm performance because of inadequate INV proxies, namely patent count and R&D expenditure (Ranta et al., 2021). This study fills this gap by adopting a market-based measure of environmental INV developed by Bellstam et al. (2021), showing that corporate INV is positively associated with firm FP.

Environmental INV is a long-term, resource-intensive, uncertain development strategy (Tseng et al., 2013). When making decisions on environmental INV, the predictability of governmental laws and regulations is one of the most important factors (Li et al., 2021). EPU makes it difficult for firms to predict the timing, character, and possible impact of policy actions. In recent years, COVID-19 and Brexit have caused great uncertainty for firms; therefore, it is crucial to explore the economic consequences of policy uncertainty, particularly its impact on corporate decision-making with a focus on environmental INV.

Despite establishing a conceptual connection between EPU and corporate environmental INV, the empirical evidence remains unclear. According to the waiting-option view of real options theory, companies wait and see when there is much uncertainty and postpone investing in new projects, since such projects have high costs, take a long time, and cannot be undone (Hsu et al., 2014; Wang

et al., 2017). High levels of uncertainty impede corporate INV, as numerous empirical studies have demonstrated (Bhattacharya et al., 2017; Shankar, 2020; Xu, 2020; Cui et al., 2021). In contrast, the growth-option view contends that the worth of INV is assessed by how well it presents opportunities for firms to grow; over time, INV can boost a company's value and competitive advantages (Kulatilaka & Perotti, 1998). Firms are encouraged to innovate when the growth-option uncertainty value exceeds the waiting-option uncertainty value (Weeds, 2002).

This study investigates the connection between EPU and corporate environmental INV using the two theories that describe how uncertainty affects INV. Economic policy changes are frequent, resulting in high EPU in the stock market (Cheng et al., 2020). Environmental INV is significant in measuring sustainable development, wherein corporations play an important role, and emerging markets need environmental INV to advance environmental protection. The impact of environmental INV is examined in this paper as a key model for emerging economies.

2. LITERATURE REVIEW

2.1 Economic Policy Uncertainty and Financial Performance Nexus

Existing research shows that uncertainty generates a negative economic outlook; for instance, Alexopoulos and Cohen (2009) found that unstable economic conditions cause short, sharp recessions. Similarly, Sharma and Paramati (2021) documented a dampening effect of EPU on imports in the long run, while Leduc and Liu (2015) found that heightened uncertainty raises unemployment. Aye et al. (2019) observed that high levels of uncertainty weaken the effectiveness of monetary and fiscal policies. According to Al-Thaqeb and Algharabali (2019), EPU is the economic risk connected to future government policies and regulatory frameworks that are not yet specified. Regulatory institutions and politicians make decisions that directly and indirectly influence the environment where firms operate (Julio & Yook, 2012), and instability about the content and timing of fiscal or monetary policy changes significantly increases uncertainty about a business's future profitability (Zhang et al., 2015). High EPU is associated with reduced capital expenditure (Bloom, 2009), conservative pay-out policies (Walkup, 2016), increased cost of borrowing (Colak et al., 2017), more cash holding (Phan et al., 2019), and declined stock prices (Trung, 2019). Prior studies claim that EPU creates fear among decision-makers and consumers, inducing companies to freeze investment decisions and consumers to reduce expenses (Idnani et al., 2023; Madanoglu & Ozdemir, 2019).

Relatively few rigorous empirical studies, predominantly focusing on the US economy, have examined the influence of EPU on firms' FP. Iqbal et al. (2020) noted a negative impact of EPU on FP (Tobin's Q, return on equity, return on assets, and net profit margin) of US-listed non-financial firms. Likewise, Garcia-

Gomez et al. (2021) found that the FP of tourism companies in the US is adversely affected by EPU. Previous studies also confirm the heterogeneous impact of uncertainty shocks on food prices (Wen et al., 2021), INV decisions (Di & Han, 2023), inflation (Anderl & Caporale, 2023), and the stock market (Sharma, 2024). The asymmetric dynamics of interaction between EPU and FP have not been widely examined, and FP is influenced by numerous firm-specific factors such as environmental behaviour (Hou et al., 2022), R&D opportunities (Horra et al., 2022), growth prospects (Bhagat et al., 2016), and leverage (Bajaj et al., 2021). Consequently, this study delves deeper into exploring the effects of the interaction between EPU and INV on a firm's FP.

The study's contributions to the current body of literature are manifold. First, although mature literature focuses on the determinants of FP (Al-Homaidi et al., 2020; Mishra et al., 2021), the influence of EPU requires careful examination because the economic environment in which a firm operates changes continually. Second, to offer a more nuanced analysis of the effect of EPU on firms, the study uses market-based (Tobin's Q) measures of FP. Third, alternative specifications of EPU, namely lagged values of both domestic and global EPU, have been considered (Das & Kumar, 2018). Fourth, most prior studies investigating the EPU-FP link fail to consider relevant variables, leading to model misspecification and omitted-variable bias (Iqbal et al., 2020); this study combines the EPU index with firm-specific and macroeconomic variables. The S&P 1500 index has been chosen because it offers a unique opportunity to explore existing findings for a rapidly growing economy amid unprecedentedly high global uncertainty (Im et al., 2020) and frequent economic policy changes (Sharma & Paramati, 2021).

The present study measures FP using four proxies following Chen et al. (2012) and Garcia-Gomez et al. (2021): (1) return on assets (ROA), (2) return on equity (ROE), (3) net profit margin (NPM), and (4) Tobin's Q. EPU is measured using the index developed by Baker et al. (2016), which quantifies EPU through textual analysis of policy-related news articles. Uncertainty is an unobservable concept, and the literature has established several empirical strategies to proxy for it, including forecaster disagreement (Bachmann et al., 2013), estimated time-fixed effects reflecting common shocks (Gilchrist et al., 2014), Google trend data (Castelnuovo & Tran, 2017), and common components in the volatility of financial or macroeconomic variables (Carriero et al., 2018). Bloom (2009) and Choi et al. (2018) used aggregate stock market volatility as a proxy for country-specific uncertainty, while Ludvigson et al. (2016) distinguished between financial and macroeconomic uncertainty. Istrefi and Mouabbi (2018) employed interest-rate forecasts to build uncertainty measures across several countries, and Baker et al. (2016) developed EPU indexes for the US and other major countries based on newspaper coverage frequency.

Al-Thaqeb and Algharabali (2019) asserted that policy-induced uncertainty harms the economy at both micro- and macroeconomic levels because it diminishes investment motivation. Bordo et al. (2016) argued that EPU tightens constraints on bank financing, reducing bank credit growth, while Fernandez-Villaverde et al. (2015) found that a surprise fiscal volatility shock can reduce output by 1.5 percentage points. Mueller et al. (2017) suggested that uncertainty regarding future economic policy negatively affects currency exchange and financial markets, and Leduc and Liu (2016) documented that uncertainty resembles a negative aggregate demand shock that cuts inflation and raises unemployment. The effects of EPU also extend to gold prices (Balcilar et al., 2016), oil and futures markets (Fang et al., 2018), gasoline prices (Olanipekun et al., 2019), foreign investment (Al-Thaqeb et al., 2020), and bitcoin market volatility (Matkovskyy et al., 2020).

EPU is also a significant indicator of risk for the corporate sector because it adversely influences enterprises' consumption, employment, and investment (Yung & Root, 2019). According to Huang et al. (2015), companies experience financial difficulties during uncertain times, which leads them to cut back on or stop paying dividends. According to Arellano and Bonhomme (2016), US economic crises tightened firm financial conditions, as evidenced by higher credit spreads and decreases in debt purchases and equity dividends. According to Luo and Zhang (2019), excessive EPU in the Chinese A-share market increases the chance of stock-price crashes by causing more substantial volatility in cash flows and earnings. This strengthens managers' incentives to falsify financial information and smooth earnings. In a similar vein, Pastor and Veronesi (2012) suggested that stock values decline during high-EPU periods due to increased uncertainty regarding a company's future operations and profitability. According to Brunnermeier et al. (2009), financial market risk premiums are greatly increased by an unclear regulatory environment, which slows employment and productivity while increasing borrowing costs. Jens (2017) discovered that businesses usually put off investment initiatives before to presidential elections, and Bhattacharya et al. (2017) looked at 43 nations and found a significant decline in patenting during times of policy uncertainty around national elections. According to Gulen and Ion (2016), unstable economic situations force businesses to reduce capital investments; during the global financial crisis, capital investment in the US fell by 32%, especially among businesses that depend on government contracts or have irreversible assets. While Im et al. (2017) demonstrated that firms facing more uncertainty store around twice as much cash as firms facing lower uncertainty, Kelly et al. (2016) argued that external uncertainty increases firms' overall risk and encourages conservative investment behavior. While Nagar et al. (2019) described how uncertainty exacerbates information asymmetry among investors, Liao et al. (2019) found that during times of elevated EPU, the advantages of strengthening internal control outweigh

the costs, encouraging managers to do so. While the relationship between EPU and several company-level indicators has been thoroughly studied in the literature, the direct impact of EPU on firm performance has received far less attention. While Ahsan and Qureshi (2021) discovered a significant negative relationship between EPU and firm performance (Tobin's Q, ROE, and ROA), indicating that policy-induced uncertainty reinforces risk factors for managers and investors, Madanoglu and Ozdemir (2019) used Smith Travel Research data to demonstrate that EPU negatively influences the operating performance of hotels in the US. While Armstrong et al. (2011) argued that policy uncertainty increases information asymmetry between market participants and managers, raising the cost of capital and decreasing firm performance, Balcilar et al. (2016) noted reduced economic growth because EPU lowers an economy's total wealth and shrinks corporate profitability. According to Dichev and Tang (2009), organizations are unable to achieve their initial business plan due to growing uncertainty, which leads to repeated deviations from goals and performance swings.

Overall, evidence for the nexus between EPU and firm FP remains scant (Garcia-Gomez et al., 2021; Iqbal et al., 2020), and the available evidence is based largely on developed-country case studies that cannot be generalised to developing-country settings, given the substantially different economic structures involved. To overcome this, the present study uses a sample of companies within the S&P 1500 index, which provides a distinct opportunity to examine the EPU-FP link amid frequent policy turnover and secularly rising EPU (Chada, 2023). Thus, the study hypothesis is as follows:

Hypothesis 1 (H1): EPU has a negative effect on a firm's financial performance.

2.2 EPU, Corporate Environmental Innovation and a Firm's Financial Performance

Corporate environmental INV has a significant impact on an organisation's external environment. According to Bhattacharya, Hsu, Tian, and Xu (2017), the two primary factors promoting corporate INV are economic systems and market conditions. A growing number of researchers have focused on the impact of EPU on corporate environmental INV since Baker et al. (2016) measured EPU using newspaper coverage frequency. Most research indicates that corporate environmental INV is impeded by rising EPU. As per Xu (2020), an increase in EPU may result in a higher cost of capital, hence impeding corporate environmental INV. The adverse effects of EPU on corporate environmental INV can also be explained by operational risk and financial distress (Cui, Wang, Liao, & Fang, 2021). For firms with weak risk-taking capacities and whose CEOs have a low-risk preference, EPU has a negative impact on corporate environmental INV, according to Lou et al. (2022). Both breakthrough and incremental INV are

impeded by an increase in EPU, as confirmed by Wei (2022). Certain studies take a different stance: China's EPU positively impacted corporate environmental INV during the low-EPU era before 2008, but remained high and negatively impacted corporate environmental INV thereafter. According to Guan, Xu, Huo, Hua, and Wang (2021), market competition is a significant transmission channel, and EPU has a positive impact on corporate technology INV but a negative impact on corporate business-model INV.

Prior studies generally used EPU indicators developed by Baker et al. (2016) and Huang and Luk (2020); because these indicators are nationwide, it is difficult to reflect the EPU perceived by individual firms. Additionally, the current literature on EPU and INV mainly focuses on INV output, whereas few studies focus on INV efficiency. According to RBV, firms gain a competitive advantage through heterogeneous and immobile resources; however, whether corporate environmental INV improves firm performance remains under debate because of inadequate INV proxies. Much theoretical and empirical evidence documents that corporate environmental INV improves firm performance (Denlertchaikul, Chatjuthamard, Jiraporn, & Phiromswad, 2022).

For example, studies find that an increase in corporate environmental INV leads to increased firm profitability (Sougiannis, 1994), a positive impact on profit margin (Eberhart et al., 2004), an increase in market value (Armstrong et al., 2006), and an increase in intangible assets, which are frequently regarded as a form of INV (Kramer et al., 2011). Examples of intangible assets include intellectual capital, human capital, and process-related capital (Skinner, 2008). Empirical studies show that intangible assets add value to the firm, lower the cost of production, and are positively associated with firm performance (Riahi-Belkaoui, 2003); for instance, know-how and trademarks help firms strengthen their competitive advantage (Mohnen & Hall, 2013). Thus, it is generally believed that innovation-oriented firms are likely to outperform firms that are not innovation-driven (Hsu & Ziedonis, 2008).

Despite the numerous findings on the positive association between corporate environmental INV and firm performance, some studies argue that the high cost of INV investment may outweigh the benefits, since the INV development process requires considerable capital investment while carrying substantial risk (Chan et al., 2001). Only firms with sufficient capital and accumulated profit can absorb investment failure (Coad et al., 2016); investment in INV is therefore risky and challenging, exacerbating information asymmetry and conflicts of interest with financiers (Freel & Robson, 2004). Consequently, firms may face financial constraints while engaging in INV, and the increase in EPU indicates an increase in risk in the external environment more broadly (Pastor & Veronesi, 2013). This study extends the RBV framework by discussing the theoretical connection between EPU and the change in the association between corporate INV and firm

performance, with financing cost as the underlying mechanism. In the presence of EPU, intangible or INV-related assets would be less value-relevant compared to a standard operating environment (Abdul-Shukor et al., 2008).

When EPU is high, investment in environmental INV can be considered an acquisition of the firm's future growth, allowing the firm to gain a competitive advantage (Gilchrist et al., 2014). It is further concluded that innovative firms benefit from an increase in the value of a marginal unit of capital during periods of uncertainty. Thus, when EPU is high, firms with high environmental INV can better expand their existing market share and earn higher profits than firms with low corporate environmental INV, which lack a growth option (Vo & Le, 2017). Consequently, the growth-option model suggests that, in the presence of EPU, innovative firms will benefit more in terms of firm performance compared to non-innovative firms. Thus, the study hypotheses are:

H1a: Environmental innovation positively influences financial performance.

H1b: Environmental innovation mitigates the negative impact of economic policy uncertainty on financial performance.

2.3 Resource-Based View and Real Options Theory

This study's conceptual framework is grounded in the resource-based view (RBV) and real options theory.

2.3.1 Resource-Based View

The RBV was expanded by Awan et al. (2018). The RBV postulates that resources which are valuable, rare, difficult to imitate, and non-substitutable best position a firm for long-term success. Because resources related to INV are usually difficult to imitate, RBV suggests that INV may enhance a firm's competitive advantage and contribute to its FP. Examples of such resources include intangible assets, such as employee intelligence, skills, managerial insight, and improved production processes. This study adopts the RBV conceptual framework and extends it by examining how different operating environments, such as EPU, affect the contribution of innovative resources to a firm's FP.

2.3.2 Real Options Theory

The development of real options theory has been examined in both research reviews and practitioner manuals, and many management scholars have applied aspects of financial option theory to organisational settings (McGrath, 1999). The concept of real options has generated considerable interest in the management literature over the past decade (Adner & Levinthal, 2004; McGrath, 1999; Kogut & Kulatilaka, 2001). The waiting-to-invest strand of real options theory emphasises that uncertainty enhances the value of waiting, leading firms to delay

irreversible capital investments (Bloom, Bond, & Van Reenen, 2001). Similarly, Garcia-Gomez et al. (2021) proposed that a firm's financial margin is highly affected when uncertainty rises, damaging shareholders' interests and negatively influencing FP. According to real options theory, firms facing high levels of uncertainty are unlikely to invest without significant investment opportunities; the 2008 global financial crisis further highlighted the role that sentiment plays in firm investment decisions. This study proposes a conceptual model, illustrated in Figure 1, that integrates RBV and real options theory to explain the joint influence of EPU and environmental innovation on firm performance.

3. METHODOLOGY

3.1 Research Design

To investigate the impact of environmental innovation on firm FP in the presence of EPU, this study proposes the conceptual model outlined above, linking EPU, corporate environmental innovation, and financial performance through the lens of RBV and real options theory.

3.2 Data and Methodology

3.2.1 Variable Definitions

Economic policy uncertainty (EPU): This study develops EPU metrics for S&P 1500 enterprises using the methodology of Baker et al. (2016). EPU is a reflection of the difficulty to forecast future economic policies, including trade disputes, tax regimes, and election results.

Measuring innovation (INV): Historically, researchers have used patent activity and R&D spending as proxies for innovation (Hsu et al., 2014; Lerner et al., 2011). Nevertheless, these widely used proxies have serious drawbacks because they do not accurately reflect the type and extent of innovative output (Bellstam et al., 2021). Patent counts can only measure innovation output related to intellectual property, ignoring elements like new marketing strategies, organizational strategies, or external relationships that are not patentable (Moser, 2012), while R&D expenditure measures observable input but fails to capture the quality of innovation output (Aghion et al., 2013).

Firm's financial performance (FP): Based on previous research, the study uses Tobin's Q (Peters & Taylor, 2017), a market-based measure of FP that is most frequently used to examine the relationship between INV and firm FP. When compared to the traditional Tobin's Q, the market-based measure used provides a better proxy for firm performance since it captures firm-level estimations of intangible assets and represents how capital markets value the organization (Ayyagari et al., 2020). Because it takes measurement error in intangible capital into account, Peters and Taylor's (2017) q, which is computed

as the firm's market value divided by the total of its physical and intangible capital stocks, has been shown to be a superior proxy.

3.2.2 Data Sources

To acquire the requisite data for this study, we relied on the LSEG database. The data pertain exclusively to non-financial and non-utility firms listed on the S&P 1500 index from 2004 to 2023. Companies lacking five years of data were excluded to ensure that the sample was representative and accurate. Baker et al. (2016) quantified EPU for major countries and regions worldwide, with data accessible from the Economic Policy Uncertainty database; the index encompasses uncertainty related to taxation, expenditure, monetary, and regulatory policy, derived from the frequency of economic-policy mentions in newspapers, the number of expiring tax code provisions, and forecaster disagreement regarding future inflation and government expenditure. This study measures firm FP using Tobin's Q, consistent with Chen et al. (2012), Chen and Lin (2015), Garcia-Gomez et al. (2021), and Iqbal et al. (2020). Since EPU data is recorded monthly while financial information is reported quarterly, semi-annually, or annually, monthly EPU values were converted into annual EPU data by averaging monthly values. Firm-specific data, namely Tobin's Q, were obtained from the S&P 1500 index database.

3.3 Empirical Models

The initial model includes all the study's independent variables and tests their effect on financial performance (Tobin's Q). Model 2 tests the interaction effect of innovation and EPU.

Model 1:

$$\text{Tobin's Q} = \beta_1 \text{SIZE} + \beta_2 \text{LEV} + \beta_3 \text{ESG} + \beta_4 \text{SOC} + \beta_5 \text{ENV} + \beta_6 \text{GOV} + \beta_7 \text{INV} + \beta_8 \text{AGE} + \beta_9 \text{EPU} + \alpha$$

Model 2:

$$\text{Tobin's Q} = \beta_1 \text{SIZE} + \beta_2 \text{LEV} + \beta_3 \text{ESG} + \beta_4 \text{SOC} + \beta_5 \text{ENV} + \beta_6 \text{GOV} + \beta_7 \text{INV} + \beta_8 \text{AGE} + \beta_9 \text{EPU} + \beta_{10} (\text{INV} \times \text{EPU}) + \alpha$$

Blundell and Bond's (1998) System GMM methodology was also applied, using a two-step robust estimation approach with Windmeijer (2005) corrections. This approach effectively captures the dynamic nature of the model and enables estimation of the speed of adjustment while mitigating heteroscedasticity, autocorrelation, and endogeneity.

System GMM Model:

$$\text{Tobin's Q}_{it} = \gamma \text{Tobin's Q}_{i(t-1)} + \beta_1 \text{SIZE}_{it} + \beta_2 \text{LEV}_{it} + \beta_3 \text{ESG}_{it} + \beta_4 \text{SOC}_{it} + \beta_5 \text{ENV}_{it} + \beta_6 \text{GOV}_{it} + \beta_7 \text{AGE}_{it} + \beta_8 (\text{INV}_{it} \times \text{EPU}_{it}) + \alpha_i + \lambda_t + \varepsilon_{it}$$

In this model, Tobin's Q represents the dependent variable for firm *i* at time *t*, while the lagged Tobin's Q captures dynamic effects. The independent variables include firm-specific factors such as SIZE, LEV, ESG, SOC, ENV, GOV, AGE, and INV. The interaction term (INV × EPU) accounts for the combined effect of investment and economic policy uncertainty. The model incorporates firm-specific effects (α_i), time-specific effects (λ_t), and an error term (ε_{it}) to capture unobserved heterogeneity and stochastic variation.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics, offering details such as the count, mean, variance, standard deviation, minimum, maximum, and sum of the variables.

Table 1. Descriptive Statistics

Variable	Count	Mean	Variance	SD	Min	Max	Sum
SIZE	26,447	22.14031	3.443894	1.855773	6.907755	28.89567	585544.7
TOBIN's Q	24,796	22.07896	2.867037	1.693233	6.925111	32.09281	547469.9
LEV	22,836	-0.62175	2.523534	1.588634	-13.2992	7.664587	-14198.3
ESG	17,775	45.95915	384.4106	19.60639	0.598597	95.16237	816923.8
SOC	17,775	47.74812	464.6955	21.5568	0.263458	98.1409	848722.9
ENV	17,775	35.66235	783.6052	27.99295	0	98.54581	633898.3
GOV	17,775	53.52312	477.5092	21.85198	0.249062	99.39944	947818.5
INV	17,775	22.45937	895.562	29.92594	0	99.89712	399215.4
Age	28,520	23.86606	758.6012	27.54272	0	170	680660
EPU	28,620	142.1528	3025.685	55.00622	67.13629	326.3201	4068412

Note: LEV = Leverage; ESG = Environmental, Social, Governance composite; SOC = Social; ENV = Environmental; GOV = Governance; INV = Innovation; EPU = Economic policy uncertainty.

With 26,447 observations, the SIZE variable has a mean value of 22.14 and a comparatively low variation, indicating a moderate distribution of firm sizes around the mean. Some businesses have a negative debt-to-equity ratio, as indicated by the negative mean for LEV. Each of the three subcomponents of the ESG composite—SOC, ENV, and GOV—has 17,775 observations; the average scores for SOC, ENV, and GOV are 47.75, 35.66, and 53.52, respectively, indicating medium levels of social, environmental, and governance performance. Businesses with nearly no INV and businesses with extremely high INV values are represented by the skewed distribution of the INV variable, which has a relatively low mean but a significant variance. EPU has a mean of 142.15 with a standard deviation of 55.01, indicating significant volatility in policy uncertainty

during the sample period, and firm age varies significantly over the sample. These moments serve as a basis for checking for outliers and determining standard errors

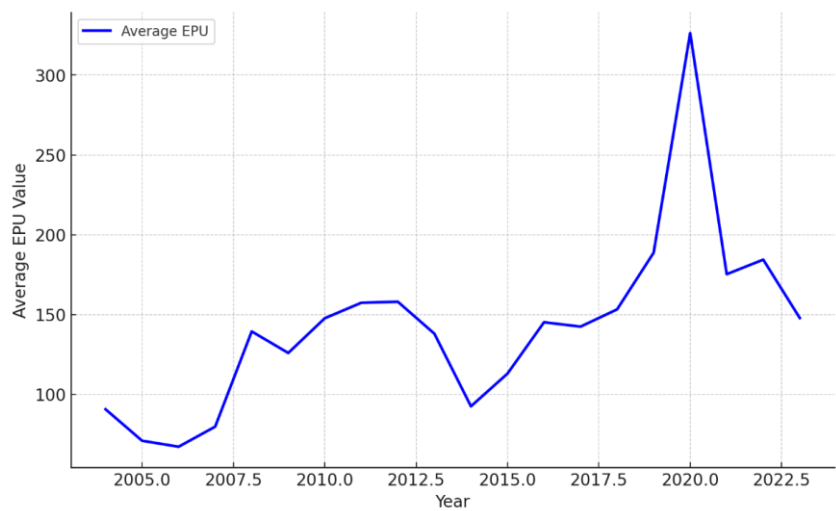


Figure 1. EPU Over Time

Significant variation over the sample period is highlighted by the EPU index displayed in Figure 1. In contrast, periods of low EPU may indicate a recovering economy or increased political and policy stability; larger values indicate higher levels of uncertainty, which may be linked to urgent social issues, economic and political instability, or major policy changes. Because high EPU increases a company's susceptibility to risk, it may deter investment, entrepreneurship, and growth. Policymakers can use this information to identify the causes of uncertainty and take action to promote economic stability.

4.2 Correlation Results

The correlation coefficients between the research variables are shown in Table 2. Firm size and market performance are significantly correlated, as evidenced by the high positive correlation of 0.7117 between SIZE and Tobin's Q. While LEV has comparatively low coefficients with the other variables, indicating a limited influence within this dataset, ESG and SOC have a significant correlation of 0.889, ESG and ENV correlate at 0.751, and ESG and GOV correlate at 0.682. Tobin's Q (-0.0706) and ESG (0.156) do not co-vary much with EPU, and the typically modest correlations suggest that multicollinearity is not a significant concern for the ensuing econometric research.

Table 2. Correlation Matrix

Variable	SIZE	T's Q	LEV	ESG	SOC	ENV	GOV	INV	AGE	EPU
SIZE	1									
TOBIN's Q	0.7117	1								
LEV	0.2214	0.0615	1							
ESG	0.4438	0.4878	0.1242	1						
SOC	0.4119	0.4823	0.1162	0.889	1					
ENV	0.503	0.5021	0.1326	0.8697	0.7513	1				
GOV	0.2241	0.2036	0.0723	0.682	0.3817	0.4087	1			
INV	0.2551	0.2982	0.0982	0.547	0.4296	0.6901	0.2464	1		
AGE	0.1044	0.1499	0.0326	0.1608	0.1481	0.1425	0.0983	0.0976	1	
EPU	0.0758	0.0706	0.0051	0.156	0.1436	0.1495	0.0845	0.1068	0.0097	1

4.3 Regression Results

Table 3 presents the OLS regression results for two models of firm-level antecedents and their effect on performance. Firm size (SIZE) has the highest positive coefficient (0.754***), while leverage (LEV) has a consistently negative coefficient (-0.127***), indicating that higher leverage is associated with lower performance. Among the ESG components, ENV is significantly positive and stable (0.004***), and SOC is positive but less strongly significant (0.003*), while governance (GOV) appears only marginally relevant. In Model 1, INV has a significantly negative effect (-0.002***), while in Model 2 the interaction term (INV×EPU) has a positive coefficient (0.001***), showing that EPU moderates the relationship between investment and performance. EPU itself has a direct, negative impact on performance in both models (-0.005***). The adjusted R-squared values of 0.73 and 0.74 for Models 1 and 2, respectively, indicate that the models explain a substantial share of performance variability, and that firm size, leverage, and environmental performance are critical determinants of firm performance.

Table 3. OLS Regression Results

Variable	Model 1	Model 2
SIZE	0.754*** (0.006)	0.754*** (0.006)
LEV	-0.127*** (0.005)	-0.127*** (0.005)
ESG	0.004 (0.003)	0.004 (0.002)
SOC	0.003* (0.001)	0.003* (0.001)
ENV	0.004*** (0.001)	0.004*** (0.001)
GOV	-0.002* (0.001)	-0.002
INV	-0.002*** (0.000)	-0.005*** (0.000)

Variable	Model 1	Model 2
AGE	0.022*** (0.002)	0.022*** (0.002)
EPU	-0.005*** (0.001)	-0.005*** (0.001)
INV × EPU	—	0.001*** (0.000)
Constant	6.437*** (0.207)	6.450*** (0.206)
Observations	15,796	15,796
Adjusted R ²	0.73	0.74

Note: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 4 reports the System GMM results, focusing on the dynamic relationship among the variables. The coefficient on lagged Tobin's Q is highly significant (0.813***), indicating strong persistence in firm performance. Firm size has a positive and significant influence (0.316*), while leverage exerts a negative but insignificant effect (-0.034). The ESG composite shows a negative coefficient (-0.054**), suggesting that higher ESG scores may be associated with reduced short-term FP, whereas its social (0.019*), environmental (0.018**), and governance (0.016**) subcomponents each exert a positive and significant effect. Firm age is positive and significant (0.016*), suggesting that firm maturity is associated with stronger performance. The interaction term (INV×EPU) is negative and significant (-0.517), indicating that investment tends to generate inefficiencies when EPU is elevated. Year and industry effects are included to account for time- and sector-fixed differences. The first-order serial correlation test is confirmed, while the second-order test is not significant, supporting the model specification; the Hansen test (p = 0.40) confirms that the instruments are valid and that the model is not over-identified. With 7,200 observations across 864 cross-sections, the model yields a satisfactory F-statistic of 25.65 (p < 0.01).

Table 4. System GMM Results

Variable	Coefficient
Lagged Tobin's Q	0.813***
SIZE	0.316*
LEV	-0.034
ESG	-0.054**
SOC	0.019*
ENV	0.018**
GOV	0.016**
AGE	0.016*
INV × EPU	-0.0517*

Variable	Coefficient
Year effects	Yes
Industry effects	Yes
Observations	7,200
F-statistic	25.65
F-statistic (p-value)	0.00
AR(1)	-10.30
AR(1) p-value	0.00
AR(2)	0.98
AR(2) p-value	0.45
Hansen statistic	6.13
Hansen p-value	0.40
Number of cross-sections	864
Number of instruments	50

*Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

5. DISCUSSION

Environmental INV is a component of innovation more broadly and is one of the strategies for fostering sustainable growth (Ilyas & Osiyevskyy, 2022). Additionally, environmental INV supports the growth of sustainable businesses since it may have a favourable effect on a company's FP (Hashemi et al., 2015). Given the scarcity of studies on corporate environmental INV strategies, offering direction and recommendations to relevant groups is complex. This study evaluated the impact of EPU and environmental INV on the FP of listed S&P 1500 index companies. The findings are consistent with Iqbal et al. (2020), who concluded that a rise in EPU leads to more significant risk factors in the sentiments of corporate managers and investors (Idnani et al., 2023), and hence a firm's FP declines. Further, the waiting-to-invest strand of real options theory emphasises that uncertainty enhances the value of waiting, so firms delay irreversible capital investments (Bloom, 2001). Similarly, Garcia-Gomez et al. (2021) proposed that a firm's financial margin is highly affected when uncertainty rises, damaging shareholders' interests and negatively influencing FP.

The findings indicate that environmental INV changes the adverse effects of EPU into more positive outcomes, thereby positively affecting a firm's FP. RBV and real options theory can both be used to explain the positive impact of environmental INV on a company's FP (Prakash, 2002). Process and product INV are both considered environmental organisational resources under RBV (Cheng et al., 2014); because environmental process INV is process-oriented and

environmental product INV is product-oriented, businesses applying both complementary approaches gain a more significant competitive advantage. By incorporating the interests of external parties rather than only the firm's financial objectives, environmental INV helps a firm win the trust and support of external institutions and key stakeholders (Prakash, 2002). Environmental INV is a specialised instrument for achieving sustainable development, presenting a chance to minimise conflicts of interest, increase stakeholder confidence, and strengthen the firm's social standing.

The findings show positive and significant associations between firm FP and Tobin's Q, demonstrating that the strong positive effect of environmental INV on FP contributes to profitability and growth in market value, supporting the RBV framework (Guesalaga et al., 2018). The fact that a decrease in EPU positively impacts businesses' FP shows that investing in environmental INV can be profitable, consistent with several empirical investigations that report a positive linear relationship between environmental INV and FP. This study contributes to the literature in several ways. First, many empirical studies rely on questionnaires rather than openly accessible, objective data to analyse organisational performance (Wang & Sarkis, 2013); this study is among the few to use publicly accessible, objective data from the S&P 1500 index. Moreover, while a few studies have considered only the time effect (Tamayo-Torres et al., 2019), this study uses panel data to explore the relationship between EPU, environmental INV, and FP within the S&P 1500 index, adding a novel contribution to the body of literature.

6. CONCLUSION AND IMPLICATIONS

This study examined the impact of EPU on environmental INV and FP using data from S&P 1500 index firms. The results show a significant negative relationship between EPU and FP. Additionally, the study examined the moderating effect of environmental INV on the impact of EPU on FP, finding evidence that EPU exacerbates the decline in FP, while environmental innovation mitigates this negative impact. Using System GMM estimation, EPU is found to be negatively associated with Tobin's Q. The empirical results imply that awareness of the unfavourable impact of increased policy-induced information asymmetry is necessary to guard against declining FP.

Accordingly, managers must conduct annual risk assessments to ensure that the influence of EPU is properly considered. Before or during uncertain periods, managers can adopt cost-saving behaviours, such as postponing investment decisions, holding less inventory, and reducing labour staffing, alongside flexible policies that permit rapid adjustment of firm activity. Since rising EPU is expected to reduce customer demand as consumers exercise greater caution (Yung & Root, 2019) while firms continue to bear higher fixed costs, firms should also consider diversifying their customer portfolios by targeting groups

less sensitive to EPU. Notably, the negative relationship between EPU and a firm's FP can be observed even after a lag of one year. Overall, the results suggest that governments should aim to be more predictable and transparent in their economic decision-making in order to build a stable financial environment and prevent harm to business, given the more pronounced impact of global EPU on firm performance relative to domestic EPU. Governments should consider providing tax incentives, creating refinancing options, and opening new credit channels to protect firms from foreign or global uncertainty.

Finally, this study examined whether INV moderates the EPU-FP link and discovered that the negative impact of EPU is lessened by the interaction term between EPU and INV on Tobin's Q, with the negative impact of EPU being more noticeable for highly indebted enterprises. These findings imply that in order to prevent the negative effects of uncertainty, managers should keep a sufficient capital structure and take proactive measures. More precisely, as highly leveraged enterprises are more vulnerable to uncertainties and have limited access to capital, it is critical to establish new credit channels for them.

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CHAPTER 13

Digitalization, Institutions and Economic Development

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1. Introduction

The causes of cross-country differences in economic performance have long been debated, with existing studies highlighting the roles of geography, culture, capital accumulation, and technological progress. (Solow, 1956; Weber, 2005; Gallup et al., 1998; Mankiw et al., 1992; Diamond, 2004; Landes, 2017). The models developed by Lucas (1988), Romer (1990), and Barro (1990), among others, show that long-run economic performance depends on changes in factors such as human capital, technological progress, innovation, and government expenditures, which continuously affect the productive capacity of an economy. Most of these models suggest that sustained economic growth requires continuous factor accumulation or technological improvement. Therefore, cross-country differences in economic performance are generally attributed to differences in physical capital, human capital, technology, and productivity. However, these models provide limited explanations regarding the deeper factors that determine why some countries are more successful in accumulating capital, adopting new technologies, and increasing productivity. In this respect, institutions, as the set of rules and constraints defining the forms of social, economic, and political interactions, constitute one of the main factors that may explain the emergence and persistence of these differences (Acemoglu and Robinson, 2013).

Traditional growth models generally assume that the economy operates in a frictionless environment in which economic agents can engage in productive activities without facing significant information, communication, or transaction costs. They also implicitly assume that property rights are clearly defined and that economic transactions can be carried out without the risk of contractual violations. However, in real world, property rights are not always perfectly defined, and economic transactions are subject to various costs arising from uncertainty, information asymmetries, unequal bargaining power, and monitoring and enforcement problems (North, 1991: 98–102). These problems may discourage saving and investment or prevent available financial resources from being allocated to their most productive uses. Inclusive institutions may reduce uncertainty, secure property rights, protect investors, and improve the allocation of financial resources. In contrast, weak institutions may increase transaction costs, create uncertainty, and direct resources towards less productive activities. Therefore, institutions affect not only the amount of investment in an economy but also the efficiency with which savings and financial resources are transformed into productive capital.

At the same time, the rise and increasing adoption of digital technologies, commonly referred to as digitalization, have transformed the international economic system and affected economies at a rapid pace (Labhard and Lehtimäki, 2022). Digital technologies have influenced various areas, including labour markets (Bührer and Hagist, 2017), education (Haleem et al., 2022), sustainability (Seele and Lock, 2017), and energy sector (Xu et al., 2022). More recently, a growing literature has examined the relationship between digitalization and economic growth. Several studies suggest that information and

communication technologies contribute positively to gross domestic product, productivity, and economic development (Norton, 1992; Röller and Waverman, 2001; Vu, 2011). Digitalization may support economic growth through several channels. It can reduce information, communication, search, and transaction costs, improve access to financial services, and facilitate the transfer of funds between savers and investors. Digitalization can contribute to capital accumulation by improving the efficiency of financial intermediation and by making it easier to direct available savings towards productive investments.

However, the economic effects of digitalization are not the same across all countries. Previous studies indicate that the impact of digitalization may depend on the development level and the economic and institutional characteristics of a country (Habibi and Zabardast, 2020; Myovella et al., 2020). Overall, the empirical evidence remains mixed. These differences may arise from country groupings, methodological approaches, and model specifications. Nevertheless, the mixed results may also indicate that digitalization alone is not sufficient to generate economic growth. Its economic benefits may depend on whether countries have the institutional conditions required to support digital transactions and productive investment. Therefore, digitalization and institutional quality can be considered complementary factors that jointly determine the efficiency of capital accumulation.

Based on this argument, this paper extends the Solow growth model by incorporating digitalization and institutional quality into the capital accumulation process. The main argument is that these factors improve the efficiency with which savings and financial resources are transformed into productive capital. Digitalization reduces communication, information, and transaction costs, while high-quality institutions reduce uncertainty, enforcement problems, and the risk of resource misallocation. The theoretical model predicts that higher levels of institutional quality and digitalization increase the steady-state levels of capital stock and output per capita. Economies with stronger institutions and more developed digital infrastructure are also expected to experience faster economic growth during the transition towards their steady states. In this respect, the paper provides a theoretical explanation for why countries with similar saving rates may experience different levels of capital accumulation and economic prosperity. It also offers a theoretical framework that may provide a foundation for future empirical research on the joint effects of institutions, public trust, and digitalization on economic growth.

2. Theoretical Model

This section introduces a theoretical model demonstrating how digitalization and institutional quality jointly affect the capital formation and production through determining the level of transaction/information costs in the economy. As stated above, the model presented in this section is an augmented version of the Solow growth model which assumes that capital markets are operating in a frictionless environment and therefore total investment should be equal to total savings. Unlike the original Solovian framework, the model below suggests a

more realistic structure that incorporates possible effects of digital infrastructure and institutions on savings-investment relationship.

The output production in the model economy is characterized by the following form of the Cobb-Douglas function:

$$(1) \quad Y(t) = K(t)^\alpha [A(t)L(t)]^{1-\alpha}, \quad (0 < \alpha < 1)$$

where Y is output, K is the stock of physical capital, L is labor, A is the level of technology, and α is the capital elasticity of output. Equation (1) indicates that output production shows constant returns to scale and depends on three different factors: capital stock, labor force, and technology. For simplicity, it is assumed that technology and population is growing at an exogenous rate of x and n , respectively:

$$(2) \quad A(t) = A(0)e^{xt},$$

$$(3) \quad L(t) = L(0)e^{nt}.$$

The distinctive assumption of the model is that the capital market is subject to transaction/information costs. That is, total savings cannot be turned into physical investments on a one-to-one basis, as in the Solow model. Instead, the transmission process is imperfect and only a fraction of savings can be converted into investments:

$$(4) \quad vS(t) = I_K(t) \Rightarrow vSY = I_K. \quad (0 < v \leq 1; 0 < s < 1)$$

Here, S is total savings, I_K is gross capital investments, s is the savings ratio, and v is the capital market efficiency rate. Equation (4) suggests that a portion of savings, $(1 - v)$, is allocated to cover existing transaction costs in the capital market while financing new investments. Accordingly, the capital accumulation process in the model is described as follows:

$$(6) \quad \dot{K}(t) = vSY - \delta K \quad (0 < \delta < 1)$$

where $\dot{K}$ stands for the change in capital stock and δ denotes the depreciation rate.

The model assumes that capital market efficiency, v , is not merely an artificial constant but rather a function of several key variables, such as digital infrastructure and institutional quality, that shape the economic environment. Formally,

$$(7) \quad v = h(Q, D) = Q^\theta D^\rho. \quad (0 < Q, D \leq 1; 0 < \theta, \rho < 1) \quad \text{and} \quad (v_Q > 0; v_D > 0).$$

Here, Q is the quality of the institutional structure, D is the development level of digital infrastructure, and θ and ρ , respectively, denote the weights of institutional factors and digitalization. Equation (7) implies that institutional quality and digitalization have positive effects on the transmission mechanism in the capital market: high-quality institutions, combined with well-developed digital infrastructure, can lower transaction costs and foster capital formation.

Therefore, the model here suggests that savings ratio is not the only determinant of capital accumulation as in the Solow model. Indeed, cross-country differences in investments can stem from differences in institutional and digital infrastructure.

Assuming $\hat{y} = \frac{Y}{AL}$, and $\hat{k} = \frac{K}{AL}$, the intensified form of the production function can be written as follows:

$$(8) \quad \hat{y}(t) = \hat{k}(t)^\alpha.$$

Substituting (7) and (8) in the capital accumulation function in per effective terms will give the following equation of motion:

$$(10) \quad \dot{\hat{k}} = Q^\theta D^\rho s \hat{k}^\alpha - (x + n + \delta) \hat{k}.$$

To solve the model, the economy is assumed to be at its steady-state equilibrium ($\dot{\hat{k}} = 0$). Under this assumption, equation (10) provides the following results for capital stock and output per capita in the long run:

$$(11) \quad k^*(t) = A(t) \left(\frac{s Q^\theta D^\rho}{x+n+\delta} \right)^{1/(1-\alpha)},$$

$$(12) \quad y^*(t) = A(t) \left(\frac{s Q^\theta D^\rho}{x+n+\delta} \right)^{\alpha/(1-\alpha)},$$

where $k^* = \frac{K}{L}$ and $y^* = \frac{Y}{L}$. Equations (11) and (12) summarize the theoretical implications of the present model. According to these equations, cross-country differences in per capita capital stock and output are determined by several key variables. Similar to the Solow model, the results indicate that capital formation and income are positively associated with higher saving rates, highlighting the critical role of savings in shaping economic prosperity. Equations (11) and (12) also show that productivity level, A , is expected to affect capital accumulation and income positively. Moreover, the model suggests that the effective depreciation rate, $(x + n + \delta)$, is negatively correlated with income level: the higher the rates of population growth, technological progress, and depreciation, the lower the output per capita in the long run.

Besides the traditional Solovian variables, the results emphasize the role of capital market structure on capital accumulation and economic development. The equations derived from the model suggest that high-quality institutions are conducive to capital formation and output production. In other words, countries having inclusive institutions are likely to have higher levels of capital and income in the long run. Additionally, the theoretical results indicate that developing better digital infrastructure pays off in the long term: Economies with more advanced digital technologies that reduce transaction/information costs would have higher capital stock and income compared to their counterparts.

Taken together, the results above have several important implications regarding the convergence hypothesis. First, the model points to the fact that capital stock and output can vary across countries due to the differences in

structural factors. For instance, equation (12) shows that even among a group of countries having similar Solovian properties, variations in institutional and digital structures could lead to substantial differences in income levels. Indeed, the model predicts that such income disparities may persist or widen over time unless there is convergence in the structural factors influencing capital markets. Second, the model indicates that low savings rates may not be the only reason for a slow pace of capital accumulation. The results show that low-quality institutions and digital technologies can hinder transmission mechanism from savings to investments and lower capital stock in the long run.

The implications of the model for the growth rate are more complex than its level effects. Since output per effective worker, $\hat{y}$, is constant at steady-state, the model predicts that per capita output (or capital) grows at the rate of technical change, x in the long run. Formally,

$$(13) \quad g_y = g_A = x.$$

Equation (13) shows that long-run economic growth depends solely on technological progress, as envisaged by the original Solow model. However, this finding does not mean that other factors have no growth implications. On the contrary, the model at hand reveals that both Solovian variables and structural factors have significant impacts on economic growth during the transitional period. This result can be shown explicitly by the following convergence equation derived from the model:

$$(14) \quad \ln y(t) - \ln y(0) = (1 - e^{-\lambda t}) \left[\ln A(0) - \ln y(0) + \left(\frac{\alpha}{1-\alpha} \right) \ln s + \left(\frac{\alpha\theta}{1-\alpha} \right) \ln Q + \left(\frac{\alpha\rho}{1-\alpha} \right) \ln D - \left(\frac{\alpha}{1-\alpha} \right) \ln(x + n + \delta) \right] + xt.$$

where $\lambda = (1 - \alpha)(x + n + \delta)$, showing the speed of convergence. In a more compact form, this equation can be rewritten as follow:

$$(15) \quad \ln y(t) - \ln y(0) = \mu - \beta_1 \ln y(0) + \beta_2 \ln s + \beta_3 \ln Q + \beta_4 \ln D - \beta_5 \ln(x + n + \delta)$$

$(\mu = [(1 - e^{-\lambda t}) \ln A(0)] + xt, \beta_i \text{ is coefficient on variable } i).$

Equations (14) and (15) demonstrate that the growth process is governed by several key variables during the transitional period. For instance, the results show that the growth rate is negatively associated with the initial income level: Countries with lower income levels are expected to grow faster, highlighting the potential advantage of starting behind in the development race. The results also reveal that higher saving rates combined with a lower effective depreciation rates can speed up the convergence process. Furthermore, the equations above reveal the critical role of structural factors in economic progress. As shown in (14) and (15), an economy having high-quality institutions and advanced digital infrastructure is expected to record a faster growth rate until reaching its steady state. In this respect, these results imply that institutions and digitalization level would have not only *level* effects but also *growth* effects, in the short run.

Depending on the length of the transition period, these growth effects might be quite sizeable and even reverse the convergence process. For instance, an initially poor country might fail to catch up with high income levels of previously prosperous country if it is characterized by weak institutions or having a poor digital infrastructure, which together would either totally or partially offset its potential advantage. Accordingly, the theoretical model developed here provides a partial explanation for the empirical phenomenon of lack of convergence among income levels across the world.

3. Conclusion

This study develops an extended version of the Solow growth model to examine the role of digitalization and institutional quality in capital accumulation and economic development. The main argument is that economic performance depends not only on the amount of savings available in an economy but also on the efficiency with which these savings are transformed into productive investments. By incorporating institutional quality and digitalization into the capital accumulation process, the model provides a theoretical framework for explaining how differences in the economic and institutional environment may contribute to variations in capital formation, income levels, and economic growth across countries.

The theoretical results suggest that both institutional quality and digitalization positively affect the steady-state levels of physical capital and output per capita. While digitalization can reduce information, communication, and transaction costs, high-quality institutions can reduce uncertainty, protect property rights, and facilitate economic transactions. Through these mechanisms, both factors improve the efficiency of capital markets and increase the proportion of savings converted into productive investments. Accordingly, economies with better institutional structures and more developed digital infrastructure are expected to achieve higher steady-state levels of capital and income, even when they have similar saving rates and other characteristics. This finding suggests that differences in saving rates alone may not sufficiently explain the observed variations in capital accumulation and economic development across countries.

The model also provides implications for economic growth and convergence. Consistent with the original Solow framework, the long-run growth rate of output per capita remains determined by exogenous technological progress. However, institutional quality and digitalization can influence economic growth during the transition towards the steady state. By improving the efficiency of capital accumulation and raising the steady-state level of income, these factors can contribute to higher transitional growth rates. The model therefore distinguishes between the long-run level effects of institutional quality and digitalization and their growth effects during the transitional period.

These results also have implications for understanding income differences and convergence across countries. The model suggests that economies with similar initial income levels and saving rates may follow different growth paths depending on their institutional and digital characteristics. In particular, countries

with weak institutions and less developed digital infrastructure may experience lower capital accumulation and converge towards lower steady-state income levels. Consequently, lower initial income does not necessarily guarantee that an economy will catch up with more developed countries. Differences in institutional quality and digitalization may therefore help explain why income disparities persist across countries, even when the tendency towards conditional convergence remains consistent with the neoclassical growth framework.

The findings offer several implications for economic policy. First, policies aimed at increasing domestic savings and investment should also consider the institutional and structural conditions that influence the allocation of financial resources. Improving the protection of property rights, reducing uncertainty, and strengthening the institutional environment may contribute to a more efficient transformation of savings into productive capital. Second, investment in digital infrastructure may support capital formation by reducing information and transaction costs and facilitating financial transactions. However, the theoretical framework also suggests that the potential benefits of digitalization should be considered together with institutional quality. Therefore, policies promoting digitalization and institutional development may complement traditional measures aimed at encouraging capital accumulation and economic growth.

Finally, this study is theoretical in nature, and its implications remain to be examined empirically. Future research could investigate whether institutional quality and digitalization influence economic growth through their effects on the efficiency of capital accumulation. In particular, empirical models incorporating the interaction between institutional quality and digitalization could provide further insights into their joint effects on investment and economic performance. Such analyses would also help determine whether the mechanisms proposed in this study differ across countries with varying levels of economic development. In this respect, the theoretical framework developed here provides a basis for further research on the relationship between digitalization, institutions, capital formation, and economic growth.

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